MSE | MASTER OF SCIENCE IN ENGINEERING

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Master of Science in Engineering

Module Descriptions
Modulbeschreibungen
Descriptions de module

Valid for academic year
Gültig für akademisches Jahr
Valable pour l'année académique

2026-27

Module Description, available in: EN

Academic Writing and Presenting

General Information

Number of ECTS Credits

3

Module code

CM_AcWritPre

Valid for academic year

2026-27

Last modification

2021-02-04

Coordinator of the module

Hanspeter Schmid (FHNW, hanspeter.schmid@fhnw.ch)

Explanations regarding the language definitions for each location:

- Instruction is given in the language specified for each location and module execution.
- Documentation is available in the language(s) listed for each location and module execution. If the documentation is in multiple languages, the percentage distributed is indicated (100% = all documentation provided).
- The examination, including both questions and answers, is provided entirely (100%) in the language(s) specified for each location and module execution. The exams are on-site.

	Lausanne			Lugano	Zurich		
Instruction	**X** E 100%				**X** E 100%		
Documentation	**X** E 100%				**X** E 100%		
Examination	**X** E 100%				**X** E 100%		

Module Category

CM Context module

Profile Recommendations

This module is recommended for the following profiles:

	Lausanne	Zurich
Profile	CE, CS, DS, ICS	EIE, ICS, Pho

Lessons

2 lecture periods and 1 tutorial period per week

Entry level competences

Prerequisites, previous knowledge

English level B2 (CEFR)

Brief course description of module objectives and content

The goal of this module is to help students to further develop their knowledge and skills in academic writing and presenting through the medium of English. Students will learn what it means to write academic texts and to present to an audience in an accurate, appropriate, and convincing manner. The module is divided into a writing and a presenting part.
The writing part of the module focuses on key document types students are expected to master in their academic and professional careers. Using examples and engaging students in practical exercises, the writing part particularly highlights the importance of the academic argument, analysing its structure, components and styles. It looks at how arguments can be built into bigger text blocks that form part of academic text types such as abstracts, introductions, analyses, and others.

The presenting part of the module focuses on how to prepare and deliver academic presentations. How much detail is necessary? Which sources should be referenced? What information should be included in the presentation slides? How do I create interest in the topic? In this second part of the module, the emphasis will be placed on argumentation techniques but also highlight appearance, self-confidence, clarity and orientation to the audience.
Students are encouraged to work on real writing and presentation projects in English as part of the course.

Aims, content, methods

Learning objectives and competencies to be acquired

At the end of the module, students are able

- to produce academic texts in writing and speaking, paying attention to accuracy, argumentation and the intended target audience;
- to reflect critically on the quality of academic texts, both in speaking and writing;
- to assess writing and presentation abilities, using appropriate instruments for self- and peer-assessment;
- to gain some understanding for possible future development in the area of academic writing and presenting.

Module content with weighting of different components

Academic writing

- Academic writing style (vocabulary, sentence formation, linking, etc.)
- Academic text types and their structure
- Academic publishing
- Academic argumentation
- Reader orientation in writing
- Writing as a process in applied research

Academic presenting

- Presenting as telling a story
- Visual and textual aids during presentation
- Rhetorical clarity
- Presenting in a convincing and enthusiastic manner
- Handling stage fright

Teaching and learning methods

- Blended learning, plenary lectures
- Self-study project
- Work in small groups

Literature

A reader will be provided at the start of the semester.

Assessment

Additional performance assessment during the semester

The module contains additional performance assessment(s) during the semester. The achieved mark of the additional performance assessment(s) applies to both the regular and the resit exam.

Description of additional performance assessment during the semester

Within the semester, three quizzes and/or individual work assignments (writing and presenting) contribute a total of 30% to the final mark as detailed in the syllabus handed out at the start of the term. The final exam then contributes the remaining 70% to the final mark.

Basic principle for exams

As a rule, all standard final exams are conducted in written form. For resit exams, lecturers will communicate the exam format (written/oral) together with the exam schedule.

Standard final exam for a module and written resit exam

Kind of exam

Written exam

Duration of exam

120 minutes

Permissible aids

Aids permitted as specified below:

Permissible electronic aids

Open Internet.
ChatGTP can be used, but must be referenced. If an answer was given using ChatGTP, the text must be marked with "..." [ChatGTP output] or "..." [edited ChatGTP ouput].
The same has to be done for any other text production or editing tool.

Other permissible aids

Open book, open Internet, as described above.

Exception: In case of an electronic Moodle exam, adjustments to the permissible aids may occur. Lecturers will announce the final permissible aids prior to the exam session.

Special case: Resit exam as oral exam

Kind of exam

Oral exam

Duration of exam

30 minutes

Permissible aids

Aids permitted as specified below:

Permissible electronic aids

PDF version of the slide lessons and/or written personal summaries.

No other material or information search is allowed (PC in flight mode, no connection available)

Other permissible aids

Open book. Printed documents (all lectures) and/or written personal summaries

Module Description, available in: EN, FR

Advanced Project Management

General Information

Number of ECTS Credits

3

Module code

CM_AdvProjMgmt

Valid for academic year

2026-27

Last modification

2021-02-05

Coordinator of the module

Virginie Pasquon (SUPSI, virginie.pasquon@supsi.ch)

Explanations regarding the language definitions for each location:

- Instruction is given in the language specified for each location and module execution.
- Documentation is available in the language(s) listed for each location and module execution. If the documentation is in multiple languages, the percentage distributed is indicated (100% = all documentation provided).
- The examination, including both questions and answers, is provided entirely (100%) in the language(s) specified for each location and module execution. The exams are on-site.

	Lausanne			Lugano	Zurich		
Instruction		**X** F 100%		**X** E 100%			
Documentation		**X** F 70%	**X** E 30%	**X** E 100%			
Examination		**X** F 100%		**X** E 100%			

Module Category

CM Context module

Profile Recommendations

This module is recommended for the following profiles:

	Lausanne	Lugano
Profile	ElE, EnEn, Mic	BE, CE, CS, DS, ME, MA

Lessons

2 lecture periods and 1 tutorial period per week

Entry level competences

Prerequisites, previous knowledge

Basic Knowledge in Project Management

Brief course description of module objectives and content

The goals of an organization can be efficiently pursued only through proper project management, as a means able to consistently tackle their needs. Thus the role of the Project Manager becomes essential, as responsible to achieve the objectives, respecting the constraints determined by the project context. Modern Project Managers must have in-depth technical and management knowledge.
The course provides the students with the main tools and methods to manage projects and to analyse the organizational context, to provide useful information that can translate into organizational improvements and increased efficiency in the pursuit of business objectives. The course gives also the opportunity to certificate the knowledge acquired in project management with the CAPM certification (Certified Associated in Project Management) provided by the PMI (Project Management Institute).

Aims, content, methods

Learning objectives and competencies to be acquired

- understand the project management lexicon to communicate in a correct way
- provide theoretical and practical knowledge for proper and integrated project management
- define the project plans to plan and manage the project
- define the project life cycle to improve the project strategy
- define the main tools and techniques to manage the project
- define the processes and the related work flow for an efficient project management
- understand the power of knowledge to improve the results of the organization

Module content with weighting of different components

- Project introduction to understand the context
- Terminology introduction to use a common lexicon
- Scope and objectives definition to define requirements, assumptions and constraints
- Definition and use of the WBS (Work Breakdown Structure) to define the main components of the project
- Time management to define project activities, critical path and project schedule
- Cost management to define project budget and the project contingency
- Control management to protect the plans with the Earned Value Management System

Teaching and learning methods

Front lessons – to better understand the content of the lessons: best practices and excercises
Test Case – to be developed in little group or by themselves
Content Test – to understand the knowledge of the concepts of the previous lessons
Project work – to develop a project in little group applying the contents of the lessons

Literature

PMI (2012), PMBOK V. ed., PMI
IPMA (2007), ICB v.3.0, IPMA
A. Bassi (2009), „Gestire l'innovazione nelle PMI, Franco Angeli
A. Bassi, M. Sampietro, T. Villa (2011), Lavorare per progetti, ETAS
R. Mulkay (2012), PMP Exam Prep, RMC

Assessment

Additional performance assessment during the semester

The module contains additional performance assessment(s) during the semester. The achieved mark of the additional performance assessment(s) applies to both the regular and the resit exam.

Description of additional performance assessment during the semester

Project work (1/3 of final mark)

Basic principle for exams

As a rule, all standard final exams are conducted in written form. For resit exams, lecturers will communicate the exam format (written/oral) together with the exam schedule.

Standard final exam for a module and written resit exam

Kind of exam

Written exam

Duration of exam

120 minutes

Permissible aids

No aids permitted

Exception: In case of an electronic Moodle exam, adjustments to the permissible aids may occur. Lecturers will announce the final permissible aids prior to the exam session.

Special case: Resit exam as oral exam

Kind of exam

Oral exam

Duration of exam

30 minutes

Permissible aids

No aids permitted

Description du module, disponible en: EN, FR

Advanced Project Management

Informations générales

Nombre de crédits ECTS

3

Code du module

CM_AdvProjMgmt

Valable pour l'année académique

2026-27

Dernière modification

2021-02-05

Coordinateur/coordinatrice du module

Virginie Pasquon (SUPSI, virginie.pasquon@supsi.ch)

Explications concernant les langues d'enseignement par site :

- L'enseignement est dispensé dans la langue indiquée ci-dessous pour chaque site et chaque exécution du module.
- Les supports de cours sont disponibles dans les langues indiquées ci-dessous pour chaque site et chaque exécution du module. Lorsque plusieurs langues sont utilisées, la proportion de contenu disponible dans chaque langue est précisée (100 % = ensemble des supports de cours).
- Les examens (questions et réponses) sont entièrement rédigés dans la langue indiquée ci-dessous pour le site et l'exécution du module concernés. Ils se déroulent en présentiel.

	Lausanne			Lugano	Zurich		
Leçons		**X** F 100%		**X** E 100%			
Documentation		**X** F 70%	**X** E 30%	**X** E 100%			
Examen		**X** F 100%		**X** E 100%			

Catégorie de module

CM modules contextuels

Recommandations de profil

Ce module est recommandé pour les profils suivants :

	Lausanne	Lugano
Profil	ElE, EnEn, Mic	BE, CE, CS, DS, ME, MA

Leçons

2 leçons et 1 leçon de pratique par semaine

Compétences préalables

Connaissances préalables, compétences initiales

Connaissances de base en gestion de projet

Brève description du contenu et des objectifs

Seule une gestion de projet appropriée peut garantir la poursuite efficace des objectifs d'une organisation et donner les moyens de répondre de manière cohérente aux besoins.

Ainsi, le gestionnaire de projet occupe un rôle essentiel en tant que responsable de la réalisation des objectifs tout en respectant les contraintes déterminées par le contexte du projet.

Les gestionnaires de projet modernes doivent posséder des connaissances techniques et de gestion approfondies.

Le cours fournit aux étudiant-e-s les principaux outils et méthodes pour gérer des projets et pour analyser le contexte organisationnel, afin de pouvoir déterminer des informations utiles susceptibles de mener à des améliorations organisationnelles et à une efficacité accrue dans la poursuite des objectifs de l'entreprise.

Le cours donne également la possibilité de certifier les connaissances acquises en gestion de projet avec la certification CAPM (Certified Associated in Project Management) délivrée par le PMI (Project Management Institute).

Objectifs, contenus, méthodes

Objectifs d'apprentissage, compétences à acquérir

- comprendre le lexique de la gestion de projet pour communiquer de manière correcte
- acquérir des connaissances théoriques et pratiques pour une gestion de projet appropriée et intégrée
- définir les plans de projet pour planifier et gérer le projet
- définir le cycle de vie du projet afin d'améliorer la stratégie du projet
- définir les principaux outils et techniques pour gérer le projet
- définir les processus et le flux de travail correspondant pour une gestion de projet efficace
- comprendre l'impact des connaissances pour améliorer les résultats de l'organisation

Contenu des modules avec pondération du contenu des cours

- Introduction au projet pour comprendre le contexte
- Introduction à la terminologie pour utiliser un lexique commun
- Définition du champ d'application et des objectifs pour définir les exigences, les hypothèses et les contraintes
- Définition et utilisation de la SRT (structure de répartition du travail) pour définir les principales composantes du projet
- Gestion du temps pour définir les activités du projet, le chemin critique et le calendrier du projet
- Gestion des coûts pour définir le budget et la contingence du projet
- Gestion du contrôle pour protéger les plans avec le système de gestion de la valeur acquise

Méthodes d'enseignement et d'apprentissage

Cours magistral - pour mieux comprendre le contenu des leçons : bonnes pratiques et exercices

Cas type - à développer en petit groupe ou individuellement

Test de contenu - pour évaluer la connaissance des concepts des leçons précédentes

Travail de projet - pour développer un projet en petit groupe en appliquant le contenu des leçons

Bibliographie

PMI (2012), PMBOK V. ed., PMI
IPMA (2007), ICB v.3.0, IPMA
A. Bassi (2009), „Gestire l'innovazione nelle PMI, Franco Angeli
A. Bassi, M. Sampietro, T. Villa (2011), Lavorare per progetti, ETAS
R. Mulkay (2012), PMP Exam Prep, RMC

Evaluation

Évaluation supplémentaire pendant le semestre

Le module comprend une ou des évaluation(s) supplémentaire(s) pendant le semestre. La note obtenue pour la ou les évaluation(s) supplémentaire(s) est valable à la fois pour l'examen final et pour l'examen de répétition.

Description de l'évaluation supplémentaire pendant le semestre

Travail de projet (1/3 de la note finale)

Principe pour les examens

En règle générale, tous les examens réguliers de fin de module se déroulent sous forme écrite. Concernant les examens de répétition, leur format (écrit ou oral) sera communiqué par l’enseignant-e en même temps que le calendrier des examens.

Examen de fin de module régulier et examen écrit de répétition

Type de l'examen

Examen écrit

Durée de l'examen

120 minutes

Aides autorisées

Sans aides

Exception : En cas d'examen électronique sur Moodle, des modifications des aides autorisées peuvent survenir. Dans ce cas, les aides autorisées seront annoncées par les enseignant-e-s avant l'examen.

Cas spécial: examen de répétition oral

Type de l'examen

Examen oral

Durée de l'examen

30 minutes

Aides autorisées

Sans aides

Module Description, available in: EN

Management of Complex Processes

General Information

Number of ECTS Credits

3

Module code

CM_ComplPro

Valid for academic year

2026-27

Last modification

2022-01-23

Coordinator of the module

Harold Tiemessen (OST, harold.tiemessen@ost.ch)

Explanations regarding the language definitions for each location:

- Instruction is given in the language specified for each location and module execution.
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- The examination, including both questions and answers, is provided entirely (100%) in the language(s) specified for each location and module execution. The exams are on-site.

	Lausanne			Lugano	Zurich		
Instruction	**X** E 100%				**X** E 100%		
Documentation	**X** E 100%				**X** E 100%		
Examination	**X** E 100%				**X** E 100%		

Module Category

CM Context module

Profile Recommendations

This module is recommended for the following profiles:

	Lausanne	Zurich
Profile	CS, EIE, ME	CS, EIE, EnEn, ME, MA, Avi, BT, Pho

Lessons

2 lecture periods and 1 tutorial period per week

Entry level competences

Prerequisites, previous knowledge

Brief course description of module objectives and content

One of the biggest challenges encountered in management is recognizing opportunities and making use of them while giving consideration to the associated risks. The constantly increasing dynamism and complexity of the environment in which companies and organizations operate is, however, making it difficult to take successful decisions. Multifactorial correlations, non-linearities, feedback effects and time lags make it difficult to correctly predict the impacts of a decision.
Students gain insight into the methods and tools employed for decision-making when faced with complex questions. They learn about cause-and-effect diagrams and quantitative simulation models and apply these in case studies.

Aims, content, methods

Learning objectives and competencies to be acquired

Students

- are familiar with the systemic approach, can correctly identify the limits of a system and are aware that models only depict reality imperfectly
- are able to analyze complex processes applying the correct methodology and communicate about them
- know how to manage conflicts of objectives with the correct methodology (e.g. costs versus quality)
- can depict complex processes as a cause-and-effect network
- can depict technical and operational processes in the form of an event-orientated simulation model
- are familiar with the most important steps of a simulation study
- understand the problem-solving cycle as a creative process
- have learned to implement systemic problem-solving methods in operational practice

Module content with weighting of different components

1. Basics of types of decision, decision making process and six sources of influence
2. Shared mental models
3. Introduction to system dynamics (causal loop diagrams, stocks and flows, analysis of dynamic system behavior)
4. Simulation paradigms applied to understand behavior of dynamic systems governed by human decisions

Teaching and learning methods

Lecture with examples to be solved in a group. Exercises and case studies.

Literature

- Sterman J: Business Dynamics. McGraw-Hill (2010). ISBN 978-0071068123
- Senge P.: Die fünfte Disziplin. Klett-Cotta (2008). ISBN 978-3608913798
- Warren K.: Competitive Strategy Dynamics. Wiley (2002) ISBN 978-0471899495
- Sherwood D.: Den Wald vor lauter Bäumen sehen. Wiley (2003). ISBN 978-3527500574
- Gandolfi, A: Von Menschen und Ameisen. Orell Füssli (2001). ISBN 978-3280026694
- Vester F.: The Art of Interconnected Thinking (2007) ISBN 978-3-939314-05-9
- Probst G. & Ulrich H.: Anleitung zum ganzheitlichen Denken und Handeln (1988) ISBN 3-258-03976-3 - Pensée globale et management : résoudre les problèmes complexes (1989) ISBN 2-7081-1066-7
- Law, A.M.: Simulation modeling and analysis. McGraw Hill Boston (2006). ISBN 978-0071255196
- Patterson K., Grenny J., Maxfield D., McMillan R., Switzler A.: Influencer (2008) ISBN 13: 978-0-07-148499-2.

Assessment

Additional performance assessment during the semester

The module does not contain an additional performance assessment during the semester

Basic principle for exams

As a rule, all standard final exams are conducted in written form. For resit exams, lecturers will communicate the exam format (written/oral) together with the exam schedule.

Standard final exam for a module and written resit exam

Kind of exam

Written exam

Duration of exam

120 minutes

Permissible aids

Aids permitted as specified below:

Permissible electronic aids

No electronic aids permitted

Other permissible aids

Notes and books

Exception: In case of an electronic Moodle exam, adjustments to the permissible aids may occur. Lecturers will announce the final permissible aids prior to the exam session.

Special case: Resit exam as oral exam

Kind of exam

Oral exam

Duration of exam

30 minutes

Permissible aids

Aids permitted as specified below:

Permissible electronic aids

No electronic aids permitted

Other permissible aids

Notes and books

Module Description, available in: EN, FR

Corporate Management and Entrepreneurship

General Information

Number of ECTS Credits

3

Module code

CM_Entrepr

Valid for academic year

2026-27

Last modification

2020-03-04

Coordinator of the module

Mathias Beck (FHGR, mathias.beck@fhgr.ch)

Explanations regarding the language definitions for each location:

- Instruction is given in the language specified for each location and module execution.
- Documentation is available in the language(s) listed for each location and module execution. If the documentation is in multiple languages, the percentage distributed is indicated (100% = all documentation provided).
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	Lausanne			Lugano	Zurich		
Instruction		**X** F 100%			**X** E 100%		
Documentation		**X** F 100%			**X** E 100%		
Examination		**X** F 100%	**X** E 100%		**X** E 100%		

Module Category

CM Context module

Profile Recommendations

This module is recommended for the following profiles:

	Lausanne	Zurich
Profile	CS, EnEn	CE, CS, Avi, Geo

Lessons

2 lecture periods and 1 tutorial period per week

Entry level competences

Prerequisites, previous knowledge

Basic Knowledge in Business Administration

Brief course description of module objectives and content

In the module « Corporate Management and Entrepreneurship », students are enabled to evaluate business models. They learn the building blocks of a business modell and elements of sustainable management practices. Along the business model, relevant aspects from different fields such as strategy, marketing, finance and organization are relevant.

Aims, content, methods

Learning objectives and competencies to be acquired

Business model

- Students know the elements of the business model and are able to visualize and analyse the elements of it.
- Students are able to develop a business model for a new business idea.

Strategy and management

- Students know the most important instruments of Strategic Management.
- Students can apply instruments and make evaluations of organizations.

Finance

- Students know a selection of relevant financial performance indicators.
- Students are familiar with various corporate financing tools and know which ones are strategically adapted to their level of development.

Marketing

- Students have a comprehensive understanding of marketing concepts for decision-making in practice.
- Students are able to develop the course of action for specific marketing goals, strategies and measurements.

Organisation

- Students know the basic concepts of organizational structures and processes.
- Students are able to analyse organizational decision and design situations and develop appropriate solution approaches.

Module content with weighting of different components

Business model

- Business model : Elements and building blocks
- Customer segments and channels
- Product development process

Strategy

- Organizational strategies
- Internal and external analysis of enterprises

Marketing

- Market system and marketing
- Course of action and marketing goals

Organisation

- Organizational structure and processes
- Design approaches in organizations

Finance

- Financing (cost structure and cash flow planning)
- Sources of financing and types of financing

Teaching and learning methods

- Lectures as the main lessons (2 lessons)
- Seminars for exercises (case studies) (1 lesson)
- Independent study (case study analysis)

Literature

- Osterwalder, A./Pigneur, Y. (2010): Business Model Generation. 1st edition. London
- Other case studies in the form of manuals or downloadable documents

Assessment

Additional performance assessment during the semester

The module does not contain an additional performance assessment during the semester

Basic principle for exams

As a rule, all standard final exams are conducted in written form. For resit exams, lecturers will communicate the exam format (written/oral) together with the exam schedule.

Standard final exam for a module and written resit exam

Kind of exam

Written exam

Duration of exam

120 minutes

Permissible aids

Aids permitted as specified below:

Permissible electronic aids

No electronic aids permitted

Other permissible aids

One page with notes according to the lecturer's criteria

Exception: In case of an electronic Moodle exam, adjustments to the permissible aids may occur. Lecturers will announce the final permissible aids prior to the exam session.

Special case: Resit exam as oral exam

Kind of exam

Oral exam

Duration of exam

30 minutes

Permissible aids

No aids permitted

Description du module, disponible en: EN, FR

Gestion d'entreprise et entrepreneuriat

Informations générales

Nombre de crédits ECTS

3

Code du module

CM_Entrepr

Valable pour l'année académique

2026-27

Dernière modification

2020-03-04

Coordinateur/coordinatrice du module

Mathias Beck (FHGR, mathias.beck@fhgr.ch)

Explications concernant les langues d'enseignement par site :

- L'enseignement est dispensé dans la langue indiquée ci-dessous pour chaque site et chaque exécution du module.
- Les supports de cours sont disponibles dans les langues indiquées ci-dessous pour chaque site et chaque exécution du module. Lorsque plusieurs langues sont utilisées, la proportion de contenu disponible dans chaque langue est précisée (100 % = ensemble des supports de cours).
- Les examens (questions et réponses) sont entièrement rédigés dans la langue indiquée ci-dessous pour le site et l'exécution du module concernés. Ils se déroulent en présentiel.

	Lausanne			Lugano	Zurich		
Leçons		**X** F 100%			**X** E 100%		
Documentation		**X** F 100%			**X** E 100%		
Examen		**X** F 100%	**X** E 100%		**X** E 100%		

Catégorie de module

CM modules contextuels

Recommandations de profil

Ce module est recommandé pour les profils suivants :

	Lausanne	Zurich
Profil	CS, EnEn	CE, CS, Avi, Geo

Leçons

2 leçons et 1 leçon de pratique par semaine

Compétences préalables

Connaissances préalables, compétences initiales

Connaissances fondamentales en gestion de l'entreprise

Brève description du contenu et des objectifs

Dans le cadre du module Management d'entreprise et entrepreneuriat, les étudiants apprennent à jauger et évaluer les entreprises et leurs business modèles. Les étudiants connaissent les principales composantes d'un business modèle et de la gestion durable d'entreprise.
C'est au sein du business modèle que sont élaborés les principaux aspects de la stratégie (analyse interne et externe), le marketing, le financement et l'organisation de l'entreprise.

Objectifs, contenus, méthodes

Objectifs d'apprentissage, compétences à acquérir

Business modèle

- Les étudiants connaissent les éléments composant un modèle économique et sont en mesure de représenter et d'analyser ces éléments pour des entreprises choisies.
- Les étudiants sont capables de concevoir un business modèle adapté pour une idée économique nouvelle.

Stratégie et gestion d'entreprise

- Les étudiants connaissent les principaux outils du management stratégique
- Les étudiants peuvent mettre en pratique des outils stratégiques sur des situations données et procéder à des évaluations stratégiques simples.

Gestion financière d'entreprise

- Les étudiants connaissent une sélection d'indicateurs financiers pertinents
- Les étudiants connaissent divers outils de financement de l'entreprise et savent lesquels sont adaptés d'un point de vue stratégique, en fonction du niveau de développement.

Marketing

- Les étudiants s'inspirent d'une conception du marketing globale qu'ils ont intégrée et la mettent en pratique sur des situations et des prises de décision.
- Les étudiants sont en mesure d'élaborer des options d'action pour des entreprises en concevant des objectifs, des stratégies et des mesures de marketing concrets et coordonnés entre eux.

Organisation

- Les étudiants connaissent les concepts fondamentaux de l'organisation structurelle et procédurale.
- Les étudiants sont en mesure d'analyser des situations de prise de décision liée à l'organisation et d'aménagement de l'organisation à l'aide des concepts appris et de concevoir des propositions de solution adaptées.

Contenu des modules avec pondération du contenu des cours

Business modèle

- Modèle économique et de gestion: Eléments et composantes
- Segments de clientèle et canaux de distribution
- Réalisation de la prestation et procédé de développement de produits

Stratégie

- Stratégies d'entreprise, développement de stratégie, mise en œuvre de la stratégie
- Analyse interne et externe de l'entreprise

Marketing

- Système de marché et marketing
- Options d'action et objectifs marketing

Organisation

- Organisation structurelle et procédurale
- Options d'aménagement dans les organisations

Gestion financière de l'entreprise

- Financement (structure des coûts et plan de trésorerie)
- Sources de financement et types de financement

Méthodes d'enseignement et d'apprentissage

Enseignement frontal pour les cours magistraux (2 leçons)
Cours en séminaires pour les exercices (études de cas) (1 leçon)
Etude autonome (analyse des études de cas)

Bibliographie

- Osterwalder, A./Pigneur, Y. (2010): Business Model Generation. 1ère ed. Londres
- Autres études de cas sous forme de manuels ou documents à télécharger

Evaluation

Évaluation supplémentaire pendant le semestre

Le module ne comprend pas d'évaluation supplémentaire pendant le semestre

Principe pour les examens

En règle générale, tous les examens réguliers de fin de module se déroulent sous forme écrite. Concernant les examens de répétition, leur format (écrit ou oral) sera communiqué par l'enseignant-e en même temps que le calendrier des examens.

Examen de fin de module régulier et examen écrit de répétition

Type de l'examen

Examen écrit

Durée de l'examen

120 minutes

Aides autorisées

Les aides suivantes sont autorisées:

Aides électroniques autorisées

Aucune aide électronique autorisée

Autres aides autorisées

Une page de notes selon les critères du professeur

Exception : En cas d'examen électronique sur Moodle, des modifications des aides autorisées peuvent survenir. Dans ce cas, les aides autorisées seront annoncées par les enseignant-e-s avant l'examen.

Cas spécial: examen de répétition oral

Type de l'examen

Examen oral

Durée de l'examen

30 minutes

Aides autorisées

Sans aides

Module Description, available in: EN

Ethics and Corporate Responsibility

General Information

Number of ECTS Credits

3

Module code

CM_Ethics

Valid for academic year

2026-27

Last modification

2024-10-14

Coordinator of the module

Thorsten Busch (ZHAW, buth@zhaw.ch)

Explanations regarding the language definitions for each location:

- Instruction is given in the language specified for each location and module execution.
- Documentation is available in the language(s) listed for each location and module execution. If the documentation is in multiple languages, the percentage distributed is indicated (100% = all documentation provided).
- The examination, including both questions and answers, is provided entirely (100%) in the language(s) specified for each location and module execution. The exams are on-site.

	Lausanne			Lugano	Zurich		
Instruction					**X** E 100%		
Documentation					**X** E 100%		
Examination					**X** E 100%		

Module Category

CM Context module

Profile Recommendations

This module is recommended for the following profiles:

	Zurich
Profile	CE, DS, ICS, Med, ReLa

Lessons

2 lecture periods and 1 tutorial period per week

Entry level competences

Prerequisites, previous knowledge

none

Brief course description of module objectives and content

In an environment that is changing increasingly quickly, students will be taught the ability to assume social responsibility either as engineers or in management functions at companies. They will develop a profound awareness of the ethical aspects of their actions and for the ecological and social impacts of companies. In their subsequent professional careers, they will thus be better able to judge the consequences of their work for society, to deal with conflicts in these areas, and to contribute to the corporate responsibility strategies of their organizations in a manner appropriate to their positions.

Aims, content, methods

Learning objectives and competencies to be acquired

- Students know the theoretical foundations of various ethical theories
- They are familiar with various levels of ethics (individual ethics and corporate ethics)
- They can apply a wide range of ethical approaches to a specific situation
- They are familiar with the concept of the broader corporate responsibility of organizations
- They are familiar with the main elements of the implementation of corporate responsibility in companies
- They are able to analyze and critically judge the corporate responsibility strategy of a given company on the basis of publicly available information

Module content with weighting of different components

Ethics

- fundamental ethical concepts
- ethics of duties and ethics of consequences; human rights; the common good
- discourse ethics; justice; forming ethical judgements
- ethics of the environment and the future; sustainable development
- ethics of technology; estimating the consequences of technology, technology assessment
- ethics codices, guidelines, professional norms
- specific case studies from various disciplines

Corporate Responsibility:

- the role of organizations/companies in society
- the expectations of stakeholder groups and dealing with these expectations (stakeholder management)
- various classic concepts of corporate responsibility
- corporate responsibility in ecological, social, economic and technological areas, business case for CSR/sustainability
- elements of the implementation of corporate responsibility (issue identification, governance, guiding philosophy/policy, issue strategies, measurement and monitoring, non-financial reporting, auditing and certification

Teaching and learning methods

Lecture, case studies, individual and group exercises.

The final exam consists of a written work assignment and written questions.

Literature

References for literature will be provided during the lectures on a language-specific basis.

Assessment

Additional performance assessment during the semester

The module does not contain an additional performance assessment during the semester

Basic principle for exams

As a rule, all standard final exams are conducted in written form. For resit exams, lecturers will communicate the exam format (written/oral) together with the exam schedule.

Standard final exam for a module and written resit exam

Kind of exam

Written exam

Duration of exam

120 minutes

Permissible aids

Aids permitted as specified below:

Permissible electronic aids

Students will take an online exam via Moodle while being physically present in a lecture hall in Zurich. They can use their computers or other devices

to take the Moodle exam, which generally is open-book, i.e. students may use their lecture slides and personal notes.

Other permissible aids

Aside from the aids above, students may only use a dictionary because the exam will be held in English.

Exception: In case of an electronic Moodle exam, adjustments to the permissible aids may occur. Lecturers will announce the final permissible aids prior to the exam session.

Special case: Resit exam as oral exam

Kind of exam

Oral exam

Duration of exam

30 minutes

Permissible aids

No aids permitted

Module Description, available in: EN, FR

Innovation and Changemanagement

General Information

Number of ECTS Credits

3

Module code

CM_InnChang

Valid for academic year

2026-27

Last modification

2021-02-12

Coordinator of the module

Dieter Conzelmann (FHGR, Dieter.Conzelmann@fhgr.ch)

Explanations regarding the language definitions for each location:

- Instruction is given in the language specified for each location and module execution.
- Documentation is available in the language(s) listed for each location and module execution. If the documentation is in multiple languages, the percentage distributed is indicated (100% = all documentation provided).
- The examination, including both questions and answers, is provided entirely (100%) in the language(s) specified for each location and module execution. The exams are on-site.

	Lausanne			Lugano	Zurich		
Instruction		**X** F 100%			**X** E 100%		
Documentation		**X** F 70%	**X** E 30%		**X** E 100%		
Examination		**X** F 100%			**X** E 100%		

Module Category

CM Context module

Profile Recommendations

This module is recommended for the following profiles:

	Lausanne	Zurich
Profile	CE, DS, ElE	BE, EnEn, ME, MA, Avi, BT, Geo

Lessons

2 lecture periods and 1 tutorial period per week

Entry level competences

Prerequisites, previous knowledge

none

Brief course description of module objectives and content

The goal of this module is to teach students the fundamentals of operational planning and innovation management through an integrated innovation management model, while introducing key concepts. This knowledge will enable students to understand and connect various internal and external interfaces within innovation projects, allowing them to interpret and influence these effectively. Additionally, students will learn to develop a new, innovative business model based on the theory of innovation management. The module prepares students to become "innovation managers" in a comprehensive and well-rounded capacity.

Aims, content, methods

Learning objectives and competencies to be acquired

The module has the following learning aims:

- The students are able to evaluate innovation management concepts in practice, to develop these and to implement adaptations
- The students are able to apply organisational ambidexterity as a management principle along the spectrum between everyday business (exploitation) and renewal (exploration)
- The students are able to communicate various subject areas in innovation management to third parties
- The students can estimate possible disruptive potential and develop suitable measures to harness this potential or to react to it
- The students can analyse and evaluate the innovation process within a company, identify its deficits and gaps, develop improvements on this basis, and implement these
- The students can develop an implementation plan for an innovation project as a risk-reduction process and take on responsibility for the implementation of this plan
- The students are familiar with more agile approaches as a stage gate for the development of products (services and material goods) and can judge which approach is to be selected for which development

Module content with weighting of different components

The **Innovation and Change Management** module covers the following topics:

- **Foundations:** Definitions and key concepts; types of innovations; commercial and economic significance of innovations.
- **Innovation System:** Exploration of international, national, and regional innovation systems; key instruments for innovation promotion.
- **Innovation Cycle:** Overview of the innovation management model, including innovation routines, dynamic capabilities, and strategic areas of focus; relevance to general management and associated methodologies.
- **Innovation Strategy:** Examination of strategic fit, strategic alternatives, success factors, imitation strategies, related diversification, co-creation, and new ventures.
- **Innovation Structure:** Innovation-supportive processes and organizational structures; change-capable organizational profiles; open vs. closed innovation.
- **Innovation Culture:** Building an innovation-friendly corporate culture; phases of change management including initiation, conceptualization, mobilization, implementation, and embedding; Corporate Entrepreneurship.
- **Innovation Controlling:** Key performance indicators, BSC approaches, and methods for tracking success and participation in innovation initiatives.
- **Definition and History of Innovation Processes:** Key terms, historical evolution of innovation processes, and distinction between routine and innovation processes.
- **The Innovation Dilemma:** Analysis of incremental, radical, and disruptive innovations and potential solutions to the challenges faced by innovative companies.
- **Corporate Innovation Process Structure:** Presentation of the innovation process as a phased model.
- **Initiative and Selection Phases:** Structuring the initial phases of the innovation process, including the selection of ideas and initiatives.
- **Implementation Phase:** Managing the development of new products as a risk-reduction strategy in the innovation process.
- **Escalation of Commitment:** Addressing the challenges of "escalation of commitment" during the implementation phase of innovation.
- **Intellectual Property Law:** Overview of intellectual property strategies and methods for protecting innovative ideas.

Teaching and learning methods

In-person methods: Interactive teaching discussions, case-based learning, practical exercises, and presentations.
Self-study methods: Independent study of literature, preparation and review of class materials, classroom participation, and group projects.

Students will apply the concepts learned by working on practical examples, identifying innovation-related challenges, and selecting and utilizing the appropriate tools and methods to solve these problems effectively.

Literature

Notes will be provided.

The following literature recommendations should also be taken into account:

- Osterwalder (2020): The invincible company
- Chesbrough, H. W. (2007): Why Companies Should Have Open Business Models. MIT Sloan Management Review, 2007, S. 22 – 28. Cooper, R. (2001): Winning at new products. New York: HarperCollins.
- Drucker, P. (2003): The Disciplin of Innovation, in Harvard Business Review on the Innovative Enterprise.

- Goffin, K., Mitchell, R. (2017): Innovation Management. Effective Strategy & Implementation. 3rd edition. Macmillan Education Elt. London.
- Moss Kanter, R. (2006). Innovation: The Classic Traps. Harvard Business Review, November, S. 73 – 83.
- O'Reilly, Ch., Tushmann, M. (2017) Lead and Disrupt. How to Solve the Innovator's Dilemma. Stanford Business Books. Sarasvathy, S., Dew, N. Velamuri, S., Venkataraman, S. (2005): Three Views of Entrepreneurial Opportunity", in Handbook of
- Entrepreneurship Research - An Interdisciplinary Survey and Introduction, ed. Acs, Z. and Audretsch, D., Springer Science and Business Media.
- von Hippel, E. (1988). The Source of Innovation. New York: Oxford University Press (USA).

Assessment

Additional performance assessment during the semester

The module contains additional performance assessment(s) during the semester. The achieved mark of the additional performance assessment(s) applies to both the regular and the resit exam.

Description of additional performance assessment during the semester

Throughout the semester, students will complete regular assignments and prepare a knowledge transfer report based on a practical example. At the end of the semester, they will present their findings. This midterm assessment will contribute 30% to the overall module grade.

Basic principle for exams

As a rule, all standard final exams are conducted in written form. For resit exams, lecturers will communicate the exam format (written/oral) together with the exam schedule.

Standard final exam for a module and written resit exam

Kind of exam

Written exam

Duration of exam

120 minutes

Permissible aids

Aids permitted as specified below:

Permissible electronic aids

No electronic aids permitted

Other permissible aids

open book, summary

Exception: In case of an electronic Moodle exam, adjustments to the permissible aids may occur. Lecturers will announce the final permissible aids prior to the exam session.

Special case: Resit exam as oral exam

Kind of exam

Oral exam

Duration of exam

30 minutes

Permissible aids

Aids permitted as specified below:

Permissible electronic aids

No electronic aids permitted

Other permissible aids

open book, summary

Description du module, disponible en: EN, FR

Gestion de l'innovation et du changement

Informations générales

Nombre de crédits ECTS

3

Code du module

CM_InnChang

Valable pour l'année académique

2026-27

Dernière modification

2021-02-12

Coordinateur/coordinatrice du module

Dieter Conzelmann (FHGR, Dieter.Conzelmann@fhgr.ch)

Explications concernant les langues d'enseignement par site :

- L'enseignement est dispensé dans la langue indiquée ci-dessous pour chaque site et chaque exécution du module.
- Les supports de cours sont disponibles dans les langues indiquées ci-dessous pour chaque site et chaque exécution du module. Lorsque plusieurs langues sont utilisées, la proportion de contenu disponible dans chaque langue est précisée (100 % = ensemble des supports de cours).
- Les examens (questions et réponses) sont entièrement rédigés dans la langue indiquée ci-dessous pour le site et l'exécution du module concernés. Ils se déroulent en présentiel.

	Lausanne			Lugano	Zurich		
Leçons		**X** F 100%			**X** E 100%		
Documentation		**X** F 70%	**X** E 30%		**X** E 100%		
Examen		**X** F 100%			**X** E 100%		

Catégorie de module

CM modules contextuels

Recommandations de profil

Ce module est recommandé pour les profils suivants :

	Lausanne	Zurich
Profil	CE, DS, EIE	BE, EnEn, ME, MA, Avi, BT, Geo

Leçons

2 leçons et 1 leçon de pratique par semaine

Compétences préalables

Connaissances préalables, compétences initiales

aucun

Brève description du contenu et des objectifs

L'objectif de ce module est d'enseigner aux étudiants les principes fondamentaux de la planification opérationnelle et de la gestion de l'innovation par le biais d'un modèle intégré de gestion de l'innovation, tout en introduisant des concepts clés. Ces connaissances permettront aux étudiants de comprendre et de relier les différentes interfaces internes et externes des projets d'innovation, ce qui leur permettra de les interpréter et de les influencer efficacement. En outre, les étudiants apprendront à développer un nouveau modèle d'entreprise innovant basé sur la théorie de la gestion de l'innovation. Le module prépare les étudiants à devenir des « gestionnaires de l'innovation » de manière complète et équilibrée.

Objectifs, contenus, méthodes

Objectifs d'apprentissage, compétences à acquérir

Le module poursuit les objectifs suivants:

- Les étudiants sont capables d'évaluer dans la pratique les concepts de gestion de l'innovation de les faire évoluer et de mettre en œuvre des ajustements.
- Les étudiants sont en mesure de gérer l'ambidextrie à la jonction entre l'exploitation et l'exploration comme principe de management
- Les étudiants savent expliquer les différents thèmes de la gestion de l'innovation à des tiers
- Les étudiants peuvent analyser un potentiel disruptif et concevoir des mesures adaptées pour exploiter ce potentiel et savoir y réagir
- Les étudiants sont capables d'analyser le processus d'innovation d'une entreprise, d'identifier les lacunes et les défauts, d'en déduire des améliorations et de les mettre en œuvre
- Les étudiants peuvent concevoir un plan de réalisation pour un projet d'innovation dans le cadre d'une procédure de réduction des risques et prendre des responsabilités dans le cadre de sa mise en œuvre
- Les étudiants connaissent les démarches agiles sous forme de stage-gate pour le développement de produits (prestations de service et biens matériels) et sont capables de juger quelle démarche est plus appropriée en fonction du développement

Contenu des modules avec pondération du contenu des cours

Le module **Innovation et Gestion du Changement** couvre les sujets suivants :

- **Fondations :** Définitions et concepts clés ; types d'innovations ; importance commerciale et économique des innovations.
- **Système d'Innovation :** Exploration des systèmes d'innovation internationaux, nationaux et régionaux ; principaux instruments de promotion de l'innovation.
- **Cycle d'Innovation :** Aperçu du modèle de gestion de l'innovation, incluant les routines d'innovation, les capacités dynamiques et les domaines stratégiques d'activité ; pertinence pour la gestion générale et les méthodes associées.
- **Stratégie d'Innovation :** Étude de l'ajustement stratégique, des alternatives stratégiques, des facteurs de succès, des stratégies d'imitation, de la diversification connexe, de la co-création et des nouvelles entreprises.
- **Structure d'Innovation :** Processus et structures organisationnelles favorables à l'innovation ; profils d'organisations capables de changement ; innovation ouverte vs fermée.
- **Culture d'Innovation :** Création d'une culture d'entreprise favorable à l'innovation ; phases de gestion du changement, y compris l'initiation, la conceptualisation, la mobilisation, la mise en œuvre et l'ancrage ; entrepreneuriat d'entreprise.
- **Contrôle de l'Innovation :** Indicateurs de performance clés, approches de la BSC et méthodes pour suivre le succès et la participation aux initiatives d'innovation.
- **Définition et Histoire des Processus d'Innovation :** Termes clés, évolution historique des processus d'innovation, et distinction entre processus de routine et d'innovation.
- **Le Dilemme de l'Innovation :** Analyse des innovations incrémentales, radicales et disruptives, et solutions potentielles aux défis auxquels sont confrontées les entreprises innovantes.
- **Structure du Processus d'Innovation en Entreprise :** Présentation du processus d'innovation comme un modèle par phases.
- **Phases d'Initiative et de Sélection :** Structuration des phases initiales du processus d'innovation, y compris la sélection des idées et des initiatives.
- **Phase de Mise en Œuvre :** Gestion du développement de nouveaux produits comme stratégie de réduction des risques dans le processus d'innovation.
- **Escalade d'Engagement :** Aborder les défis de "l'escalade d'engagement" lors de la phase de mise en œuvre de l'innovation.
- **Droit de la Propriété Intellectuelle :** Aperçu des stratégies de propriété intellectuelle et des méthodes de protection des idées innovantes.

Méthodes d'enseignement et d'apprentissage

Méthodes en présentiel : Discussions interactives, études de cas didactiques, exercices pratiques et présentations.
Méthodes d'auto-apprentissage : Étude indépendante de la littérature, préparation et révision des supports de cours, participation en classe et projets de groupe.

Les étudiants appliqueront les concepts appris en travaillant sur des exemples pratiques, en identifiant les défis liés à l'innovation et en sélectionnant et utilisant les outils et méthodes appropriés pour résoudre ces problèmes de manière efficace.

Bibliographie

Un script sera distribué aux étudiants.

Prendre en compte les recommandations bibliographiques suivantes:

- Baitsch, C. (1997). Innovation und Kompetenz Zur Verknüpfung zweier Chimären (L'innovation et la compétence pour relier deux chimères). In: F. Heideloff & T. Radel (Hrsg.): Organisation von Innovation: Strukturen, Prozesse, Interventionen (Organisation de l'innovation: structures, processus et interventions). (59-74). München und Mering: Hampp.
- Chesbrough, H. W. (2007): Why Companies Should Have Open Business Models. MIT Sloan Management Review, 2007, S. 22 – 28.
- Cooper, R. (2001): Winning at new products. New York: HarperCollins.
- Drucker, P. (2003): The Disciplin of Innovation, in Harvard Business Review on the Innovative Enterprise.
- Hauschildt, J. (2004). Innovationsmanagement. 3. Auflage. München: Vahlen.
- Kotter, J. (1997). Chaos Wandel Führung. Düsseldorf: Econ.
- Krüger, W. (2006). Excellence in Change, 2. Auflage. Gabler.
- Moss Kanter, R. (2006). Innovation: The Classic Traps. Harvard Business Review, November, S. 73 – 83.

- O'Reilly, Ch., Tushmann, M. (2017) Lead and Disrupt. How to Solve the Innovator's Dilemma. Stanford Business Books.
- Sarasvathy, S., Dew, N. Velamuri, S., Venkataraman, S. (2005): Three Views of Entrepreneurial Opportunity", in Handbook of Entrepreneurship Research - An Interdisciplinary Survey and Introduction, ed. Acs, Z. and Audretsch, D., Springer Science and Business Media.
- von Hippel, E. (1988). The Source of Innovation. New York: Oxford University Press (USA).
- Wolf, P. (2007): Disruptive Innovation. In: Internationale Zeitschrift für Veränderung, Lernen, Dialog (Revue internationale pour le changement, l'apprentissage, le dialogue). Profile 13, S. 37-43.

Evaluation

Évaluation supplémentaire pendant le semestre

Le module comprend une ou des évaluation(s) supplémentaire(s) pendant le semestre. La note obtenue pour la ou les évaluation(s) supplémentaire(s) est valable à la fois pour l'examen final et pour l'examen de répétition.

Description de l'évaluation supplémentaire pendant le semestre

Tout au long du semestre, les étudiants devront réaliser des devoirs réguliers et préparer un rapport de transfert de connaissances basé sur un exemple pratique. À la fin du semestre, ils présenteront leurs résultats. Cette évaluation de mi-parcours contribuera à hauteur de 30 % à la note finale du module

Principe pour les examens

En règle générale, tous les examens réguliers de fin de module se déroulent sous forme écrite. Concernant les examens de répétition, leur format (écrit ou oral) sera communiqué par l'enseignant-e en même temps que le calendrier des examens.

Examen de fin de module régulier et examen écrit de répétition

Type de l'examen

Examen écrit

Durée de l'examen

120 minutes

Aides autorisées

Les aides suivantes sont autorisées:

Aides électroniques autorisées

Aucune aide électronique autorisée

Autres aides autorisées

Format papier: livre ouvert, synthèse

Exception : En cas d'examen électronique sur Moodle, des modifications des aides autorisées peuvent survenir. Dans ce cas, les aides autorisées seront annoncées par les enseignant-e-s avant l'examen.

Cas spécial: examen de répétition oral

Type de l'examen

Examen oral

Durée de l'examen

30 minutes

Aides autorisées

Les aides suivantes sont autorisées:

Aides électroniques autorisées

Aucune aide électronique autorisée

Autres aides

Format papier: livre ouvert, synthèse

Module Description, available in: EN

Innovation and Lean

General Information

Number of ECTS Credits

3

Module code

CM_InnoLEAN

Valid for academic year

2026-27

Last modification

2022-10-17

Coordinator of the module

Paolo Pedrazzoli (SUPSI, paolo.pedrazzoli@supsi.ch)

Explanations regarding the language definitions for each location:

- Instruction is given in the language specified for each location and module execution.
- Documentation is available in the language(s) listed for each location and module execution. If the documentation is in multiple languages, the percentage distributed is indicated (100% = all documentation provided).
- The examination, including both questions and answers, is provided entirely (100%) in the language(s) specified for each location and module execution. The exams are on-site.

	Lausanne			Lugano	Zurich		
Instruction				**X** E 100%			
Documentation				**X** E 100%			
Examination				**X** E 100%			

Module Category

CM Context module

Profile Recommendations

This module is recommended for the following profiles:

	Lugano
Profile	BE, CS, MA

Lessons

2 lecture periods and 1 tutorial period per week

Entry level competences

Prerequisites, previous knowledge

Brief course description of module objectives and content

The course introduces the concepts of Lean innovation and lean thinking. It also foster a complex serious-gaming session where the students can develop their own factory and implement a set of innovations. Indeed, the student will be able to devise and implement a production practice that considers to be waste the expenditure of resources for any goal other than the creation of value for the customer.

Aims, content, methods

Learning objectives and competencies to be acquired

- Understand the lean lexicon
- Provide theoretical and practical knowledge for proper Lean Innovation
- Define a lean implementation project plan and manage the project
- Acquire the main tools and techniques to manage a lean transformation

Module content with weighting of different components

- Lean approach
- Lean Methods and Tools
- Lean Implementation
- Serious Game session

Teaching and learning methods

Front lessons – to better understand the content of the lessons: best practices and excercises
Test Case – to be developed in small groups or by themselves
Lean Lab – serious gaming to develop a deep understanding of the theoretical concepts

Literature

Assessment

Additional performance assessment during the semester

The module does not contain an additional performance assessment during the semester

Basic principle for exams

As a rule, all standard final exams are conducted in written form. For resit exams, lecturers will communicate the exam format (written/oral) together with the exam schedule.

Standard final exam for a module and written resit exam

Kind of exam

Written exam

Duration of exam

120 minutes

Permissible aids

No aids permitted

Exception: In case of an electronic Moodle exam, adjustments to the permissible aids may occur. Lecturers will announce the final permissible aids prior to the exam session.

Special case: Resit exam as oral exam

Kind of exam

Oral exam

Duration of exam

30 minutes

Permissible aids

No aids permitted

Module Description, available in: EN

Integrated Sustainable Management of Production Systems

General Information

Number of ECTS Credits

3

Module code

CM_IntSust

Valid for academic year

2026-27

Last modification

2022-01-10

Coordinator of the module

Alessandro Fontana (SUPSI, alessandro.fontana@supsi.ch)

Explanations regarding the language definitions for each location:

- Instruction is given in the language specified for each location and module execution.
- Documentation is available in the language(s) listed for each location and module execution. If the documentation is in multiple languages, the percentage distributed is indicated (100% = all documentation provided).
- The examination, including both questions and answers, is provided entirely (100%) in the language(s) specified for each location and module execution. The exams are on-site.

	Lausanne			Lugano	Zurich		
Instruction				**X** E 100%			
Documentation				**X** E 100%			
Examination				**X** E 100%			

Module Category

CM Context module

Profile Recommendations

This module is recommended for the following profiles:

	Lugano
Profile	BE, DS, ME, MA

Lessons

2 lecture periods and 1 tutorial period per week

Entry level competences

Prerequisites, previous knowledge

none

Brief course description of module objectives and content

Companies are increasingly interested in conducting their activities so that a long-term future is assured for its business, society and environment. The purpose of this class is to deal with the well-recognized but sometimes vague concept of sustainability from an engineering perspective. The module is meant to introduce students to the implementation of sustainable management in industries and provide them with tools enabling the enhancement of the sustainability performances of production systems.

Aims, content, methods

Learning objectives and competencies to be acquired

During lectures, practitioners gain knowledge on the sustainability concept and are educated on its concrete application into the present industrial context. Standards, sustainability assessment tools, reporting systems and best practices are presented as the main instruments to answer market and regulations sustainability requirements raised in the last decades. The approach used to treat the sustainable management of manufacturing systems is a holistic one since all the three sustainability dimensions are addressed (i.e. environment, economy and society) and the industrial activities considered include the design and the management of product, process and supply chain in an integrated way. The course is divided into two main blocks aiming at:

1. Defining what is meant by sustainability and present the role of standards and regulations into sustainable management systems;
2. Providing students with tools allowing to assess, report and communicate on sustainability performances of products and processes. The measure of sustainability level enable to monitor the management system effectiveness and to enhance performances.

Module content with weighting of different components

The sustainability concept applied into the industrial context: Course ID -01

- Introduction to sustainability: the concept and its history;
- The elements of sustainability implementation in industry;
- The implementation of Environmental, Health and Safety and Energy Management systems;
- Corporate Social Responsibility;
- Circular Economy concept

Sustainability Assessment, Reporting and Labelling: Course ID -02

- Assessing the environmental performances: the Life Cycle Assessment (LCA);
- The GHG Protocol;
- Environmental labeling of products.

Teaching and learning methods

Frontal theoretical lessons, case studies and exercises supported by the use of Life Cycle Impact Assessment databases.

Literature

ISO 14001

ISO 45001

ISO 50001

ISO 26000

ISO 14040 and 14044

ISO 14020 series

GHG Protocol

Assessment

Additional performance assessment during the semester

The module does not contain an additional performance assessment during the semester

Basic principle for exams

As a rule, all standard final exams are conducted in written form. For resit exams, lecturers will communicate the exam format (written/oral) together with the exam schedule.

Standard final exam for a module and written resit exam

Kind of exam

Written exam

Duration of exam

120 minutes

Permissible aids

No aids permitted

Exception: In case of an electronic Moodle exam, adjustments to the permissible aids may occur. Lecturers will announce the final permissible aids prior to the exam session.

Special case: Resit exam as oral exam

Kind of exam

Oral exam

Duration of exam

30 minutes

Permissible aids

No aids permitted

Module Description, available in: EN, FR

Privacy and Law

General Information

Number of ECTS Credits

3

Module code

CM_PrivLaw

Valid for academic year

2026-27

Last modification

2024-10-29

Coordinator of the module

Marc Fischer (HSLU, marc.fischer@hslu.ch)

Explanations regarding the language definitions for each location:

- Instruction is given in the language specified for each location and module execution.
- Documentation is available in the language(s) listed for each location and module execution. If the documentation is in multiple languages, the percentage distributed is indicated (100% = all documentation provided).
- The examination, including both questions and answers, is provided entirely (100%) in the language(s) specified for each location and module execution. The exams are on-site.

	Lausanne			Lugano	Zurich		
Instruction		**X** F 100%			**X** E 100%		
Documentation		**X** F 100%			**X** E 100%		
Examination		**X** F 100%			**X** E 100%		

Module Category

CM Context module

Profile Recommendations

This module is recommended for the following profiles:

	Lausanne	Zurich
Profile	CE, ICS, ME	CE, CS, DS, ICS, Geo, ReLa

Lessons

2 lecture periods and 1 tutorial period per week

Entry level competences

Prerequisites, previous knowledge

None

Brief course description of module objectives and content

In the Privacy and Law module, students gain an awareness of the threats to privacy & laws in the fast changing digital society and are prompted to reflect on values in the historical and intercultural context.
Students acquire an overview (system and reference knowledge) of actual legal aspects that have not been specifically covered in either the vocational baccalaureate or in the Bachelor's degree course. In the knowledge and information society these are, in particular, the legal aspects privat data protection, copyright, brand rights, patents, forms of collaboration in the digital economy, relevant contracts etc.

Aims, content, methods

Learning objectives and competencies to be acquired

Understanding the different dimensions of privacy. Thinking in the corresponding contexts. Transferring privacy aspects to and within the private and work environment and reflecting upon these, establishing links with learning content in the MRU and the technical modules.
Acquiring an appreciation of the legal aspects confronting an engineer in demanding professional situations. Gaining awareness in order to avoid damages due to infringements of rights or legal uncertainty. Acquisition of speaking and listening skills in order to conduct the corresponding specialist discussions with experts.

Module content with weighting of different components

- Introduction to law and the privacy aspects of law
- Knowledge of the industry relevant contracts (word & labour, licence, NDA, SLA etc.)
- Ventures in digital environment (forms, GeBüV, Compliance etc.)
- Knowledge of the creation and development of privacy as a fundamental/human right (GDPR included)
- Knowledge of IP-law (copyrights, trade marks, design, patents, unfair competition)
- Knowledge of legal aspects of new technologies as AI etc.
- Formative tests

Teaching and learning methods

(Online) Frontal instruction in the lectures (2 lessons per week)
(Online) Seminar-type teaching in the tutorials (1 lesson per week)

Literature

Lecture handouts provided by the lecturer and the references to current literature they contain

Assessment

Additional performance assessment during the semester

The module does not contain an additional performance assessment during the semester

Basic principle for exams

As a rule, all standard final exams are conducted in written form. For resit exams, lecturers will communicate the exam format (written/oral) together with the exam schedule.

Standard final exam for a module and written resit exam

Kind of exam

Written exam

Duration of exam

120 minutes

Permissible aids

Aids permitted as specified below:

Permissible electronic aids

Laptop

Other permissible aids

Open Book

Exception: In case of an electronic Moodle exam, adjustments to the permissible aids may occur. Lecturers will announce the final permissible aids prior to the exam session.

Special case: Resit exam as oral exam

Kind of exam

Oral exam

Duration of exam

30 minutes

Permissible aids

Aids permitted as specified below:

Permissible electronic aids

No electronic aids permitted

Other permissible aids

Open Book

Description du module, disponible en: EN, FR

La sphère privée et le droit

Informations générales

Nombre de crédits ECTS

3

Code du module

CM_PrivLaw

Valable pour l'année académique

2026-27

Dernière modification

2024-10-29

Coordinateur/coordinatrice du module

Marc Fischer (HSLU, marc.fischer@hslu.ch)

Explications concernant les langues d'enseignement par site :

- L'enseignement est dispensé dans la langue indiquée ci-dessous pour chaque site et chaque exécution du module.
- Les supports de cours sont disponibles dans les langues indiquées ci-dessous pour chaque site et chaque exécution du module. Lorsque plusieurs langues sont utilisées, la proportion de contenu disponible dans chaque langue est précisée (100 % = ensemble des supports de cours).
- Les examens (questions et réponses) sont entièrement rédigés dans la langue indiquée ci-dessous pour le site et l'exécution du module concernés. Ils se déroulent en présentiel.

	Lausanne			Lugano	Zurich		
Leçons		**X** F 100%			**X** E 100%		
Documentation		**X** F 100%			**X** E 100%		
Examen		**X** F 100%			**X** E 100%		

Catégorie de module

CM modules contextuels

Recommandations de profil

Ce module est recommandé pour les profils suivants :

	Lausanne	Zurich
Profil	CE, ICS, ME	CE, CS, DS, ICS, Geo, ReLa

Leçons

2 leçons et 1 leçon de pratique par semaine

Compétences préalables

Connaissances préalables, compétences initiales

Aucune

Brève description du contenu et des objectifs

Le module «Privacy and Law» sensibilise les étudiant-es aux menaces pesant sur la vie privée dans la société postmoderne et incite à la réflexion sur des valeurs dans les contextes interculturel et historique.
Les étudiants reçoivent une vue d'ensemble (connaissance de système et d'orientation) concernant les aspects juridiques, qui n'ont été spécialement thématisés ni dans le cadre de la maturité professionnelle ni dans les études de bachelor. Dans la société du Savoir et de l'Information, il s'agit là en particulier des aspects juridiques des biens immatériels comme les données, les droits d'auteur, brevets, les droits liés à la marque etc.

Objectifs, contenus, méthodes

Objectifs d'apprentissage, compétences à acquérir

Compréhension des différentes dimensions de la vie privée. Penser aux liens entre celles-ci. Transfert et réflexion des aspects de la vie privée sur et dans les environnements privé et professionnel, faire des liens avec les contenus d'apprentissage dans le Master Research Units et les modules techniques.
Sensibilisation à des aspects juridiques, auxquels les ingénieurs sont confrontés dans des situations professionnelles exigeantes. Acquérir une sensibilisation pour éviter des dommages à cause d'atteinte au droit ou d'incertitudes juridiques. Acquisition d'une compétence de discussion et d'écoute, pour pouvoir conduire des entretiens spécialisés appropriés avec des expert-es.

Contenu des modules avec pondération du contenu des cours

- Introduction au droit et à ses aspects de la vie privée
- Comprendre et réfléchir aux liens entre la protection des données, le droit d'auteur et la vie privée, et à leur interconnexion avec les développements technologiques, connaître les conflits d'objectifs
- Connaître l'apparition et le développement de la notion de «vie privée» dans les droits de l'homme / le droit fondamental
- Connaître les grandes lignes de la protection des données et de la personnalité
- Connaître les concepts du lancement d'alerte
- Connaître les grands principes du droit d'auteur
- Comprendre les possibilités et les limites des répercussions des droits en matière
- Connaître les grandes lignes des contrats importants dans l'industrie
- Connaître grandes lignes du droit des brevets
- Connaître les grandes lignes du droit des marques et du droit sur un design
- Evaluation formative

Méthodes d'enseignement et d'apprentissage

Cours magistral (en ligne) dans les cours (2 leçons par semaine)
Cours en séminaire (en ligne) dans les exercices (1 leçon par semaine)

Bibliographie

Handout du cours de l'enseignant-e et renvoi des notes à la littérature actuelle

Evaluation

Évaluation supplémentaire pendant le semestre

Le module ne comprend pas d'évaluation supplémentaire pendant le semestre

Principe pour les examens

En règle générale, tous les examens réguliers de fin de module se déroulent sous forme écrite. Concernant les examens de répétition, leur format (écrit ou oral) sera communiqué par l'enseignant-e en même temps que le calendrier des examens.

Examen de fin de module régulier et examen écrit de répétition

Type de l'examen

Examen écrit

Durée de l'examen

120 minutes

Aides autorisées

Les aides suivantes sont autorisées:

Aides électroniques autorisées

Laptop

Autres aides autorisées

Open Book

Exception : En cas d'examen électronique sur Moodle, des modifications des aides autorisées peuvent survenir. Dans ce cas, les aides

autorisées seront annoncées par les enseignant-e-s avant l'examen.

Cas spécial: examen de répétition oral

Type de l'examen

Examen oral

Durée de l'examen

30 minutes

Aides autorisées

Les aides suivantes sont autorisées:

Aides électroniques autorisées

Aucune aide électronique autorisée

Autres aides

Open Book

Module Description, available in: EN, FR

Quality and Risk Management

General Information

Number of ECTS Credits

3

Module code

CM_QRM

Valid for academic year

2026-27

Last modification

2025-10-16

Coordinator of the module

Clotaire Michel (ZHAW, micc@zhaw.ch)

Explanations regarding the language definitions for each location:

- Instruction is given in the language specified for each location and module execution.
- Documentation is available in the language(s) listed for each location and module execution. If the documentation is in multiple languages, the percentage distributed is indicated (100% = all documentation provided).
- The examination, including both questions and answers, is provided entirely (100%) in the language(s) specified for each location and module execution. The exams are on-site.

	Lausanne			Lugano	Zurich		
Instruction		**X** F 100%		**X** E 100%	**X** E 100%		
Documentation		**X** F 100%		**X** E 100%	**X** E 100%		
Examination		**X** F 100%		**X** E 100%	**X** E 100%		

Module Category

CM Context module

Profile Recommendations

This module is recommended for the following profiles:

	Lausanne	Lugano	Zurich
Profile	DS, ICS, ME, Mic	CS, DS, ME	ME, MA, Med

Lessons

2 lecture periods and 1 tutorial period per week

Entry level competences

Prerequisites, previous knowledge

no

Brief course description of module objectives and content

The CM_QRM addresses the most relevant basics in integrated quality and risk management. Theory is applied and specified by examples and case studies. The module concentrates on current standards and best practices on quality and risk management and introduces the most established approaches.

Aims, content, methods

Learning objectives and competencies to be acquired

The students realise that quality and risk management is an integral guiding process at enterprises that covers quality assurance as well as comprehensive product and system design, development, optimisation.

Quality management

- The students know and understand the close relation of integral QRM in enterprises and organisations.
- They understand that this concerns the change management on organisation level as well as on individual level of staff.
- They know and understand the principles of how to use QM processes.
- They are able to explain the characteristics of most relevant normative quality assurance models.
- They know and understand the most relevant tools and Best Practices in usage, implementation and control of QM processes.
- They understand the pre-conditions of how to achieve and assure a QM certification.

Risk management

- The students know the most relevant national and international Best Practices and standards in risk management and risk engineering.
- They know the most relevant risk assessment approaches, how to use them and to relate them into the context of operational risk management.
- They understand the concept of integrated risk management: they know significant interfaces to other management processes as well as to the areas of environment, society and policy.
- They are able to conduct exemplary case studies (with regard to risk identification, analysis and evaluation).
- They are able to analyse similar problems, to develop solutions and to evaluate them.

Module content with weighting of different components

Quality Management QM

- Introduction to Module QRM
- Quality Management (Levels of QM, factors influencing quality, quality improvement, Deming circle, Concept and role of customer satisfaction “Kano Model”, Customer Experience Management)
- Process Management System
- Overview of, e.g., specified ISO Norms on QM, environment, safety corporate social responsibility (ISO 9001:2015, ISO 14001:2015, OHSAS 18001:2007, ISO 26000)
- Total Quality Management TQM (Philosophy, connect to Deming)
- Business Excellence (Excellence term, what it stands for, relation to EFQM Model)
- EFQM[1)] Model (Fundamental concepts, criteria model, RADAR[2)] Logic, implementation, innovation processes)
- Quality 4.0
- Synopsis (Review of main aspects in integrated quality management)

[1)]: European Foundation for Quality Management; [2)]: Results, Approach, Deployment, Assessment, Refinement

Risk Management RM

- Introduction of basic principles of risk management
- Entrepreneurial RM policy (context, case studies)
- Principles of risk assessment and risk engineering (basic concepts, definitions)
- Risk identification: Fishbone Diagram, Bow Tie Analysis, Failure Mode and Effects Analysis (FMEA)
- Risk analysis (scenario analysis, basics of reliability analysis including fault tree analysis, event tree analysis)
- Risk evaluation (risk matrix, Frequency/Consequence curves)
- Synopsis (Review of main aspects in integrated risk management)

Teaching and learning methods

Frontal theoretical lessons
Practical excercises
Case studies

Literature

ISO 9000, EFQM, ISO 31000:2018, ISO 31010:2019, ONR 49000ff:2014
Literature on QM und RM (electronically distributed).

Assessment

Additional performance assessment during the semester

The module contains additional performance assessment(s) during the semester. The achieved mark of the additional performance assessment(s) applies to both the regular and the resit exam.

Description of additional performance assessment during the semester

30% of the grade will be awarded based on work performed during the semester.

Basic principle for exams

As a rule, all standard final exams are conducted in written form. For resit exams, lecturers will communicate the exam format (written/oral) together with the exam schedule.

Standard final exam for a module and written resit exam

Kind of exam

Written exam

Duration of exam

120 minutes

Permissible aids

Aids permitted as specified below:

Permissible electronic aids

- Literature
- Course slides
- Personal notes
- Any other document that has been created before the beginning of the exam
- Internet connection is allowed
- Queries to AI-tools such as Chat-GPT, Google Search or DeepL are not allowed

Other permissible aids

No other aids permitted

Exception: In case of an electronic Moodle exam, adjustments to the permissible aids may occur. Lecturers will announce the final permissible aids prior to the exam session.

Special case: Resit exam as oral exam

Kind of exam

Oral exam

Duration of exam

30 minutes

Permissible aids

No aids permitted

Description du module, disponible en: EN, FR

Qualité et gestion du risque

Informations générales

Nombre de crédits ECTS

3

Code du module

CM_QRM

Valable pour l'année académique

2026-27

Dernière modification

2025-10-16

Coordinateur/coordinatrice du module

Clotaire Michel (ZHAW, micc@zhaw.ch)

Explications concernant les langues d'enseignement par site :

- L'enseignement est dispensé dans la langue indiquée ci-dessous pour chaque site et chaque exécution du module.
- Les supports de cours sont disponibles dans les langues indiquées ci-dessous pour chaque site et chaque exécution du module. Lorsque plusieurs langues sont utilisées, la proportion de contenu disponible dans chaque langue est précisée (100 % = ensemble des supports de cours).
- Les examens (questions et réponses) sont entièrement rédigés dans la langue indiquée ci-dessous pour le site et l'exécution du module concernés. Ils se déroulent en présentiel.

	Lausanne			Lugano	Zurich		
Leçons		**X** F 100%		**X** E 100%	**X** E 100%		
Documentation		**X** F 100%		**X** E 100%	**X** E 100%		
Examen		**X** F 100%		**X** E 100%	**X** E 100%		

Catégorie de module

CM modules contextuels

Recommandations de profil

Ce module est recommandé pour les profils suivants :

	Lausanne	Lugano	Zurich
Profil	DS, ICS, ME, Mic	CS, DS, ME	ME, MA, Med

Leçons

2 leçons et 1 leçon de pratique par semaine

Compétences préalables

Connaissances préalables, compétences initiales

aucun

Brève description du contenu et des objectifs

Le module a pour objectif de transmettre les bases fondamentales de la gestion du risque et de la qualité, en concrétisant la théorie par des exemples tirés de la pratique. Outre qu'il s'oriente sur les normes actuelles et les bonnes pratiques en vigueur dans le domaine de la gestion du risque et de la qualité, ce module introduit aux méthodes éprouvées.

Objectifs, contenus, méthodes

Objectifs d'apprentissage, compétences à acquérir

Les étudiantes et étudiants comprennent que la gestion du risque et de la qualité est un processus de gestion global, ayant plus particulièrement pour objectifs l'assurance qualité ainsi que le développement de l'ensemble des produits et du système.

Gestion de la qualité

- Les étudiantes et étudiants connaissent et comprennent le lien étroit unissant gestion globale de la qualité et gestion du risque dans les entreprises et les organisations.
- Ils comprennent que cette démarche implique une gestion du changement, au niveau de l'organisation d'une part et au niveau individuel des collaboratrices et collaborateurs d'autre part.
- Ils connaissent et comprennent les principes régissant l'application des processus d'assurance qualité.
- Ils sont capables d'expliquer les principales caractéristiques des modèles normatifs d'assurance qualité les plus importants.
- Ils connaissent et comprennent les principaux instruments et les meilleures pratiques en matière d'utilisation, de mise en œuvre et d'évaluation des processus d'assurance qualité.
- Ils comprennent les exigences auxquelles il faut répondre afin d'obtenir et de pérenniser une certification dans le domaine de la gestion de qualité.

Gestion du risque

- Les étudiantes et étudiants connaissent les normes et les standards actuels les plus importants en matière de gestion du risque, aux niveaux national et international.
- Ils connaissent les principales méthodes d'appréciation du risque et sont capables de les utiliser et de les mettre en œuvre dans un contexte de gestion du risque en entreprise.
- Ils comprennent le concept de gestion intégrée du risque : ils connaissent les interdépendances importantes avec d'autres processus de management, ainsi qu'avec l'environnement, la société et la politique.
- Ils sont en mesure d'effectuer des études de cas (c'est-à-dire d'identifier, d'analyser et d'évaluer les risques).
- Ils sont capables d'analyser des problèmes analogues, de développer des solutions et de les évaluer.

Contenu des modules avec pondération du contenu des cours

Gestion de la qualité

- Introduction au module relatif à l'assurance qualité
- Gestion de la qualité (niveaux de gestion de la qualité, facteurs influençant la qualité, amélioration de la qualité, cercle Deming, concept et rôle du « modèle de Kano » sur la satisfaction de la clientèle, Management ou Customer Experience)
- Gestion du processus (système de gestion globale du processus)
- Aperçu des normes par ex. spécifiées sur la gestion de la qualité, l'environnement, la sécurité, la responsabilité sociale de l'entreprise (ISO 9001:2015, ISO 14001:2015, OHSAS 18001:2007, ISO 26000)
- Gestion totale de la qualité (philosophie, lien avec Deming)
- Excellence commerciale (terme « excellence », ce qu'il représente, lien avec le modèle EFQM)
- Modèle EFQM[1)] (concepts fondamentaux, modèle de critères, logique RADAR[2)], mise en œuvre, processus d'innovation)
- Qualité 4.0
- Récapitulatif (passage en revue des aspects centraux de la gestion de la qualité intégrée)

[1)]; European Foundation for Quality Management ; [2)]: Results, Approach, Deployment, Assessment, Refinement

Gestion du risque

- Introduction au principes fondamentaux de la gestion du risque
- Politique entrepreneuriale de la gestion du risque (contexte, cas de figure)
- Principes l'appréciation du risque (concepts de base, définitions)
- Identification des risques (diagramme en arêtes de poisson, méthode d'analyse dite du nœud papillon, Analyse des modes de défaillances et de leurs effets, AMDEC (FMEA Failure Mode and Effects Analysis)
- Analyse des risques: analyse de scénarios, bases de l'analyse de la fiabilité y c. arbres d'événements (ETA), arbres de défaillance (FTA)
- Évaluation des risques (matrice des risques, courbes fréquence/conséquence)
- Récapitulatif (passage en revue des aspects centraux de la gestion du risque intégrée)

Méthodes d'enseignement et d'apprentissage

Enseignement théorique frontal
Travaux dirigés pratiques
Résolution de cas de figure

Bibliographie

ISO 9000, EFQM, ISO 31000:2018, ISO 31010:2019, ONR 49000
Bibliographie concernant la gestion de la qualité et la gestion du risque (distribuée électroniquement)

Evaluation

Évaluation supplémentaire pendant le semestre

Le module comprend une ou des évaluation(s) supplémentaire(s) pendant le semestre. La note obtenue pour la ou les évaluation(s) supplémentaire(s) est valable à la fois pour l'examen final et pour l'examen de répétition.

Description de l'évaluation supplémentaire pendant le semestre

Le travail effectué pendant le semestre compte pour 30% de la note finale

Principe pour les examens

En règle générale, tous les examens réguliers de fin de module se déroulent sous forme écrite. Concernant les examens de répétition, leur format (écrit ou oral) sera communiqué par l'enseignant-e en même temps que le calendrier des examens.

Examen de fin de module régulier et examen écrit de répétition

Type de l'examen

Examen écrit

Durée de l'examen

120 minutes

Aides autorisées

Les aides suivantes sont autorisées:

Aides électroniques autorisées

- littérature
- support de cours
- notes personnelles
- Tout document créé avant le début de l'examen
- Connexion à Internet autorisée
- Requêtes à des outils d'IA comme Chat-GPT, recherche Google ou DeepL interdites

Autres aides autorisées

Aucune autre aide autorisée

Exception : En cas d'examen électronique sur Moodle, des modifications des aides autorisées peuvent survenir. Dans ce cas, les aides autorisées seront annoncées par les enseignant-e-s avant l'examen.

Cas spécial: examen de répétition oral

Type de l'examen

Examen oral

Durée de l'examen

30 minutes

Aides autorisées

Sans aides

Module Description, available in: EN

Smart services

General Information

Number of ECTS Credits

3

Module code

CM_SmartSer

Valid for academic year

2026-27

Last modification

2024-10-08

Coordinator of the module

Jürg Meierhofer (ZHAW, meeo@zhaw.ch)

Explanations regarding the language definitions for each location:

- Instruction is given in the language specified for each location and module execution.
- Documentation is available in the language(s) listed for each location and module execution. If the documentation is in multiple languages, the percentage distributed is indicated (100% = all documentation provided).
- The examination, including both questions and answers, is provided entirely (100%) in the language(s) specified for each location and module execution. The exams are on-site.

	Lausanne			Lugano	Zurich		
Instruction					**X** E 100%		
Documentation					**X** E 100%		
Examination					**X** E 100%		

Module Category

CM Context module

Profile Recommendations

This module is recommended for the following profiles:

	Zurich
Profile	BE, DS

Lessons

2 lecture periods and 1 tutorial period per week

Entry level competences

Prerequisites, previous knowledge

Prior to joining the module, the students should have an understanding of business process modeling and engineering, e.g., terms like process charts, swimlanes, process models, resources, value chain etc. (see, e.g., the paper of John Krogstie: Introduction to Business Processes and Business Process Modeling, https://link.springer.com/chapter/10.1007/978-3-319-42512-2_1)

Brief course description of module objectives and content

Smart Service Design and Engineering - Value Creation:

- Basics of Smart Service Design (Customer insight, customer journey, value proposition design, use of data insights)
- Selected topics of Service Science and Service Dominant Logic
- Service blueprinting as a relevant step in the service engineering process
- Characteristics of Data Services and Data Products
- Use of data in the smart service design process and in the services themselves - Smart Data
- data sources
- Iterative improvement up to product maturity
- Discussion of applications in the industrial and the sector
- Discussion of real-life cases

Smart Business Model Design - Value Capturing:

- Fundamentals for Engineering Value Flows in Service Ecosystems and Service Business Models
- From Service Blueprint to Business Model
- Quantification of service business models
- Basics Business Model Design and Business Model Canvas
- Service Ecosystem Design
- Quantification of the business model
- Discussion of real-life cases

Data Protection, Data Security, Data Ethics:

- Fundamentals of data protection and data security
- Relevant aspects for Data Product Design
- Legal aspects vs. ethics
- Discussion of real-life cases

Aims, content, methods

Learning objectives and competencies to be acquired

- Understand and apply the essential principles of Smart Service Design and Engineering - i.e. the development of intelligent services on the basis of data (comprehensive methods for the development of novel data-driven services, for their operation as well as their improvement in operations).
- Able to integrate the data specific aspects into their service design.
- Apply the methods of data-driven service engineering in practical case studies primarily in industrial envi-ronments (B2B), but also in consumer areas (B2C)
- Know and understand the relevant basics of Service Business Model Design including the types of industrial Service Models.
- Evaluate these business models quantitatively. To weigh up variants and draw conclusions about the engineering process with the aim of achieving an opera-tionally and economically balanced model.
- Understand the design of service ecosystems.
- Able to understand the essential principles of data protection, data security, and data ethics.

Module content with weighting of different components

Smart Service Design and Engineering - Value Creation: 40%
Smart Business Model Design - Value Capturing: 40%
Data Protection, Data Security, Data Ethics: 20%

Teaching and learning methods

- Lectures
- Group work, presentation and discussion of case studies
- Self study of papers and analysis of business case studies

Literature

- A. Wierse, T. Riedel: Smart Data Analytics, Walter de Gruyter, 2017.
- A. Polaine, L. Løvlie, B. Reason, Service Design: From Insight to Implementation, Rosenfeld, 2013.
- A. Osterwalder, Y. Pigneur et al., Value Proposition Design: How to Create Products and Services Customers Want, Wiley, 2014.
- E. Siegel, Predictive Analytics: The Power to Predict Who Will Click, Buy, Lie, or Die, Wiley, 2016.
- F. Provost, T. Fawcett, Data Science for Business: What you need to know about data mining and data-analytic thinking, O'Reilly, 2013.
- A. Osterwalder, Y. Pigneur, Business Model Generation, Wiley, 2010.
- C. Kowalkowski, W. Ulaga: Service strategy in action: a practical guide for growing your B2B service and solution business, Service Strategy Press, 2017.

- O. Gassmann, K. Frankenberger, M. Csik: Business Model Navigator: 55 Models That Will Revolutionise Your Business, Harlow Pearson, 2014.
- D. S. Evans, R. Schmalensee, Matchmakers, Matchmakers: The New Economics of Multisided Platforms, Harvard Business Review Press, 2016.
- W. Stallings, Cryptography and Network Security: Principles and Practice (7th Edition), Pearson, 2016.
- N. Passadelis et al., Datenschutzrecht, Beraten in Privatwirtschaft und öffentlicher Verwaltung, Basel 2015.
- Stickdorn, Marc, Markus Edgar Hormess, Adam Lawrence, and Jakob Schneider 2018: This Is Service Design Doing: Applying Service Design Thinking in the Real World. O'Reilly Media, Inc.

Assessment

Additional performance assessment during the semester

The module does not contain an additional performance assessment during the semester

Basic principle for exams

As a rule, all standard final exams are conducted in written form. For resit exams, lecturers will communicate the exam format (written/oral) together with the exam schedule.

Standard final exam for a module and written resit exam

Kind of exam

Written exam

Duration of exam

120 minutes

Permissible aids

Aids permitted as specified below:

Permissible electronic aids

- open book, all materials including PC, laptop, tablets etc. allowed
- during the exam session, any telecommunication (network, wifi, bluetooth, wlan etc.) and the respective programs/apps for communications must be turned off

Other permissible aids

No other aids permitted

Exception: In case of an electronic Moodle exam, adjustments to the permissible aids may occur. Lecturers will announce the final permissible aids prior to the exam session.

Special case: Resit exam as oral exam

Kind of exam

Oral exam

Duration of exam

30 minutes

Permissible aids

Aids permitted as specified below:

Permissible electronic aids

- open book, all materials including PC, laptop, tablets etc. allowed
- during the exam session, any telecommunication (network, wifi, bluetooth, wlan etc.) and the respective programs/apps for communications must be turned off

Other permissible aids

No other aids permitted

Module Description, available in: EN, FR

Sustainable Development

General Information

Number of ECTS Credits

3

Module code

CM_SustDev

Valid for academic year

2026-27

Last modification

2020-02-10

Coordinator of the module

Grégoire Meylan (FHNW, gregoire.meylan@fhnw.ch)

Explanations regarding the language definitions for each location:

- Instruction is given in the language specified for each location and module execution.
- Documentation is available in the language(s) listed for each location and module execution. If the documentation is in multiple languages, the percentage distributed is indicated (100% = all documentation provided).
- The examination, including both questions and answers, is provided entirely (100%) in the language(s) specified for each location and module execution. The exams are on-site.

	Lausanne			Lugano	Zurich		
Instruction		**X** F 100%			**X** E 100%		
Documentation		**X** F 70%	**X** E 30%		**X** E 100%		
Examination		**X** F 100%			**X** E 100%		

Module Category

CM Context module

Profile Recommendations

This module is recommended for the following profiles:

	Lausanne	Zurich
Profile	EnEn, Mic	EnEn, Med, BT, ReLa

Lessons

2 lecture periods and 1 tutorial period per week

Entry level competences

Prerequisites, previous knowledge

Brief course description of module objectives and content

Sustainable development is essential for many parts of modern society. This module provides an overview of the history of sustainable development, of established concepts, as well as of relevant initiatives and organisations globally and in Switzerland. Further, methodologies and tools are introduced for engineers to contribute to sustainable development on a technical level. Students learn the fields of application of the various methods as well as their strengths and weaknesses. They learn to apply the tools to analyze and improve the ecological performance of products and industrial processes.

Aims, content, methods

Learning objectives and competencies to be acquired

The students ...

- can define the term sustainable development and related concepts and know their similarities and differences as well as their history.
- understand the national and international debates, agendas and policy approaches to sustainable development and are able to consider what they mean in the context of their own field of study.
- are able to identify the roles of important stakeholders in sustainable development decision making.
- are able to analyze the implications of sustainable development for organizations, their executives and employees. Based on cases from various sectors, students are able to develop suitable strategies for action.
- understand what they personally can do to become more socially and environmentally responsible in their future professional and personal lives.
- know and understand different technical concepts to achieve a sustainable economy, sustainable business models and sustainable product design.
- know the most relevant tools for technical sustainability analysis and ecodesign, their fields of applications, strengths and weaknesses.
- are able to select the appropriate methods and tools when confronted with a specific technical sustainability problem.
- are able to interpret results generated with these methods and derive system optimizations.
- are able to identify, analyze and discuss sustainability-related challenges and issues and to develop problem-oriented solutions.
- are able to communicate and enact these solutions confidently and effectively.

Module content with weighting of different components

- The global challenge of sustainability. Climate change, the end of the fossil age, planetary boundaries, global footprint.
- Sustainable development goals and their implications, other concepts.
- Organisations, political panels and global structure regarding sustainability and climate change, international negotiations and concepts (e.g. Paris agreement).
- Business concepts and examples of sustainability (Dyllick, GRI, Global Compact etc.)
- National aspects for the transformation (decarbonisation) of the existing building stock and related infrastructure
- Technical concepts to achieve a sustainable economy (industrial ecology, circular economy, etc.)
- Theory and practice of sustainability analysis and ecodesign methodologies and tools (substance flow analysis, life cycle assessment, a.o.)

Teaching and learning methods

- Lectures
- Exercises
- Group discussion
- Moderated plenary discussion
- Post-decision case studies
- Guest speaker
- Reflective paper

Literature

Global challenge

- Come on, A Report to the Club of Rome; E.U. von Weizsäcker 2017
- Haski-Leventhal, D. (2018): Strategic Corporate Social Responsibility: Tools and Theories for Responsible Management; Los Angeles: SAGE
- Sachs, J. D. (2015): The Age of Sustainable Development; New York: Columbia University Press.

Concepts and tools

- Towards the circular economy, Vol. 1-3. Ellen MacArthur Foundation, https://www.ellenmacarthurfoundation.org/publications
- Technologies and Eco-innovation towards Sustainability I, Eco Design of Products and Services, Editors: Hu, A.H., Matsumoto, M., Kuo, T.C., Smith, S. (Eds.), https://www.springer.com/gp/book/9789811311802
- Life Cycle Assessment - Theory and Practice - Editors: Hauschild, Michael, Rosenbaum, Ralph K., Olsen, Stig (Eds.), ISBN 978-3-319-56475-3, https://www.springer.com/gp/book/9783319564746
- Handbook of Material Flow Analysis: For Environmental, Resource, and Waste Engineers, Second Edition, ISBN 9781498721349 - CAT# K25579, https://www.crcpress.com/Handbook-of-Material-Flow-Analysis-For-Environmental-Resource-and-Waste/Brunner-Rechberger/p/book/9781498721349,

Assessment

Additional performance assessment during the semester

The module contains additional performance assessment(s) during the semester. The achieved mark of the additional performance assessment(s) applies to both the regular and the resit exam.

Description of additional performance assessment during the semester

Two group projects carried out in parallel to standard instruction as part of guided independent study (30% of final grade).

Basic principle for exams

As a rule, all standard final exams are conducted in written form. For resit exams, lecturers will communicate the exam format (written/oral) together with the exam schedule.

Standard final exam for a module and written resit exam

Kind of exam

Written exam

Duration of exam

120 minutes

Permissible aids

Aids permitted as specified below:

Permissible electronic aids

No electronic aids permitted

Other permissible aids

Open book. Literature and notes from the lecture.
Exception: In case of an electronic Moodle exam, adjustments to the permissible aids may occur. Lecturers will announce the final permissible aids prior to the exam session.

Special case: Resit exam as oral exam

Kind of exam

Oral exam

Duration of exam

30 minutes

Permissible aids

Aids permitted as specified below:

Permissible electronic aids

No electronic aids permitted

Other permissible aids

Open book. Literature and notes from the lecture.

Description du module, disponible en: EN, FR

Sustainable Development

Informations générales

Nombre de crédits ECTS

3

Code du module

CM_SustDev

Valable pour l'année académique

2026-27

Dernière modification

2020-02-10

Coordinateur/coordinatrice du module

Grégoire Meylan (FHNW, gregoire.meylan@fhnw.ch)

Explications concernant les langues d'enseignement par site :

- L'enseignement est dispensé dans la langue indiquée ci-dessous pour chaque site et chaque exécution du module.
- Les supports de cours sont disponibles dans les langues indiquées ci-dessous pour chaque site et chaque exécution du module. Lorsque plusieurs langues sont utilisées, la proportion de contenu disponible dans chaque langue est précisée (100 % = ensemble des supports de cours).
- Les examens (questions et réponses) sont entièrement rédigés dans la langue indiquée ci-dessous pour le site et l'exécution du module concernés. Ils se déroulent en présentiel.

	Lausanne			Lugano	Zurich		
Leçons		**X** F 100%			**X** E 100%		
Documentation		**X** F 70%	**X** E 30%		**X** E 100%		
Examen		**X** F 100%			**X** E 100%		

Catégorie de module

CM modules contextuels

Recommandations de profil

Ce module est recommandé pour les profils suivants :

	Lausanne	Zurich
Profil	EnEn, Mic	EnEn, Med, BT, ReLa

Leçons

2 leçons et 1 leçon de pratique par semaine

Compétences préalables

Connaissances préalables, compétences initiales

Brève description du contenu et des objectifs

Le développement durable est essentiel dans de nombreux domaines de la société moderne. Ce module donne un aperçu de l'histoire du développement durable, des concepts établis, ainsi que des initiatives et organisations pertinentes dans le monde et en Suisse.

En outre, il présente des méthodologies et des outils qui permettent aux ingénieurs de contribuer au développement durable sur le plan technique. Les étudiants apprennent les domaines d'application des différentes méthodes ainsi que leurs points forts et leurs points faibles. Ils apprennent à appliquer les outils pour analyser et améliorer la performance écologique des produits et des processus industriels.

Objectifs, contenus, méthodes

Objectifs d'apprentissage, compétences à acquérir

Les étudiant-e-s ...

- sont capables de définir le terme de développement durable et les concepts connexes et en connaître les similitudes et les différences ainsi que l'histoire.
- comprennent les débats, les programmes et les approches politiques nationaux et internationaux en matière de développement durable et sont capables d'examiner ce qu'ils signifient dans le contexte de leur propre domaine d'étude.
- sont capables d'identifier les rôles des acteurs importants dans la prise de décision en matière de développement durable.
- sont capables d'analyser les implications du développement durable pour les organisations, les cadres et les employés.
- sont capables d'élaborer des stratégies d'action appropriées sur la base de cas provenant de divers secteurs
- comprennent comment agir de manière plus responsable sur le plan social et environnemental dans leur future vie professionnelle et personnelle.
- reconaissent et comprennent différents concepts techniques pour parvenir à une économie durable, à des modèles commerciaux durables et à une conception durable des produits.
- connaissent les outils les plus pertinents pour l'analyse technique de la durabilité et l'écoconception, leurs domaines d'application, leurs forces et leurs faiblesses.
- sont capables de sélectionner les méthodes et les outils appropriés lorsqu'ils sont confrontés à un problème spécifique de durabilité technique.
- sont capables d'interpréter les résultats générés par ces méthodes et d'en déduire des optimisations de systèmes.
- sont capables d'identifier, d'analyser et de discuter des défis et des problèmes liés à la durabilité et d'élaborer des solutions appropriées.
- sont capables de communiquer et de mettre en œuvre résoluement et efficacement ces solutions.

Contenu des modules avec pondération du contenu des cours

- Le défi global de durabilité. Le changement climatique, la fin de l'ère fossile, les frontières planétaires, l'empreinte globale.
- Les objectifs de développement durable et leurs implications, autres concepts.
- Organisations, groupes politiques et structure mondiale concernant la durabilité et le changement climatique, les négociations et les concepts internationaux (par exemple, l'Accord de Paris).
- Concepts commerciaux et exemples de durabilité (Dyllick, GRI, Global Compact, etc.)
- Aspects nationaux de la transformation (décarbonisation) du parc immobilier existant et des infrastructures connexes
- Concepts techniques pour parvenir à une économie durable (écologie industrielle, économie circulaire, etc.)
- Théorie et pratique des méthodes et outils d'analyse de la durabilité et d'écoconception (analyse des flux de substances, analyse du cycle de vie, etc.)

Méthodes d'enseignement et d'apprentissage

- Cours
- Exercices
- Discussions de groupe
- Discussions en plénière avec modérateur
- Etudes de cas post-décision
- Orateur invité
- Document de réflexion

Bibliographie

Défi global

- Come on, A Report to the Club of Rome; E.U. von Weizsäcker 2017
- Haski-Leventhal, D. (2018): Strategic Corporate Social Responsibility: Tools and Theories for Responsible Management; Los Angeles: SAGE
- Sachs, J. D. (2015): The Age of Sustainable Development; New York: Columbia University Press.

Concepts et outils

- Towards the circular economy, Vol. 1-3. Ellen MacArthur Foundation, https://www.ellenmacarthurfoundation.org/publications
- Technologies and Eco-innovation towards Sustainability I, Eco Design of Products and Services, Editors: Hu, A.H., Matsumoto, M., Kuo, T.C., Smith, S. (Eds.), https://www.springer.com/gp/book/9789811311802
- Life Cycle Assessment - Theory and Practice - Editors: Hauschild, Michael, Rosenbaum, Ralph K., Olsen, Stig (Eds.), ISBN 978-3-319-56475-3, https://www.springer.com/gp/book/9783319564746
- Handbook of Material Flow Analysis: For Environmental, Resource, and Waste Engineers, Second Edition, ISBN 9781498721349 - CAT# K25579, https://www.crcpress.com/Handbook-of-Material-Flow-Analysis-For-Environmental-Resource-and-Waste/Brunner-Rechberger/p/book/9781498721349,

Evaluation

Évaluation supplémentaire pendant le semestre

Le module comprend une ou des évaluation(s) supplémentaire(s) pendant le semestre. La note obtenue pour la ou les évaluation(s) supplémentaire(s) est valable à la fois pour l'examen final et pour l'examen de répétition.

Description de l'évaluation supplémentaire pendant le semestre

Deux projets de groupe menés parallèlement à l'enseignement standard dans le cadre d'une étude indépendante guidée (30% de la note finale).

Principe pour les examens

En règle générale, tous les examens réguliers de fin de module se déroulent sous forme écrite. Concernant les examens de répétition, leur format (écrit ou oral) sera communiqué par l'enseignant-e en même temps que le calendrier des examens.

Examen de fin de module régulier et examen écrit de répétition

Type de l'examen

Examen écrit

Durée de l'examen

120 minutes

Aides autorisées

Les aides suivantes sont autorisées:

Aides électroniques autorisées

Aucune aide électronique autorisée

Autres aides autorisées

Livre ouvert. Bibliographie et notes de cours

Exception : En cas d'examen électronique sur Moodle, des modifications des aides autorisées peuvent survenir. Dans ce cas, les aides autorisées seront annoncées par les enseignant-e-s avant l'examen.

Cas spécial: examen de répétition oral

Type de l'examen

Examen oral

Durée de l'examen

30 minutes

Aides autorisées

Les aides suivantes sont autorisées:

Aides électroniques autorisées

Aucune aide électronique autorisée

Autres aides

Livre ouvert. Bibliographie et notes de cours

Module Description, available in: EN

Technology Management

General Information

Number of ECTS Credits

3

Module code

CM_TechMgmt

Valid for academic year

2026-27

Last modification

2024-10-18

Coordinator of the module

Michele Kellerhals (HSLU, michele.kellerhals@hslu.ch)

Explanations regarding the language definitions for each location:

- Instruction is given in the language specified for each location and module execution.
- Documentation is available in the language(s) listed for each location and module execution. If the documentation is in multiple languages, the percentage distributed is indicated (100% = all documentation provided).
- The examination, including both questions and answers, is provided entirely (100%) in the language(s) specified for each location and module execution. The exams are on-site.

	Lausanne			Lugano	Zurich		
Instruction					**X** E 100%		
Documentation					**X** E 100%		
Examination					**X** E 100%		

Module Category

CM Context module

Profile Recommendations

This module is recommended for the following profiles:

	Zurich
Profile	BE, EIE, Pho

Lessons

2 lecture periods and 1 tutorial period per week

Entry level competences

Prerequisites, previous knowledge

The module is particularly recommended to students subscribed to one of the following specialization areas:

- Business Engineering
- Energy & Environment
- Medical Engineering
- Mechanical Engineering
- Mechatronics & Automation

- Electrical Engineering
- Data Science
- Computer Science
- Phtotonics
- Aviation

Brief course description of module objectives and content

The module describes the practical and theoretical framework of Technology Management, and explains the lifecycle and application of technologies and the related tools and activities used in Technology Management applied to practical case studies.

Aims, content, methods

Learning objectives and competencies to be acquired

1. Students understand the elements and the application areas of Technology Management.
2. Students are familiar with the practical and theoretical framework of Technology Management and understand its importance for innovative operating companies.
3. Students learn how companies select and work with technologies.
4. Students know how to manage technology throughout its lifecycle phases and understand the influence of technology on profitability and risk exposure for companies.
5. Students know how to deal with business stakeholders relevant for Technology Management
6. Students know how to develop a technology roadmap
7. Students are able to contribute to and organize a virtual cross-disciplinary technology management team and to jointly produce a project output

Module content with weighting of different components

Technologies are among the most important strategic and operational assets of product and process driven companies. The module deals with managing technologies to enable companies to achieve competitive advantage and differentiation by sound technological innovation management. The focus of the module is on management of technology throughout its lifecycle, thus complementing topics such as Strategy, Innovation, Solutions, Product and Service Management, covering strategic and operational aspects including technology evaluation, selection, planning, development/provision, implementation, distribution, exploitation. Examples of new push technologies will be considered in the context of case studies of product/service innovations and discussed as group work. The module conveys comprehensive knowledge required for TM, e.g. technology trend analysis, technology scouting and recognition, technology roadmapping, lifecycle management, portfolio management, competitive strategies, protection, IPR- and knowledge management, corporate technology management and technology assessment. Each group will work on a case study of a real company and producing a technology roadmap as the main final semester project deliverable.

The Syllabus spread across the Semester is equally incorporated into the written exam.

Learning goal 7 "Collaboration" is spread across the semester week. Failure to equally collaborate with team members in the summative Team Project (as per MSE regulation), i.e. not reaching the correspnding learning goal 7 will lead automatically to a the entire Semestergrade Grade = 1.0 (33% of the module grade).

Teaching and learning methods

The module is taught by theory inputs, illustrative examples, case studies, discussion of controversal questions and exercises.The concept of flipped classroom is applied where possible. Content is applied in the context of a case-study based project assignment to be developed in a crossdiciplinary virtual team setting. Teams will present content using role-based pitching techniques.

Students will self-select Technology fields from a list to work on nd apply the technology fields to a company business, with the objective of producing a technology roadmap. This will be summarized in a report and documented on aweekly basis using a collaborative online Platform .

Literature

[1] Technology Management; Dilek Cetindamar, Rob Phaal, David Probert; ISBN 9780230233348.

Assessment

Additional performance assessment during the semester

The module contains additional performance assessment(s) during the semester. The achieved mark of the additional performance assessment(s) applies to both the regular and the resit exam.

Description of additional performance assessment during the semester

The module grade consists of 33% Semestergrade and 67% Module exam. The Semestergrade consists of:

- 50% individual written exam (30min) covering the student`s semester case study (date will be communicated at start of the module)
- 50% grading consisting of a written group case study report (criteria and hand-in date will be communicated at start of the module)

Basic principle for exams

As a rule, all standard final exams are conducted in written form. For resit exams, lecturers will communicate the exam format (written/oral) together with the exam schedule.

Standard final exam for a module and written resit exam

Kind of exam

Written exam

Duration of exam

120 minutes

Permissible aids

Aids permitted as specified below:

Permissible electronic aids

Open Book

Other permissible aids

Use of GenAI is forbidden during electronic exam

Exception: In case of an electronic Moodle exam, adjustments to the permissible aids may occur. Lecturers will announce the final permissible aids prior to the exam session.

Special case: Resit exam as oral exam

Kind of exam

Oral exam

Duration of exam

30 minutes

Permissible aids

Aids permitted as specified below:

Permissible electronic aids

Open Book

GenAI is forbidden

Other permissible aids

No other aids permitted

Module Description, available in: EN

Advanced Algorithms and Data Structures

General Information

Number of ECTS Credits

3

Module code

FTP_AdvAlgDS

Valid for academic year

2026-27

Last modification

2019-12-08

Coordinator of the module

Fabrizio Grandoni (SUPSI, fabrizio.grandoni@supsi.ch)

Explanations regarding the language definitions for each location:

- Instruction is given in the language specified for each location and module execution.
- Documentation is available in the language(s) listed for each location and module execution. If the documentation is in multiple languages, the percentage distributed is indicated (100% = all documentation provided).
- The examination, including both questions and answers, is provided entirely (100%) in the language(s) specified for each location and module execution. The exams are on-site.

	Lausanne			Lugano	Zurich		
Instruction				**X** E 100%			
Documentation				**X** E 100%			
Examination				**X** E 100%			

Module Category

FTP Fundamental theoretical principles

Profile Recommendations

This module is recommended for the following profiles:

	Lugano
Profile	CS, DS

Lessons

2 lecture periods and 1 tutorial period per week

Entry level competences

Prerequisites, previous knowledge

Familiarity with basic discrete math, logic and probability theory. Familiarity with one programming language such as C++, Java, or similar languages.

Brief course description of module objectives and content

Algorithms are at the heart of every computer program. Informally, an algorithm is a procedure to solve a (computational) problem within a finite number of elementary steps. The same problem can be addressed with different algorithms, hence it is important to compare the different options in order to choose the best one. Experimental analysis is one way to perform such comparison, but it has several limits. The main goal of this class is to learn how to analyze the performance of a given algorithm in a formal mathematical way. We will focus on some fundamental polynomial-time-solvable problems. Along the way, we will study some of the main techniques to design efficient algorithms, among which the use of efficient data structures.

Aims, content, methods

Learning objectives and competencies to be acquired

The main goal of this course is to learn basic techniques to design algorithms and data structures for fundamental polynomial-time-solvable problems, and mathematical tools to analyze their performance from a theoretical point of view.

Module content with weighting of different components

A. Analytical tools: worst-case analysis and asymptotic notation; analysis of recursive algorithms; analysis of randomized algorithms; amortized analysis.

B. Algorithmic techniques: greedy; dynamic programming; divide et impera; randomization; fast data structures.

C. Data structures: search trees; priority queues; union-find; hash tables.

D. Polynomial-time problems: sorting and selection; shortest paths; minimum spanning tree; maximum flow; maximum matching.

Teaching and learning methods

Interactive lectures both for theory and exercises.

Literature

- T. H. Cormen, C. E. Leiserson, R. L. Rivest, C. Stein. Introduction to Algorithms. MIT Press. Third edition.

- J. Kleinberg, E. Tardos. Algorithm Design. Addison-Wesley.

Assessment

Additional performance assessment during the semester

The module does not contain an additional performance assessment during the semester

Basic principle for exams

As a rule, all standard final exams are conducted in written form. For resit exams, lecturers will communicate the exam format (written/oral) together with the exam schedule.

Standard final exam for a module and written resit exam

Kind of exam

Written exam

Duration of exam

120 minutes

Permissible aids

No aids permitted

Exception: In case of an electronic Moodle exam, adjustments to the permissible aids may occur. Lecturers will announce the final permissible aids prior to the exam session.

Special case: Resit exam as oral exam

Kind of exam

Oral exam

Duration of exam

30 minutes

Permissible aids

No aids permitted

Module Description, available in: EN, FR

Algorithms

General Information

Number of ECTS Credits

3

Module code

FTP_Alg

Valid for academic year

2026-27

Last modification

2023-10-28

Coordinator of the module

Eric Taillard (HES-SO, eric.taillard@heig-vd.ch)

Explanations regarding the language definitions for each location:

- Instruction is given in the language specified for each location and module execution.
- Documentation is available in the language(s) listed for each location and module execution. If the documentation is in multiple languages, the percentage distributed is indicated (100% = all documentation provided).
- The examination, including both questions and answers, is provided entirely (100%) in the language(s) specified for each location and module execution. The exams are on-site.

	Lausanne			Lugano	Zurich		
Instruction		**X** F 100%			**X** E 100%		
Documentation		**X** F 50%	**X** E 50%		**X** E 100%		
Examination		**X** F 100%			**X** E 100%		

Module Category

FTP Fundamental theoretical principles

Profile Recommendations

This module is recommended for the following profiles:

	Lausanne	Zurich
Profile	CS, ICS	CS, DS, ICS

Lessons

2 lecture periods and 1 tutorial period per week

Entry level competences

Prerequisites, previous knowledge

The student has working knowledge of:

- Geometry, linear algebra, algorithms (sorting, searching, hashing) and data structures (linear structures, trees)
- Basics of graph data structures and algorithms
- Algorithmic complexity, logic, probability theory.

These topics are generally contained in books introducing algorithms. For instance, chapters 1-12, 15-17, 22-26, 28-29, 34-35 of (Cormen 09) covers

very well the prerequisites

Brief course description of module objectives and content

This module introduces students with different categories of advanced algorithms and typical application areas.
In the first part of the module, the students will have a sound understanding of data structures and algorithms for efficiently handling either very large, complex or dynamic data sets or combinations thereof. They will be able to evaluate suitable algorithms and to apply them to typical tasks such as efficiently indexing, searching, retrieving, inserting or updating data such as large volumes of hypertext or spatial data.
The students will be familiar with dynamic algorithms used, for example, in artificial intelligence.
The second part of the module will present basic techniques for designing algorithms for hard combinatorial optimization problems. The combination of these basic components —problem modeling, problem decomposition, solution building, solution improvement, learning— lead to classical metaheuristics like genetic algorithms, ant colonies or tabu search. The students will be able to design new algorithms for hard combinatorial optimization problems and to apply them.

Aims, content, methods

Learning objectives and competencies to be acquired

This module gives the student an overview of frequently used algorithms classes. Based on this strong foundation, students can design and implement the most suitable and efficient algorithms for use in their own applications. The student:

- is familiar with different categories of advanced algorithms and with typical application areas;
- has a sound understanding of data structures and algorithms for efficiently handling either very large, complex or dynamic data sets or combinations thereof;
- is able to evaluate suitable algorithms and to apply them to typical tasks such as efficiently indexing, searching, retrieving, inserting or updating data, including data types such as large volumes of hypertext or spatial data;
- is familiar with dynamic algorithms used in robotics, artificial intelligence.

Module content with weighting of different components

Algorithms and data structures for selected practical problems. Weight 50%

- Reminder on linear structures, binary search tree, heap and algorithmic complexity
- Randomized algorithms (qsort, selection in linear time, kD tree, range tree, Delaunay triangulation)
- Deterministic algorithms(selection, kD tree)
- Sweep algorithms (closest pair of points, segment intersection)
- Greedy algorithms (Huffman code, Dijkstra, Fibonacci heap)

Design of heuristic algorithms. Weight 50%

- Reminder on complexity theory, combinatorial optimization problems, problem modelling
- Greedy heuristics
- Local search heuristics
- Decomposition methods
- Randomized heuristics
- Learning heuristics
- Classical metaheuristics: GRASP, ant colonies, tabu search, simulated annealing, noising methods, genetic algorithms

Teaching and learning methods

- Ex-cathedra teaching
- Presentation and discussion of case studies
- Problem-based learning
- Theory and programming exercises

Literature

M. de Berg, G. Cheong, M. van Kreveld, M. Overmars. Computational Geometry : Algorithms and Applications, Springer, Third Edition 2008.

T. H. Cormen, C. E. Leiserson, R. L. Rivest, C. Stein. Introduction to Algorithms, third edition, MIT Press, 2009.

P. Siarry (ed.), Metaheuristics, ISBN 978-3-319-45403-0, Springer, 2016.

H. H. Hoos, Th. Stützle Stochastic Local Search: Foundations and Applications, Morgan Kaufmann / Elsevier, 2004.

Éric D. Taillard Design of Heuristic Algorithms for Hard Optimization (Series: Graduate Texts in Operations Research) Springer, 2023 ISSN 2662-6012 ISSN 2662-6020 (electronic) ISBN 978-3-031-13713-6 ISBN 978-3-031-13714-3 (eBook) https://doi.org/10.1007/978-3-031-13714-3 http://mistic.heig-vd.ch/taillard/heuristic_design/

Assessment

Additional performance assessment during the semester

The module does not contain an additional performance assessment during the semester

Basic principle for exams

As a rule, all standard final exams are conducted in written form. For resit exams, lecturers will communicate the exam format (written/oral)

together with the exam schedule.

Standard final exam for a module and written resit exam

Kind of exam

Written exam

Duration of exam

120 minutes

Permissible aids

Aids permitted as specified below:

Permissible electronic aids

No electronic aids permitted

Other permissible aids

Books, copy of slides (solutions to exercises excluded)

Exception: In case of an electronic Moodle exam, adjustments to the permissible aids may occur. Lecturers will announce the final permissible aids prior to the exam session.

Special case: Resit exam as oral exam

Kind of exam

Oral exam

Duration of exam

30 minutes

Permissible aids

No aids permitted

Description du module, disponible en: EN, FR

Algorithmique

Informations générales

Nombre de crédits ECTS

3

Code du module

FTP_Alg

Valable pour l'année académique

2026-27

Dernière modification

2023-10-28

Coordinateur/coordinatrice du module

Eric Taillard (HES-SO, eric.taillard@heig-vd.ch)

Explications concernant les langues d'enseignement par site :

- L'enseignement est dispensé dans la langue indiquée ci-dessous pour chaque site et chaque exécution du module.
- Les supports de cours sont disponibles dans les langues indiquées ci-dessous pour chaque site et chaque exécution du module. Lorsque plusieurs langues sont utilisées, la proportion de contenu disponible dans chaque langue est précisée (100 % = ensemble des supports de cours).
- Les examens (questions et réponses) sont entièrement rédigés dans la langue indiquée ci-dessous pour le site et l'exécution du module concernés. Ils se déroulent en présentiel.

	Lausanne			Lugano	Zurich		
Leçons		**X** F 100%			**X** E 100%		
Documentation		**X** F 50%	**X** E 50%		**X** E 100%		
Examen		**X** F 100%			**X** E 100%		

Catégorie de module

FTP bases théoriques élargies

Recommandations de profil

Ce module est recommandé pour les profils suivants :

	Lausanne	Zurich
Profil	CS, ICS	CS, DS, ICS

Leçons

2 leçons et 1 leçon de pratique par semaine

Compétences préalables

Connaissances préalables, compétences initiales

L'étudiant dispose de connaissances pratiques en :

- géométrie, algèbre linéaire, algorithmes (classification, recherche, hachage) et structures de données (structures linéaires, structures arborescence)
- connaissances de base de la théorie des graphes (structures de données et algorithmes)
- complexité algorithmique, logique, théorie des probabilités

Ces connaissances font partie de tout bon livre d'introduction sur les algorithmes. Par exemple, les chapitres 1-12, 15-17, 22-26, 28-29, 34-35 de Cormen (2009) couvrent parfaitement les pré-requis de ce cours.

Brève description du contenu et des objectifs

Ce module présente différentes catégories d'algorithmes avancés ainsi que leurs domaines d'application typiques.
La première partie du module approfondira les connaissances sur les structures de données qui permettent de gérer efficacement des ensembles de données très grands, complexes ou dynamiques, voire combinant ces trois caractéristiques. À l'issue du module, les étudiants seront capables de sélectionner le meilleur algorithme et de l'appliquer à des tâches telles que l'indexation, la recherche, l'extraction, l'insertion ou la mise à jour de données volumineuses, comme celles que l'on rencontre dans les systèmes d'informations géographiques, les hypertextes ou en intelligence artificielle.
La seconde partie du module présentera des techniques de base pour la conception d'algorithmes appliqués à des problèmes d'optimisation difficiles. La combinaison de ces techniques de base ?modélisation, construction de solution, amélioration de solution, décomposition de problème, apprentissage? conduit à des métaheuristiques classiques comme les algorithmes génétiques, les colonies de fourmi artificielles ou la recherche avec tabous. À l'issue du module, les étudiants seront capables de concevoir et d'appliquer ces techniques à des problèmes d'optimisation difficiles.

Objectifs, contenus, méthodes

Objectifs d'apprentissage, compétences à acquérir

Ce module donne une vue d'ensemble diverses classes d'algorithmes fréquemment utilisés en pratique. Sur la base de connaissances solides, l'étudiant est capable de concevoir et d'implanter les algorithmes les plus efficaces et les plus appropriés pour ses propres applications. À l'issue du module, l'étudiant :

- connaît différentes catégories d'algorithmes avancés et leurs domaines d'application ;
- a une bonne connaissance en structures de données avancées et leur utilisation pour gérer efficacement des données volumineuses, complexes et/ou dynamiques ;
- est en mesure d'évaluer quels algorithmes sont appropriés pour réaliser efficacement certaines tâches telles que l'indexation, la recherche, l'extraction, l'insertion ou la mise à jour de données volumineuses ;
- connaît les algorithmes dynamiques utilisés en robotique ou en intelligence artificielle

Contenu des modules avec pondération du contenu des cours

Algorithmes et structures de données pour quelques problèmes spécifiques. Poids 50%

- Rappels sur les structures linéaires, les arbres de recherche binaires, les tas et la complexité algorithmique
- Algorithmes randomisés (tri rapide, sélection en temps linéaire, arbre kD, arbre de requête d'énumération, triangulation de Delaunay)
- Algorithmes déterministes (sélection en temps linéaire, arbre kD)
- Algorithmes de balayage (plus proche paire de points, intersection de segments)
- Algorithmes gloutons (codage de Huffman, Dijkstra, tas de Fibonacci)

Conception d'algorithmes heuristiques. Poids 50%

- Rappels de théorie de la complexité, de modélisation de problèmes, d'optimisation combinatoire
- Algorithmes gloutons
- Heuristiques de recherche locale
- Méthodes de décomposition
- Heuristiques randomisées
- Heuristiques d'apprentissage
- Métaheuristiques classiques: GRASP, colonies de fourmis artificielles, recherche tabou, recuit simulé, méthodes de bruitage, algorithmes génétiques

Méthodes d'enseignement et d'apprentissage

- Enseignement ex-cathedra
- Présentation et discussion d'études de cas
- Apprentissage par résolution de problème
- Exercices théoriques et de programmation

Bibliographie

M. de Berg, G. Cheong, M. van Kreveld, M. Overmars. Computational Geometry : Algorithms and Applications, Springer, Third Edition 2008.

T. H. Cormen, C. E. Leiserson, R. L. Rivest, C. Stein. Introduction to Algorithms, third edition, MIT Press, 2009.

Traduction française : Introduction à l'algorithmique, 3e édition, Dunod, 2010.

P. Siarry (ed.), Métaheuristiques, EAN13 : 9782212139297, Eyrolles 2014.

H. H. Hoos, Th. Stützle Stochastic Local Search: Foundations and Applications, Morgan Kaufmann / Elsevier, 2004.

Éric D. Taillard Design of Heuristic Algorithms for Hard Optimization (Series: Graduate Texts in Operations Research) Springer, 2023 ISSN 2662-6012 ISSN 2662-6020 (electronic) ISBN 978-3-031-13713-6 ISBN 978-3-031-13714-3 (eBook) https://doi.org/10.1007/978-3-031-13714-3 http://mistic.heig-vd.ch/taillard/heuristic_design

Evaluation

Évaluation supplémentaire pendant le semestre

Le module ne comprend pas d'évaluation supplémentaire pendant le semestre

Principe pour les examens

En règle générale, tous les examens réguliers de fin de module se déroulent sous forme écrite. Concernant les examens de répétition, leur format (écrit ou oral) sera communiqué par l'enseignant-e en même temps que le calendrier des examens.

Examen de fin de module régulier et examen écrit de répétition

Type de l'examen

Examen écrit

Durée de l'examen

120 minutes

Aides autorisées

Les aides suivantes sont autorisées:

Aides électroniques autorisées

Aucun

Autres aides autorisées

Livres, copie des transparents (sauf solutions aux exercices)

Exception : En cas d'examen électronique sur Moodle, des modifications des aides autorisées peuvent survenir. Dans ce cas, les aides autorisées seront annoncées par les enseignant-e-s avant l'examen.

Cas spécial: examen de répétition oral

Type de l'examen

Examen oral

Durée de l'examen

30 minutes

Aides autorisées

Sans aides

Module Description, available in: EN, FR

Applied Statistics and Data Analysis

General Information

Number of ECTS Credits

3

Module code

FTP_AppStat

Valid for academic year

2026-27

Last modification

2022-10-09

Coordinator of the module

Marcel Steiner-Curtis (FHNW, marcel.steiner@fhnw.ch)

Explanations regarding the language definitions for each location:

- Instruction is given in the language specified for each location and module execution.
- Documentation is available in the language(s) listed for each location and module execution. If the documentation is in multiple languages, the percentage distributed is indicated (100% = all documentation provided).
- The examination, including both questions and answers, is provided entirely (100%) in the language(s) specified for each location and module execution. The exams are on-site.

	Lausanne			Lugano	Zurich		
Instruction		**X** F 100%		**X** E 100%	**X** E 100%		
Documentation		**X** F 100%		**X** E 100%	**X** E 100%		
Examination		**X** F 100%		**X** E 100%	**X** E 100%		

Module Category

FTP Fundamental theoretical principles

Profile Recommendations

This module is recommended for the following profiles:

	Lausanne	Lugano	Zurich
Profile	CE, DS	BE, CE, ME, MA	CE, ICS, ME, Med, Avi, BT

Lessons

2 lecture periods and 1 tutorial period per week

Entry level competences

Prerequisites, previous knowledge

Basic knowledge of the calculation of probabilities and statistics: models; parameter estimation; knowledge of how statistical tests are compiled and what confidence intervals are; user knowledge of a statistical program (Excel, R, S-PLUS, SPSS or MATLAB); fundamental laboratory experience (measuring technology)

Brief course description of module objectives and content

Students are introduced to statistical tools used in the industrial sector, and particularly in process and quality control. In this module, students learn to plan and conduct statistical evaluations independently.

Please note: An MSE cursus may not contain both similar statistics modules FTP_AppStat and FTP_PredMod. Students can only choose one of these modules.

Aims, content, methods

Learning objectives and competencies to be acquired

To be in a position to plan and evaluate experiments in an industrial environment; understand how processes are statistically controlled and improved; be capable of analyzing and interpreting data by means of regression analysis; be able to implement the methods covered with a statistical package.

Module content with weighting of different components

Statistical process and quality control (SPC): the "Magnificent Seven", control charts, operating characteristic curve, acceptance sampling (weighting 1/3)

Introduction to multiple regression analysis: model prerequisites, confidence and prediction intervals, graphic checking of model assumptions (weighting 1/3)

Overview of Design of Experiment – DoE (planning and evaluating experiments): basic principles for the planning of experimental studies, one-way and multi-way analysis of variance, factorial experiment designs and their analysis, block designs (weighting 1/3)

The contents listed are illustrated with case studies from the industrial and scientific environment. In doing so, use is made of graphical methods and statistical bases, including classic and robust estimation methods and Monte Carlo simulations.

Teaching and learning methods

Lectures, practical work on the computer with a statistics program

Literature

Lecturers' scripts with references to current literature

Assessment

Additional performance assessment during the semester

The module does not contain an additional performance assessment during the semester

Basic principle for exams

As a rule, all standard final exams are conducted in written form. For resit exams, lecturers will communicate the exam format (written/oral) together with the exam schedule.

Standard final exam for a module and written resit exam

Kind of exam

Written exam

Duration of exam

120 minutes

Permissible aids

Aids permitted as specified below:

Permissible electronic aids

pocket calculator

Other permissible aids

pens, ruler, manuscripts, books

Exception: In case of an electronic Moodle exam, adjustments to the permissible aids may occur. Lecturers will announce the final permissible aids prior to the exam session.

Special case: Resit exam as oral exam

Kind of exam

Oral exam

Duration of exam

30 minutes

Permissible aids

No aids permitted

Description du module, disponible en: EN, FR

Statistiques appliquées et analyse de données

Informations générales

Nombre de crédits ECTS

3

Code du module

FTP_AppStat

Valable pour l'année académique

2026-27

Dernière modification

2022-10-09

Coordinateur/coordinatrice du module

Marcel Steiner-Curtis (FHNW, marcel.steiner@fhnw.ch)

Explications concernant les langues d'enseignement par site :

- L'enseignement est dispensé dans la langue indiquée ci-dessous pour chaque site et chaque exécution du module.
- Les supports de cours sont disponibles dans les langues indiquées ci-dessous pour chaque site et chaque exécution du module. Lorsque plusieurs langues sont utilisées, la proportion de contenu disponible dans chaque langue est précisée (100 % = ensemble des supports de cours).
- Les examens (questions et réponses) sont entièrement rédigés dans la langue indiquée ci-dessous pour le site et l'exécution du module concernés. Ils se déroulent en présentiel.

	Lausanne			Lugano	Zurich		
Leçons		**X** F 100%		**X** E 100%	**X** E 100%		
Documentation		**X** F 100%		**X** E 100%	**X** E 100%		
Examen		**X** F 100%		**X** E 100%	**X** E 100%		

Catégorie de module

FTP bases théoriques élargies

Recommandations de profil

Ce module est recommandé pour les profils suivants :

	Lausanne	Lugano	Zurich
Profil	CE, DS	BE, CE, ME, MA	CE, ICS, ME, Med, Avi, BT

Leçons

2 leçons et 1 leçon de pratique par semaine

Compétences préalables

Connaissances préalables, compétences initiales

Connaissances de base dans le calcul des probabilités et de la statistique: modélisation, paramètres et estimations; connaissances des tests d'hypothèses et des intervalles de confiance; connaissances d'un logiciel de statistique (Excel, R, S-PLUS, SPSS ou MATLAB); connaissances de base du travail en laboratoire (technique de mesure)

Brève description du contenu et des objectifs

Le module présentera aux étudiants les outils statistiques utilisés dans le secteur industriel, en particulier dans la maîtrise statistique des procédés et le contrôle de qualité. Le module apprendra aux étudiants à planifier les expériences et à interpréter avec assurance les résultats obtenus à l'aide de méthodes statistiques.

Remarque : Un cursus MSE ne peut pas contenir les deux modules statistiques similaires FTP_AppStat et FTP_PredMod. Les étudiant-e-s ne peuvent choisir qu'un seul de ces modules.

Objectifs, contenus, méthodes

Objectifs d'apprentissage, compétences à acquérir

Savoir planifier et exploiter au maximum les expériences dans le milieu industriel; optimiser les procédés et améliorer leur qualité en minimisant l'effort expérimental; savoir analyser et interpréter les résultats obtenus par régression; appliquer les méthodes présentées au cours en utilisant un logiciel de statistique.

Contenu des modules avec pondération du contenu des cours

Maîtrise statistique des procédés et contrôle de la qualité (MSP): étapes d'un projet, cartes de contrôle (control charts), protocoles industriels, échantillonnage d'acceptation (pondération 1/3)

Introduction à la régression multivariée: conditions d'application du modèle de régression, intervalles de confiance et de prévision, vérification graphique des conditions d'application du modèle (pondération 1/3)

Introduction aux plans d'expériences – DoE (planification et analyse des résultats): principes fondamentaux des plans d'expériences, diagramme d'Ishikawa, analyse de variance univariée ou multivariée, effets principaux et interactions, plans factoriels, interprétation des résultats, plan bloc (pondération)

Les concepts présentés au cours seront illustrés par des cas concrets issus du milieu industriel. Différentes méthodes graphiques et statistiques seront utilisées comme, par exemple, les méthodes d'estimation classiques et robuste et la simulation de Monte-Carlo.

Méthodes d'enseignement et d'apprentissage

Cours magistraux, travaux pratiques sur ordinateur à l'aide d'un logiciel de statistique

Bibliographie

Polycopié du professeur et références aux ouvrages modernes

Evaluation

Évaluation supplémentaire pendant le semestre

Le module ne comprend pas d'évaluation supplémentaire pendant le semestre

Principe pour les examens

En règle générale, tous les examens réguliers de fin de module se déroulent sous forme écrite. Concernant les examens de répétition, leur format (écrit ou oral) sera communiqué par l'enseignant-e en même temps que le calendrier des examens.

Examen de fin de module régulier et examen écrit de répétition

Type de l'examen

Examen écrit

Durée de l'examen

120 minutes

Aides autorisées

Les aides suivantes sont autorisées:

Aides électroniques autorisées

calculatrice de poche

Autres aides autorisées

stylos, règle, manuscrits, livres

Exception : En cas d'examen électronique sur Moodle, des modifications des aides autorisées peuvent survenir. Dans ce cas, les aides autorisées seront annoncées par les enseignant-e-s avant l'examen.

Cas spécial: examen de répétition oral

Type de l'examen

Examen oral

Durée de l'examen

30 minutes

Aides autorisées

Sans aides

Module Description, available in: EN

Approximation Algorithms

General Information

Number of ECTS Credits

3

Module code

FTP_ApprAlg

Valid for academic year

2026-27

Last modification

2019-12-08

Coordinator of the module

Fabrizio Grandoni (SUPSI, fabrizio.grandoni@supsi.ch)

Explanations regarding the language definitions for each location:

- Instruction is given in the language specified for each location and module execution.
- Documentation is available in the language(s) listed for each location and module execution. If the documentation is in multiple languages, the percentage distributed is indicated (100% = all documentation provided).
- The examination, including both questions and answers, is provided entirely (100%) in the language(s) specified for each location and module execution. The exams are on-site.

	Lausanne			Lugano	Zurich		
Instruction				**X** E 100%			
Documentation				**X** E 100%			
Examination				**X** E 100%			

Module Category

FTP Fundamental theoretical principles

Profile Recommendations

This module is recommended for the following profiles:

	Lugano
Profile	CS, DS

Lessons

2 lecture periods and 1 tutorial period per week

Entry level competences

Prerequisites, previous knowledge

Basics of theoretical analysis of algorithms.

Brief course description of module objectives and content

An algorithm is typically called efficient if its worst-case running time is polynomial in the size of the input. This course will focus on a huge and practically relevant family of problems, namely NP-hard ones, for which (most likely) no efficient algorithm exists. This family includes fundamental problems in computational biology, network design, systems, computer vision, data mining, online markets, etc.

The first goal of this course it to learn how to identify NP-hard problems.

For a given NP-hard optimization problem it might still be possible to compute efficiently a feasible solution whose cost is (in the worst-case) within a small multiplicative factor (approximation factor) from the optimum: this is the aim of approximation algorithms. The second goal of this course is to learn how to design accurate approximation algorithms, and how to (theoretically) bound their approximation factor.

Aims, content, methods

Learning objectives and competencies to be acquired

The main goal of this course is to learn how to identify NP-hard problems, and how to design and (theoretically) analyze approximation algorithms for fundamental NP-hard optimization problems.

Module content with weighting of different components

A. Complexity Classes: polynomial Reductions; NP-completeness and NP-hardness.

B. NP-hard problems: SAT and Max-SAT; Vertex/Set Cover; Steiner Tree and generalizations; TSP; Max Cut; Knapsack and Bin Packing; k-Center and clustering; Scheduling; Facility Location; Item Pricing; etc.

C. Approximation Algorithms:

1. Basic notions: approximation factor; hardness of approximation.
2. Basic techniques: greedy; local search; randomization; dynamic programming.

LP-based techniques: randomized rounding; primal-dual; iterative rounding.

Teaching and learning methods

Interactive lectures both for theory and exercises.

Literature

- V. V. Vazirani. Approximation Algorithms. Springer.

- D. P. Williamson, D. B. Shmoys. The Design of Approximation Algorithms. Cambridge University Press.

Assessment

Additional performance assessment during the semester

The module does not contain an additional performance assessment during the semester

Basic principle for exams

As a rule, all standard final exams are conducted in written form. For resit exams, lecturers will communicate the exam format (written/oral) together with the exam schedule.

Standard final exam for a module and written resit exam

Kind of exam

Written exam

Duration of exam

120 minutes

Permissible aids

No aids permitted

Exception: In case of an electronic Moodle exam, adjustments to the permissible aids may occur. Lecturers will announce the final permissible aids prior to the exam session.

Special case: Resit exam as oral exam

Kind of exam

Oral exam

Duration of exam

30 minutes

Permissible aids

No aids permitted

Module Description, available in: EN

Biology, physiology and anatomy for engineers

General Information

Number of ECTS Credits

3

Module code

FTP_BioEng

Valid for academic year

2026-27

Last modification

2025-10-08

Coordinator of the module

Igor Stefanini (SUPSI, igor.stefanini@supsi.ch)

Explanations regarding the language definitions for each location:

- Instruction is given in the language specified for each location and module execution.
- Documentation is available in the language(s) listed for each location and module execution. If the documentation is in multiple languages, the percentage distributed is indicated (100% = all documentation provided).
- The examination, including both questions and answers, is provided entirely (100%) in the language(s) specified for each location and module execution. The exams are on-site.

	Lausanne			Lugano	Zurich		
Instruction				**X** E 100%			
Documentation				**X** E 100%			
Examination				**X** E 100%			

Module Category

FTP Fundamental theoretical principles

Profile Recommendations

This module is recommended for the following profiles:

	Lugano
Profile	DS, Med

Lessons

2 lecture periods and 1 tutorial period per week

Entry level competences

Prerequisites, previous knowledge

No previous knowledge is required

Brief course description of module objectives and content

Medical engineering is the intersection of many different disciplines. From engineering in its most varied forms, mechanics, electronics, computer science, management, to disciplines related to medicine: biology, anatomy, and physiology. In order to understand and put into practice the notions that the student will learn in this fascinating path, the same can not ignore the acquisition of basic knowledge about the human body. Thanks to this module the student will learn the basics of life as we know it, as well as the structure and functioning of the major systems present in the human body.

Aims, content, methods

Learning objectives and competencies to be acquired

The student is faced with the most important aspect of human biology, anatomy, and physiology. She/he learns the basics of:

- prokaryotic and eukaryotic cell structure and function
- the most important physiological systems
- the anatomy systems
- human pathology

Module content with weighting of different components

Basics of prokaryotic and eukaryotic cell biology including eukaryotic stem cell biology and cell cultivation techniques.

Basics of anatomy; skeleton, locomotory system, cardio-vascular system, respiratory system, nervous system (CNS & PNS) and the sensory system (eye, ear, olfactory system, vestibular system, proprioception, and touch)

Basics of physiology: introduction of the physiology of the nervous system (CNS and PNS), the cardio-vascular system, the locomotory apparatus as well as the hormone system

Basics of human pathology

Teaching and learning methods

Lectures, hands on exercise

Literature

Slides, course material and books chapters

Assessment

Additional performance assessment during the semester

The module does not contain an additional performance assessment during the semester

Basic principle for exams

As a rule, all standard final exams are conducted in written form. For resit exams, lecturers will communicate the exam format (written/oral) together with the exam schedule.

Standard final exam for a module and written resit exam

Kind of exam

Written exam

Duration of exam

120 minutes

Permissible aids

No aids permitted

Exception: In case of an electronic Moodle exam, adjustments to the permissible aids may occur. Lecturers will announce the final permissible aids prior to the exam session.

Special case: Resit exam as oral exam

Kind of exam

Oral exam

Duration of exam

30 minutes

Permissible aids

No aids permitted

Module Description, available in: EN, FR

Numerical Analysis and Computer Algebra

General Information

Number of ECTS Credits

3

Module code

FTP_CompAlg

Valid for academic year

2026-27

Last modification

2019-07-15

Coordinator of the module

Bernhard Zgraggen (OST, bernhard.zgraggen@ost.ch)

Explanations regarding the language definitions for each location:

- Instruction is given in the language specified for each location and module execution.
- Documentation is available in the language(s) listed for each location and module execution. If the documentation is in multiple languages, the percentage distributed is indicated (100% = all documentation provided).
- The examination, including both questions and answers, is provided entirely (100%) in the language(s) specified for each location and module execution. The exams are on-site.

	Lausanne			Lugano	Zurich		
Instruction		**X** F 100%			**X** E 100%		
Documentation		**X** F 80%	**X** E 20%		**X** E 100%		
Examination		**X** F 100%			**X** E 100%		

Module Category

FTP Fundamental theoretical principles

Profile Recommendations

This module is recommended for the following profiles:

	Lausanne	Zurich
Profile	EnEn, ME	EIE, ME

Lessons

2 lecture periods and 1 tutorial period per week

Entry level competences

Prerequisites, previous knowledge

Linear Algebra

- Algebra with vectors and matrices
- Elementary solving linear systems of equations (Gauss Pivoting)
- Eigenvectors and Eigenvalues

Analysis

- Univariate and multivariate calculus (differentials, integrals)
- Knowing of simple numerical recipes for equations and integrals (e.g. Bi-Section, Newton, Trapezoidal-Rule, Simpson-Rule...)
- Ordinary differential equations including simple numerical recipes (e.g. Euler)

Basics in Computer Handling
- Operating system, software installation
- Elementary skills in procedural programming

Hardware and Software
- Notebook
- Mathematical software installed (e.g. Mathematica, Matlab, Maple ... according to preference and experience)

Brief course description of module objectives and content

After successful studying students are capable to solve selected practical mathematical problems by combining appropriate numerical methods with suitable computer algebra tools. Moreover, students know how to interprete and visualize computational outcomes resulting from numerical algorithms.

Aims, content, methods

Learning objectives and competencies to be acquired

Solving mathematical problems with practial relevance by
- capable handling a computer algebra system (CAS) or appropriate mathematical software
- mastering selected numerical methods

Knowing limits of computer based methods and comprehension of
- some internals of CAS (e.g. representations of numbers and functions)
- the problems of numerical stability, errors from rounding and discretization
- algorithmic complexity (e.g. convergence speed)

Combining analytical methods of CAS with efficient numerical software

Interpreting and visualizing computational results

Module content with weighting of different components

Processing
- data from problems with practical relevance
- by tools from numerical mathematics and analytics
- up to interpretation and visualization of results

Based on a **selection** of methods listed below
- Solving systems of linear equations (LU-Decomposition, Cholesky Decomposition, Householder Transformations, QR Decomposition, sparse matrix strategies and Gauss-Seidel ...)
- Computations of zeroes and non-linear optimization
- Univariate and multivariate interpolation and approximation (Collocation, Osculation, Splining, Least-Squares Approximation, Chebyshev Approximation ...)
- Numerical differentiation and integration
- Initial and boundary value problems of ordinary differential equations

With consideration of
- Accuracy, efficiency and condition
- Problem identification and method selection
- Computeralgebra in order to establish analytical relations

Teaching and learning methods

- Derivation of mathematical facts in lectures
- Software demonstrations and visualizations by the lecturer during the lectures
- Teaching based on problems with practical relevance
- Software examples and additional materials on complimentary website (Zuerich)
- Hints to sources and literature on complimentary website (Zuerich)
- Self-studies based on sources and literature
- Doing homework as a preparation for dedicated exercise lessons

Literature

- Schaum's Outlines of Numerical Analysis, McGraw-Hill Professional, 2nd edition
- Schwarz, Hans R.; Köckler, Norbert; Numerische Mathematik, Vieweg & Teubner, 7. Auflage
- Bronstein et al., Taschenbuch der Mathematik, Harri Deutsch
- Bradie, Brian, A Friendly Introduction to Numerical Analysis, Prentice-Hall

- Alfio Quarteroni, Riccardo Sacco, Fausto Saleri, M´ethodes Num´eriques - Algorithmes, analyse et applications, Springer, 2007
- Jean-Philippe Grivet, Méthodes numériques appliqués, EDP sciences
- Koepf, Wolfram, Computeralgebra, Springer
- Moler Cleve, Numerical Computing with Matlab, http://www.mathworks.com/moler/chapters.html
- Erwin Kreyszig, Advanced Engineering Mathematics, Wiley
- Erwin Kreyszig, Advanced Engineering Mathematics – Students Solution Manual and Study Guide, Wiley
- Erwin Kreyszig/E.J. Norminton, Mathematica Computer Guide for Erwin Kreiszigs Advanced Engineering Mathematics, Wiley
- Michael Trott, The Mathematica Guide Book for Numerics, Springer

Assessment

Additional performance assessment during the semester

The module does not contain an additional performance assessment during the semester

Basic principle for exams

As a rule, all standard final exams are conducted in written form. For resit exams, lecturers will communicate the exam format (written/oral) together with the exam schedule.

Standard final exam for a module and written resit exam

Kind of exam

Written exam

Duration of exam

120 minutes

Permissible aids

Aids permitted as specified below:

Permissible electronic aids

No electronic aids permitted

Other permissible aids

Open Book

Exception: In case of an electronic Moodle exam, adjustments to the permissible aids may occur. Lecturers will announce the final permissible aids prior to the exam session.

Special case: Resit exam as oral exam

Kind of exam

Oral exam

Duration of exam

30 minutes

Permissible aids

No aids permitted

Description du module, disponible en: EN, FR

Le calcul formel et numérique en ingénierie

Informations générales

Nombre de crédits ECTS

3

Code du module

FTP_CompAlg

Valable pour l'année académique

2026-27

Dernière modification

2019-07-15

Coordinateur/coordinatrice du module

Bernhard Zgraggen (OST, bernhard.zgraggen@ost.ch)

Explications concernant les langues d'enseignement par site :

- L'enseignement est dispensé dans la langue indiquée ci-dessous pour chaque site et chaque exécution du module.
- Les supports de cours sont disponibles dans les langues indiquées ci-dessous pour chaque site et chaque exécution du module. Lorsque plusieurs langues sont utilisées, la proportion de contenu disponible dans chaque langue est précisée (100 % = ensemble des supports de cours).
- Les examens (questions et réponses) sont entièrement rédigés dans la langue indiquée ci-dessous pour le site et l'exécution du module concernés. Ils se déroulent en présentiel.

	Lausanne			Lugano	Zurich		
Leçons		**X** F 100%			**X** E 100%		
Documentation		**X** F 80%	**X** E 20%		**X** E 100%		
Examen		**X** F 100%			**X** E 100%		

Catégorie de module

FTP bases théoriques élargies

Recommandations de profil

Ce module est recommandé pour les profils suivants :

	Lausanne	Zurich
Profil	EnEn, ME	EIE, ME

Leçons

2 leçons et 1 leçon de pratique par semaine

Compétences préalables

Connaissances préalables, compétences initiales

Algèbre linéaire:

- calcul vectoriel et matriciel
- procédures élémentaires de résolution pour les systèmes d'équation linéaires (méthode du pivot de Gauss)
- valeur propre et vecteur propre

Analyse
- Equation différentielle et intégrale à une ou plusieurs variables
- Connaissance des procédés numériques simples (règle du trapèze, de Simpson, méthode du carré, de la bissection, règle de Newton …)
- équations différentielles générales, simples procédés numériques inclus

Bases en utilisation d'ordinateurs
- systèmes d'exploitation, installation de logiciels incluse
- rudiments de la programmation procédurale

Matériel et logiciel
- Possession d'un ordinateur portable
- Mathematica (version étudiant) installé

Elaboration d'un petit « cours d'introduction »: premiers pas avec Mathematica, dans le cadre de l'apprentissage autodidacte, avec le début des cours magistraux

Brève description du contenu et des objectifs

Les étudiants sont en mesure, après réussite de ce module, de résoudre des problèmes mathématiques sélectionnés dans la pratique via une combinaison de logiciels de calcul formel, à l'aide de méthodes sélectionnées dans le calcul numérique, ainsi que d'en interpréter les résultats et de les présenter grâce à la visualisation.

Objectifs, contenus, méthodes

Objectifs d'apprentissage, compétences à acquérir

Résolution de problèmes mathématiques issus de la pratique grâce à
- une manipulation compétente d'un logiciel de calcul formel (CAS)
- la maîtrise de méthodes sélectionnées dans le calcul numérique

Connaissance des limites des méthodes assistées par ordinateur en comprenant
- le fonctionnement interne des CAS (par exemple présentation de chiffres et de fonctions …)
- la stabilité numérique (erreurs d'arrondissage et de discrétisation) et la complexité algorithmique (vitesse de convergence

Association de méthodes symboliques d'un CAS à l'efficacité de logiciels numériques

Interprétation et présentation des résultats (de calcul) grâce à la visualisation

Contenu des modules avec pondération du contenu des cours

Traitement
- des données complexes issues de problèmes d'importance pratique
- via des outils de calcul numérique et de calcul symbolique
- de l'interprétation et de la visualisation des résultats

A l'aide de méthodes tirées de la liste suivante:
- Résolution de systèmes d'équation (factorisation LU, factorisation de Cholesky, transformation de Householder et factorisation QR, stratégies de matrices creuses et méthodes de Gauss-Seidel …)
- Détermination des zéros et optimisation non linéaire
- Interpolation uni-et multidimensionnelle et approximation (Interpolation, splines, ajustement de courbe, approximation de Chebyshev …)
- Dérivée et intégrale numérique
- Conditions initiales et conditions aux limites des équations différentielles ordinaires

En tenant compte de
- la précision, l'efficacité et la condition
- l'identification des problèmes et la sélection des méthodes
- le calcul formel pour la déduction de rapports complexes

Méthodes d'enseignement et d'apprentissage

- Communication d'information pure à travers le cours magistral
- Démonstration logicielle par le professeur dans le cadre du cours magistral
- Enseignement porté sur les problèmes au moyen d'exemples d'importance pratique
- Exemple de code pour site Web à compléter
- Référence à la littérature pour site Web à compléter
- Etude autodidacte assistée par les ouvrages de référence
- Traitement des tâches appropriées au cours de l'apprentissage autodidacte pour la préparation aux heures d'exercices

Bibliographie

- Schaum's Outlines of Numerical Analysis, McGraw-Hill Professional, 2nd edition
- Schwarz, Hans R.; Köckler, Norbert; Numerische Mathematik, Vieweg & Teubner, 7. Auflage
- Bronstein et al., Taschenbuch der Mathematik, Harri Deutsch
- Bradie, Brian, A Friendly Introduction to Numerical Analysis, Prentice-Hall

- Alfio Quarteroni, Riccardo Sacco, Fausto Saleri, M´ethodes Num´eriques - Algorithmes, analyse et applications, Springer, 2007
- Jean-Philippe Grivet, Méthodes numériques appliqués, EDP sciences
- Koepf, Wolfram, Computeralgebra, Springer
- Moler Cleve, Numerical Computing with Matlab, http://www.mathworks.com/moler/chapters.html
- Erwin Kreyszig, Advanced Engineering Mathematics, Wiley
- Erwin Kreyszig, Advanced Engineering Mathematics – Students Solution Manual and Study Guide, Wiley
- Erwin Kreyszig/E.J. Norminton, Mathematica Computer Guide for Erwin Kreiszigs Advanced Engineering Mathematics, Wiley
- Michael Trott, The Mathematica Guide Book for Numerics, Springer

Evaluation

Évaluation supplémentaire pendant le semestre

Le module ne comprend pas d'évaluation supplémentaire pendant le semestre

Principe pour les examens

En règle générale, tous les examens réguliers de fin de module se déroulent sous forme écrite. Concernant les examens de répétition, leur format (écrit ou oral) sera communiqué par l'enseignant-e en même temps que le calendrier des examens.

Examen de fin de module régulier et examen écrit de répétition

Type de l'examen

Examen écrit

Durée de l'examen

120 minutes

Aides autorisées

Les aides suivantes sont autorisées:

Aides électroniques autorisées

Aucune aide électronique autorisée

Autres aides autorisées

Open Book

Exception : En cas d'examen électronique sur Moodle, des modifications des aides autorisées peuvent survenir. Dans ce cas, les aides autorisées seront annoncées par les enseignant-e-s avant l'examen.

Cas spécial: examen de répétition oral

Type de l'examen

Examen oral

Durée de l'examen

30 minutes

Aides autorisées

Sans aides

Module Description, available in: EN, FR

Cryptography and Coding Theory

General Information

Number of ECTS Credits

3

Module code

FTP_CryptCod

Valid for academic year

2026-27

Last modification

2025-09-25

Coordinator of the module

Alexandre Duc (HES-SO, alexandre.duc@heig-vd.ch)

Explanations regarding the language definitions for each location:

- Instruction is given in the language specified for each location and module execution.
- Documentation is available in the language(s) listed for each location and module execution. If the documentation is in multiple languages, the percentage distributed is indicated (100% = all documentation provided).
- The examination, including both questions and answers, is provided entirely (100%) in the language(s) specified for each location and module execution. The exams are on-site.

	Lausanne			Lugano	Zurich		
Instruction		**X** F 100%			**X** E 100%		
Documentation		**X** F 70-80%	**X** E 20-30%		**X** E 100%		
Examination		**X** F 100%			**X** E 100%		

Module Category

FTP Fundamental theoretical principles

Profile Recommendations

This module is recommended for the following profiles:

	Lausanne	Zurich
Profile	CS, ICS	CS, ICS

Lessons

2 lecture periods and 1 tutorial period per week

Entry level competences

Prerequisites, previous knowledge

No particular prerequisites are required, but fundamental interest in practical applications of mathematics!

Brief course description of module objectives and content

This course provides the mathematical fundamentals of cryptography and coding theory and illustrates them with numerous practical examples.

Aims, content, methods

Learning objectives and competencies to be acquired

This course provides advanced methods of applied algebra and number theory and concentrates on their practical applications in cryptography and coding theory.

Module content with weighting of different components

- Algebra: algebraic structures (proups, fields), modular arithmetic, Chinesise remainder theorem, constuction and fundamental properties of finite fields (Galois fields GF (pm)), applications to cryptography and coding theory
- Algorithms in number theory (primality tests, integer factorization methods, elliptic curves), applications to cryptography and coding theory
- Use of a development environment (Java, C, C++, Python, Sage)

Week	Contents (Order and weighting may be adapted)
1	Algebraic basics: modular arithmetic, Euclidean algorithm, extended Euclidean algorithm, Bezout theorem, Fermat Euler theorem, Chinese Remainder theorem
2	
3	Asymmetric (public key) cryptography: Diffie Hellman key exchange, RSA algorithm, digital signatures
4	
5	Algebraic basics: polynomials and finite fields
6	Symmetric (secret key) cryptography: review of important examples (substitution cipher, transposition cipher, product cipher, block cipher,etc.)
7	Symmetric (secret key) cryptography: Hash functions, Data Encryption Standard (DES), Advanced Encryption Standard (AES), Chacha20, modes of operation, authenticated encryption
8	Elliptic Curve Diffie Hellman (ECDH), digital signatures
9	
10	One-time pad (OTP), Modern Topics in Cryptography, TLS and X509v3
11	Error-correcting codes: Cyclic codes, Reed-Solomon, BCH, Convolutional Codes
12	
13	
14	

Teaching and learning methods

- Lectures with practical application examples
- Exercices with solutions allowing knowledge application and deepening

Literature

- Buchmann, Johannes: Introduction to Cryptography, 2nd. ed., Springer Verlag, 2004, ISBN: 978-0-387-21156-5
- Paar, Christof; Pelzl, Jan; Güneysu, Tim: Understanding Cryptography, Spring Verlag 2014, ISBN: 978-3-662-69007-9
- Stinson, Douglas: Cryptography: Theory and Practice, 3rd ed., Chapman & Hall, 2005, ISBN: 978-1-584-88508-5
- Zémor, Gilles: Cours de cryptographie, Cassini, 2000, ISBN: 2-84225-020-6

Assessment

Additional performance assessment during the semester

The module does not contain an additional performance assessment during the semester

Basic principle for exams

As a rule, all standard final exams are conducted in written form. For resit exams, lecturers will communicate the exam format (written/oral) together with the exam schedule.

Standard final exam for a module and written resit exam

Kind of exam

Written exam

Duration of exam

120 minutes

Permissible aids

Aids permitted as specified below:

Permissible electronic aids

Nonprogrammable pocket calculator

Other permissible aids

Copies of the slides
Course notes (but no former exams, exercices, or solutions!)

Copies of the slides and course notes may be supplemented by any amount of handwritten notes. Books and former exams, exercices, and solutions are prohibited in print form and as complete copies.

Exception: In case of an electronic Moodle exam, adjustments to the permissible aids may occur. Lecturers will announce the final permissible aids prior to the exam session.

Special case: Resit exam as oral exam

Kind of exam

Oral exam

Duration of exam

30 minutes

Permissible aids

Aids permitted as specified below:

Permissible electronic aids

As for the written examination, but only during preparation

Other permissible aids

As for the written examination, but only during preparation

Description du module, disponible en: EN, FR

Cryptographie et théorie du codage

Informations générales

Nombre de crédits ECTS

3

Code du module

FTP_CryptCod

Valable pour l'année académique

2026-27

Dernière modification

2025-09-25

Coordinateur/coordinatrice du module

Alexandre Duc (HES-SO, alexandre.duc@heig-vd.ch)

Explications concernant les langues d'enseignement par site :

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- Les supports de cours sont disponibles dans les langues indiquées ci-dessous pour chaque site et chaque exécution du module. Lorsque plusieurs langues sont utilisées, la proportion de contenu disponible dans chaque langue est précisée (100 % = ensemble des supports de cours).
- Les examens (questions et réponses) sont entièrement rédigés dans la langue indiquée ci-dessous pour le site et l'exécution du module concernés. Ils se déroulent en présentiel.

	Lausanne			Lugano	Zurich		
Leçons		**X** F 100%			**X** E 100%		
Documentation		**X** F 70-80%	**X** E 20-30%		**X** E 100%		
Examen		**X** F 100%			**X** E 100%		

Catégorie de module

FTP bases théoriques élargies

Recommandations de profil

Ce module est recommandé pour les profils suivants :

	Lausanne	Zurich
Profil	CS, ICS	CS, ICS

Leçons

2 leçons et 1 leçon de pratique par semaine

Compétences préalables

Connaissances préalables, compétences initiales

Aucune, si ce n'est un intérêt pour les liens entre la théorie mathématique et les applications pratiques

Brève description du contenu et des objectifs

Ce cours pose les bases mathématiques de la cryptographie et du codage et présente de nombreux exemples pratiques.

Objectifs, contenus, méthodes

Objectifs d'apprentissage, compétences à acquérir

Le but de ce cours est d'enseigner des techniques avancées dans les domaines de l'algèbre appliquée et de la théorie des nombres, en mettant l'accent sur les méthodes utiles en cryptographie et en théorie du codage.

Contenu des modules avec pondération du contenu des cours

- Algèbre : structures algébriques (groupes, corps), arithmétique modulaire, théorème chinois, construction et propriétés de base des corps de Galois GF (pm), applications à la théorie du codage et en cryptographie.
- Algorithmes en théorie des nombres (test de primalité, algorithmes de factorisation, méthode des courbes elliptiques), applications à la théorie du codage et en cryptographie.
- Utilisation d'un environnement de développement (Java, C, C++, Python, Sage)

Semaine	Contenu du cours (l'ordre des thèmes et leur pondération peuvent varier)
1	Algebraic basics: modular arithmetic, Euclidean algorithm, extended Euclidean algorithm, Bezout theorem, Fermat Euler theorem, Chinese Remainder theorem
2	
3	Asymmetric (public key) cryptography: Diffie Hellman key exchange, RSA algorithm, digital signatures
4	
5	Algebraic basics: polynomials and finite fields
6	Symmetric (secret key) cryptography: review of important examples (substitution cipher, transposition cipher, product cipher, block cipher,etc.)
7	Symmetric (secret key) cryptography: Hash functions, Data Encryption Standard (DES), Advanced Encryption Standard (AES), Chacha20, modes of operation, authenticated encryption
8	Elliptic Curve Diffie Hellman (ECDH), digital signatures
9	
10	One-time pad (OTP), Modern Topics in Cryptography, TLS and X509v3
11	Error-correcting codes: Cyclic codes, Reed-Solomon, BCH, Convolutional Codes
12	
13	
14	

Méthodes d'enseignement et d'apprentissage

- Enseignement ex cathedra avec exemples concrets et appliqués
- Exercices avec corrigé permettant la mise en pratique et l'approfondissement des connaissances acquises

Bibliographie

- Buchmann, Johannes: Introduction to Cryptography, 2nd. ed., Springer Verlag, 2004, ISBN: 978-0-387-21156-5
- Paar, Christof; Pelzl, Jan; Güneysu, Tim: Understanding Cryptography, Spring Verlag 2014, ISBN: 978-3-662-69007-9
-
- Stinson, Douglas: Cryptography: Theory and Practice, 3rd ed., Chapman & Hall, 2005, ISBN: 978-1-584-88508-5
- Zémor, Gilles: Cours de cryptographie, Cassini, 2000, ISBN: 2-84225-020-6

Evaluation

Évaluation supplémentaire pendant le semestre

Le module ne comprend pas d'évaluation supplémentaire pendant le semestre

Principe pour les examens

En règle générale, tous les examens réguliers de fin de module se déroulent sous forme écrite. Concernant les examens de répétition, leur

format (écrit ou oral) sera communiqué par l’enseignant-e en même temps que le calendrier des examens.

Examen de fin de module régulier et examen écrit de répétition

Type de l'examen

Examen écrit

Durée de l'examen

120 minutes

Aides autorisées

Les aides suivantes sont autorisées:

Aides électroniques autorisées

Calculatrice de poche non programmable

Autres aides autorisées

Copie des transparents
Scripts du cours (mais sans anciens examens ni exercices ni corrigés !)

Les copies des transparents et les scripts peuvent être complétés par des notes manuscrites de volume quelconque. Ne sont autorisés ni livres, ni anciens examens, ni exercices, ni corrigés, que ce soit sous forme imprimée ou comme copies.

Exception : En cas d'examen électronique sur Moodle, des modifications des aides autorisées peuvent survenir. Dans ce cas, les aides autorisées seront annoncées par les enseignant-e-s avant l'examen.

Cas spécial: examen de répétition oral

Type de l'examen

Examen oral

Durée de l'examen

30 minutes

Aides autorisées

Les aides suivantes sont autorisées:

Aides électroniques autorisées

Comme pour l'examen écrit, mais seulement durant la préparation

Autres aides

Comme pour l'examen écrit, mais seulement durant la préparation

Module Description, available in: EN

Deep Learning

General Information

Number of ECTS Credits

3

Module code

FTP_DeLearn

Valid for academic year

2026-27

Last modification

2019-01-30

Coordinator of the module

Jean Hennebert (HES-SO, jean.hennebert@hes-so.ch)

Explanations regarding the language definitions for each location:

- Instruction is given in the language specified for each location and module execution.
- Documentation is available in the language(s) listed for each location and module execution. If the documentation is in multiple languages, the percentage distributed is indicated (100% = all documentation provided).
- The examination, including both questions and answers, is provided entirely (100%) in the language(s) specified for each location and module execution. The exams are on-site.

	Lausanne			Lugano	Zurich		
Instruction			**X** E 100%		**X** E 100%		
Documentation			**X** E 100%		**X** E 100%		
Examination			**X** E 100%		**X** E 100%		

Module Category

FTP Fundamental theoretical principles

Profile Recommendations

This module is recommended for the following profiles:

	Lausanne	Zurich
Profile	DS	DS

Lessons

2 lecture periods and 1 tutorial period per week

Entry level competences

Prerequisites, previous knowledge

Linear algebra: vector and matrix operations, Eigenvectors and –values
Multivariate calculus: partial differentiation, chain rule, gradient, Jacobian and Hessian
Statistics and probability theory: discrete and continuous distributions, multi-variate distributions, probability mass and density functions, Bayes' Rule, maximum likelihood principle
Programming: Experience in a programming language with good understanding of loops and data structures such as arrays/lists and maps/dictionaries; understanding of object oriented programming concepts. The course is taught using Python.

Brief course description of module objectives and content

Deep Learning is one of the most active subareas of Machine Learning and Artificial Intelligence at the moment. Gartner has placed it at the peak in its 2017 Hype Cycle and the trend is going on. Deep Learning techniques are based on neural networks. They are at the core of a vast range of impressive applications, ranging from image classification, automated image captioning, language translation such as Google Translate, to playing Go and arcade games.

This course focuses on the mathematical aspects of neural networks, their implementation (in Python), and their training and usage. Students will learn the fundamental concepts of Deep Learning and develop a good understanding of applicability of Deep Learning for Machine Learning tasks. After completing the course, students will have developed the skills to apply Deep Learning in practical application settings.

Aims, content, methods

Learning objectives and competencies to be acquired

Students will

- have a thorough **understanding of neural network architectures** including convolutional and recurrent networks.
- know **loss functions** (e.g. categorical cross entropy) that provide the optimization objective during training.
- understand the principles of **back propagation**.
- know the benefits of **depths and representation learning**.
- know some of the **recent advances** in the field and some of the **open research questions**.
- develop the ability to decide **whether Deep Learning is suitable** for a given task.
- gain the ability to **build and train neural network models** in a Deep Learning Framework such as TensorFlow.

Module content with weighting of different components

- **Introduction**: Logistic Neuron, training and cost functions.
  Architectures: Feed-forward and recurrent networks. Applications of neural networks.
- **Optimization strategies**: Minimization of loss functions, gradient descent, stochastic gradient descent, mini-batch gradient descent, implementation of gradient decent optimizers in Python.
- **Training of Deep Neural Networks**: Backpropagation, computational graphs, automatic differentiation, special optimizers, such as Nestrov accelerated gradient, AdaGrad, or RMSProp; tricks for faster training, batch normalization, gradient clipping, special activation functions such as non-saturating activation functions, regularization using dropout.
- **Multilayer Perceptron (MLP):** implementation of an MLP including backpropagation in Python.
- **Convolutional Neural Networks (CNNs)**: Convolutional and pooling layers, data augmentation, popular CNN architectures, transfer learning, applications.
- **Practical Considerations and Methodology**: Deep Learning frameworks such as TensorFlow; gpu vs cpu; visualizations such as activation maximization, class activation maps, saliency maps; performance metrics, selecting hyper-parameters, debugging strategies.
- **Recurrent Neural Networks**: Vanishing and exploding gradients, special memory cells, such as Gated Recurrent Units (GRU) or Long short-term memory (LSTM), static and dynamic unrolling, sequence classifiers, sequence-to-sequence models, encoder-decoder for language translation.
- **Special and Current Research Topics** such as
  - Autoencoders: principal component analysis using autoencoders; special applications such as denoising auto-encoders.
  - Generative Adversarial Models.
  - Learning embeddings for word representations, attention mechanism, transformers.

Teaching and learning methods

Classroom teaching; programming exercises

Literature

I. Goodfellow, Y. Bengio, A. Courville: “Deep Learning”, MIT Press, 2016. ISBN: 978-0262035613.

N. Buduma: “Fundamentals of Deep Learning: Designing Next-Generation Machine Intelligence Algorithms”, O’Reilly, 2017. ISBN: 978-1491925614.

A. Géron, Hands-on Machine Learning with Scikit-Learn and TensorFlow, O'Reilly, 2017 ISBN: 978-1491962299.

C. M. Bishop: “Neural Networks for Pattern Recognition”. Clarendon Press. 1996. ISBN: 978-0198538646.

K. P. Murphy, "Machine Learning, A Probabilistic Perspective", MIT Press, 2012, ISBN: 9780262018029

T. M. Mitchell, "Machine Learning", McGraw-Hill Science/Engineering/Math, 1997, ISBN: 0070428077

Assessment

Additional performance assessment during the semester

The module contains additional performance assessment(s) during the semester. The achieved mark of the additional performance assessment(s) applies to both the regular and the resit exam.

Description of additional performance assessment during the semester

- graded homework in addition to ungraded optional homework
- the average of the graded homework is valued to 25% of the final grade

Basic principle for exams

As a rule, all standard final exams are conducted in written form. For resit exams, lecturers will communicate the exam format (written/oral) together with the exam schedule.

Standard final exam for a module and written resit exam

Kind of exam

Written exam

Duration of exam

120 minutes

Permissible aids

Aids permitted as specified below:

Permissible electronic aids

No electronic aids permitted

Other permissible aids

1 A4 page (front and back) of handwritten notes

Exception: In case of an electronic Moodle exam, adjustments to the permissible aids may occur. Lecturers will announce the final permissible aids prior to the exam session.

Special case: Resit exam as oral exam

Kind of exam

Oral exam

Duration of exam

30 minutes

Permissible aids

No aids permitted

Module Description, available in: EN, FR

Digital Image Processing

General Information

Number of ECTS Credits

3

Module code

FTP_DigImPro

Valid for academic year

2026-27

Last modification

2024-10-17

Coordinator of the module

Olivier Hüsser (HES-SO, olivier.huesser@he-arc.ch)

Explanations regarding the language definitions for each location:

- Instruction is given in the language specified for each location and module execution.
- Documentation is available in the language(s) listed for each location and module execution. If the documentation is in multiple languages, the percentage distributed is indicated (100% = all documentation provided).
- The examination, including both questions and answers, is provided entirely (100%) in the language(s) specified for each location and module execution. The exams are on-site.

	Lausanne			Lugano	Zurich		
Instruction		**X** F 100%			**X** E 100%		
Documentation			**X** E 100%		**X** E 100%		
Examination		**X** F 100%			**X** E 100%		

Module Category

FTP Fundamental theoretical principles

Profile Recommendations

This module is recommended for the following profiles:

	Lausanne	Zurich
Profile	CS, Mic	EIE, MA, Med, Geo, Pho

Lessons

2 lecture periods and 1 tutorial period per week

Entry level competences

Prerequisites, previous knowledge

Math : basic calculus, linear algebra, probability, derivatives, matrix & vector product, orthogonal bases, eigenvalues, eigenvectors

Programming : good command of any structured programming language (e.g., Python, Matlab, R, Java, C, C++)

Statistics : mean, standard deviation, variance, co-variance, histograms, normal (gaussian) distribution

Signal Processing : Linear&invariant systems, Convolution, 1D-filtering, Sampling, Fourier Transform

Brief course description of module objectives and content

The goal of this module is to teach the fundamentals of image processing, while putting emphasis on their mathematical and algorithmic principles. In addition, specific 2D and 3D industrial and biomedical applications will be treated.

Aims, content, methods

Learning objectives and competencies to be acquired

Upon completion of this lecture, the students should be able to formulate an image processing problem and to propose and pursue alternative ways to it's solution. They can discuss and compare different algorithms and their implementations with regard to robustness, speed and complexity.

Module content with weighting of different components

1. Digital Image Fundamentals

- Linear and nonlinear systems
- Coordinate systems
- Geometric transformations
- Statistics: mean, standard deviation, histograms

2. From 2D to 3D

- Camera model
- Epipolar geometry

3. Linear and nonlinear filtering

- Convolution
- Correlation
- Spatial and frequency domain filtering

4. Morphological Image Processing

- Erosion & Dilatation, Opening and Closing
- Hit-or-Miss-Transformation (HMT)
- Connected Filtering

5. Image Segmentation

- Edge based
- Region based
- Intensity based

6. Image description

- Boundary descriptors
- Regional descriptors
- Texture descriptors
- Salient points

7. Object Recognition

- Model based
- Bayesian classifier
- Modern methods

Teaching and learning methods

Classroom teaching and exercises (paper & with computer)

Literature

Digital Image Processing (Gonzalez & Woods) 4th edition

Assessment

Additional performance assessment during the semester

The module does not contain an additional performance assessment during the semester

Basic principle for exams

As a rule, all standard final exams are conducted in written form. For resit exams, lecturers will communicate the exam format (written/oral) together with the exam schedule.

Standard final exam for a module and written resit exam

Kind of exam

Written exam

Duration of exam

120 minutes

Permissible aids

Aids permitted as specified below:

Permissible electronic aids

No electronic aids permitted

Other permissible aids

open book

Exception: In case of an electronic Moodle exam, adjustments to the permissible aids may occur. Lecturers will announce the final permissible aids prior to the exam session.

Special case: Resit exam as oral exam

Kind of exam

Oral exam

Duration of exam

30 minutes

Permissible aids

Aids permitted as specified below:

Permissible electronic aids

No electronic aids permitted

Other permissible aids

open book

Description du module, disponible en: EN, FR

Traitement numérique d'image

Informations générales

Nombre de crédits ECTS

3

Code du module

FTP_DigImPro

Valable pour l'année académique

2026-27

Dernière modification

2024-10-17

Coordinateur/coordinatrice du module

Olivier Hüsser (HES-SO, olivier.huesser@he-arc.ch)

Explications concernant les langues d'enseignement par site :

- L'enseignement est dispensé dans la langue indiquée ci-dessous pour chaque site et chaque exécution du module.
- Les supports de cours sont disponibles dans les langues indiquées ci-dessous pour chaque site et chaque exécution du module. Lorsque plusieurs langues sont utilisées, la proportion de contenu disponible dans chaque langue est précisée (100 % = ensemble des supports de cours).
- Les examens (questions et réponses) sont entièrement rédigés dans la langue indiquée ci-dessous pour le site et l'exécution du module concernés. Ils se déroulent en présentiel.

	Lausanne			Lugano	Zurich		
Leçons		**X** F 100%			**X** E 100%		
Documentation			**X** E 100%		**X** E 100%		
Examen		**X** F 100%			**X** E 100%		

Catégorie de module

FTP bases théoriques élargies

Recommandations de profil

Ce module est recommandé pour les profils suivants :

	Lausanne	Zurich
Profil	CS, Mic	EIE, MA, Med, Geo, Pho

Leçons

2 leçons et 1 leçon de pratique par semaine

Compétences préalables

Connaissances préalables, compétences initiales

Mathématiques : Bases d'analyse et d'algèbre linéaire, notions de probabilités, dérivées, produit matriciel et vectoriel, bases orthogonales, valeurs propres et vecteurs propres

Programmation : Bonne maîtrise d'au moins un langage structuré (p.ex., Python, Matlab, R, Java, C, C++)

Statistiques : moyenne, écart-type, variance, co-variance, histogrammes, distribution normale (gaussienne)

Traitement de signal : systèmes linéaires et invariants, convolution, filtrage 1D, échantillonnage, transformée de Fourier

Brève description du contenu et des objectifs

Le but de ce module est de décrire avec une assise mathématique et algorithmique, les bases du traitement de l'image. Certaines applications 2D et 3D, industrielles et biomédicales seront décrites.

Objectifs, contenus, méthodes

Objectifs d'apprentissage, compétences à acquérir

Après ce cours, l'étudiant est capable de mettre en oeuvre une ou plusieurs solutions pour résoudre une tâche de traitement d'image. Les alternatives doivent être discutées en termes de robustesse, de vitesse et de complexité.

Contenu des modules avec pondération du contenu des cours

1. Principes de base du traitement d'image

- Systèmes linéaires & non-linéaires,
- Systèmes de coordonnées,
- Transformations géométriques
- Statistique (moyenne, déviation standard, histogramme)

2. De 2D à 3D

- Modèle de la caméra
- Géométrie épipolaire

3. Filtrage linéaire et non linéaire

- Convolution
- Corrélation
- Filtrage spatial et fréquentiel

4. Traitement d'image morphologique

- Erosion & Dilatation, Ouverture et Fermeture
- Hit-or-Miss-Transformation (HMT)
- Filtrage connexe

5. Segmentation

- Basée sur les contours
- Basée sur les régions
- Basée sur l'intensité

6. Descripteurs d'image

- Contours
- Régions
- Texture
- Points saillants

7. Détection d'objets et classification

- Basée sur un modèle
- Classificateur bayesien
- Méthodes modernes

Méthodes d'enseignement et d'apprentissage

Cours magistral classique, exercices pratiques

Bibliographie

Digital Image Processing (Gonzalez & Woods) 4th edition

Evaluation

Évaluation supplémentaire pendant le semestre

Le module ne comprend pas d'évaluation supplémentaire pendant le semestre

Principe pour les examens

En règle générale, tous les examens réguliers de fin de module se déroulent sous forme écrite. Concernant les examens de répétition, leur format (écrit ou oral) sera communiqué par l'enseignant-e en même temps que le calendrier des examens.

Examen de fin de module régulier et examen écrit de répétition

Type de l'examen

Examen écrit

Durée de l'examen

120 minutes

Aides autorisées

Les aides suivantes sont autorisées:

Aides électroniques autorisées

Aucune aide électronique autorisée

Autres aides autorisées

open book

Exception : En cas d'examen électronique sur Moodle, des modifications des aides autorisées peuvent survenir. Dans ce cas, les aides autorisées seront annoncées par les enseignant-e-s avant l'examen.

Cas spécial: examen de répétition oral

Type de l'examen

Examen oral

Durée de l'examen

30 minutes

Aides autorisées

Les aides suivantes sont autorisées:

Aides électroniques autorisées

Aucune aide électronique autorisée

Autres aides

open book

Module Description, available in: EN, FR

Energy: Production, Consumption and Management

General Information

Number of ECTS Credits

3

Module code

FTP_Energy

Valid for academic year

2026-27

Last modification

2024-10-31

Coordinator of the module

Maurizio Barbato (SUPSI, maurizio.barbato@supsi.ch)

Explanations regarding the language definitions for each location:

- Instruction is given in the language specified for each location and module execution.
- Documentation is available in the language(s) listed for each location and module execution. If the documentation is in multiple languages, the percentage distributed is indicated (100% = all documentation provided).
- The examination, including both questions and answers, is provided entirely (100%) in the language(s) specified for each location and module execution. The exams are on-site.

	Lausanne			Lugano	Zurich		
Instruction		**X** F 100%			**X** E 100%		
Documentation			**X** E 100%		**X** E 100%		
Examination		**X** F 100%	**X** E 100%		**X** E 100%		

Module Category

FTP Fundamental theoretical principles

Profile Recommendations

This module is recommended for the following profiles:

	Lausanne	Zurich
Profile	CE	BT

Lessons

2 lecture periods and 1 tutorial period per week

Entry level competences

Prerequisites, previous knowledge

This course aims to raise students' awareness of energy issues and is intended for a broad audience. Knowledge of the fundamentals of thermodynamics and energy engineering is advantageous but not mandatory.
The course will be taught in English in Zürich and in French in Lausanne

Brief course description of module objectives and content

Energy availability, consumption, and management are among the most interesting and challenging topics of the future. Even in Switzerland, energy consumption is constantly rising, and politically, it has become an accepted fact that we must find ways to reduce energy consumption on a long-term basis. Climate change, energy availability, national security of energy supply are strong driving forces towards a change. In order to prepare Switzerland for this change, the Federal Council has developed the Energy Strategy 2050. This should enable Switzerland to take advantage of the new situation and maintain its high standard of supply. At the same time, the strategy will contribute to reducing Switzerland's energy-related environmental impact. The Energy Strategy 2050 has three main pillars: energy efficiency, implementation of renewable energy, and withdrawal from the use of nuclear energy.
This course is aimed particularly at students who have an interest in energy challenges, and it provides the necessary knowledge for understanding the multifaceted aspects of the topic. The course objectives are to introduce the students to the worldwide importance of energy, to have a clear idea about the sources available, gain knowledge about the different production techniques, gain insights on the consumption trends and understand the relevance of energy management. The students will acquire a vision of the energy technology and will be able to form opinions based on scientific facts.
In this course, we will address primary and secondary energy sources, energy transformation technologies, the relevance that energy has on global warming and the related environmental issues. The course has an engineering approach with large use of real cases and several examples related to the Swiss energy scenario. A light review of thermodynamic laws and concepts will be covered in order to be able to objectively evaluate the different energy conversion technologies.

Aims, content, methods

Learning objectives and competencies to be acquired

- To become acquainted with short, medium, and long-term energy sources that are available nationally and/or worldwide; to gain an understanding of the technical connections of efficient employment of energy in the future (Energy Strategy 2050, global warming);
- Ability to understand and communicate with specialists from various sectors such as energy management, energy production, and energy consumption;
- Ability to make a sensible choice between different technical systems that satisfy the requirements and the available energy sources, including economic, ecological, and social aspects. This involves:
    - the knowledge of the economic potential of energy systems,
    - the knowledge of methods of rational energy use, and
    - the ability to quantify energy conservation with thermodynamic methods.

Module content with weighting of different components

This module addresses the following aspects:

- Primary and secondary sources of energy
- Energy demand and potential
- Recall of Thermodynamics and fundamentals of energy science
- Energy conversion and storage
- The economic aspects of energy production and consumption
- Energy sustainability

Teaching and learning methods

Ex-cathedra teaching, presentations, case studies

Literature

- “Fundamentals of Engineering Thermodynamics”
  Michael J. Moran, Howard N. Shapiro
  Wiley
- “Energy Science: Principles, Technologies, and Impacts”
  John Andrews, Nick Jelley
  Oxford University Press

Assessment

Additional performance assessment during the semester

The module does not contain an additional performance assessment during the semester

Basic principle for exams

As a rule, all standard final exams are conducted in written form. For resit exams, lecturers will communicate the exam format (written/oral) together with the exam schedule.

Standard final exam for a module and written resit exam

Kind of exam

Written exam

Duration of exam

120 minutes

Permissible aids

Aids permitted as specified below:

Permissible electronic aids

Scientific calculator

WiFi off

Other permissible aids

Specified before the exam

Exception: In case of an electronic Moodle exam, adjustments to the permissible aids may occur. Lecturers will announce the final permissible aids prior to the exam session.

Special case: Resit exam as oral exam

Kind of exam

Oral exam

Duration of exam

30 minutes

Permissible aids

Aids permitted as specified below:

Permissible electronic aids

Scientific calculator

Other permissible aids

Specified before the exam

Description du module, disponible en: EN, FR

Gestion, production et utilisation d'énergie

Informations générales

Nombre de crédits ECTS

3

Code du module

FTP_Energy

Valable pour l'année académique

2026-27

Dernière modification

2024-10-31

Coordinateur/coordinatrice du module

Maurizio Barbato (SUPSI, maurizio.barbato@supsi.ch)

Explications concernant les langues d'enseignement par site :

- L'enseignement est dispensé dans la langue indiquée ci-dessous pour chaque site et chaque exécution du module.
- Les supports de cours sont disponibles dans les langues indiquées ci-dessous pour chaque site et chaque exécution du module. Lorsque plusieurs langues sont utilisées, la proportion de contenu disponible dans chaque langue est précisée (100 % = ensemble des supports de cours).
- Les examens (questions et réponses) sont entièrement rédigés dans la langue indiquée ci-dessous pour le site et l'exécution du module concernés. Ils se déroulent en présentiel.

	Lausanne			Lugano	Zurich		
Leçons		**X** F 100%			**X** E 100%		
Documentation			**X** E 100%		**X** E 100%		
Examen		**X** F 100%	**X** E 100%		**X** E 100%		

Catégorie de module

FTP bases théoriques élargies

Recommandations de profil

Ce module est recommandé pour les profils suivants :

	Lausanne	Zurich
Profil	CE	BT

Leçons

2 leçons et 1 leçon de pratique par semaine

Compétences préalables

Connaissances préalables, compétences initiales

Ce cours a pour objectif de sensibiliser les étudiant.e.s aux questions liées à l'énergie et s'adresse à un public large. Des connaissances de thermodynamique et d'ingénierie énergétique sont un avantage mais ne sont pas obligatoires.
L'enseignement est donné en anglais à Zürich et en Français à Lausanne.

Brève description du contenu et des objectifs

La disponibilité, la consommation et la gestion de l'énergie font partie des thèmes les plus intéressants et les plus stimulants de l'avenir. Même en Suisse, la consommation d'énergie est en constante augmentation et, sur le plan politique, il est désormais admis que nous devons trouver des moyens de réduire la consommation d'énergie à long terme. Le changement climatique, la disponibilité de l'énergie, la sécurité nationale de l'approvisionnement en énergie sont autant de raisons fortes qui nous poussent à changer.
Pour préparer la Suisse à ce changement, le Conseil fédéral a élaboré la Stratégie énergétique 2050. Celle-ci doit permettre à la Suisse de tirer parti de la nouvelle situation et de maintenir son haut niveau d'approvisionnement. Dans le même temps, la stratégie contribuera à réduire l'impact environnemental de la Suisse lié à l'énergie. La stratégie énergétique 2050 repose sur trois piliers principaux : l'efficacité énergétique, la mise en œuvre des énergies renouvelables et l'abandon de l'utilisation de l'énergie nucléaire.
Ce cours s'adresse en particulier aux étudiants qui s'intéressent aux défis énergétiques, et il fournit les connaissances nécessaires pour comprendre les aspects multiples du sujet. Les objectifs du cours sont de présenter aux étudiants l'importance mondiale de l'énergie, d'avoir une idée claire des sources disponibles, d'acquérir des connaissances sur les différentes techniques de production, d'avoir un aperçu des tendances de la consommation et de comprendre l'importance de la gestion de l'énergie. Les étudiants acquerront une vision de la technologie énergétique et seront capables d'élaborer des opinions basées sur des faits scientifiques.
Dans ce cours, nous aborderons les sources d'énergie primaires et secondaires, les technologies de transformation de l'énergie, l'impact de l'énergie sur le réchauffement climatique et les questions environnementales qui y sont liées. Le cours a une approche d'ingénierie avec une large utilisation d'exemples réels et plusieurs exemples liés au scénario énergétique suisse. Un léger rappel des lois et concepts de la thermodynamique sera traité dans le but d'être capable d'évaluer objectivement les différentes technologies de conversion énergétique.

Objectifs, contenus, méthodes

Objectifs d'apprentissage, compétences à acquérir

- Connaître à court, moyen et long terme les ressources énergétiques disponibles dans un contexte national et/ou international et comprendre les enjeux énergétiques de demain. (stratégie énergétique 2050, changement climatique)
- Savoir communiquer avec les spécialistes des divers domaines de la gestion, production et utilisation de l’énergie.
- Orienter judicieusement les choix techniques en fonction des besoins et des ressources, en tenant compte des aspects économiques, écologiques et sociaux.
    - Identifier les potentiels d’économie d’énergie
    - Trouver les solutions rationnelles liées à la consommation
    - Quantifier les gains avec des méthodes rigoureuses (thermodynamique)

Contenu des modules avec pondération du contenu des cours

Ce module traite les différents aspects suivants :

- Sources d’énergie primaires et secondaires
- Rappel de thermodynamique et des sciences de l’énergie
- Besoins et potentiels énergétiques
- Conversion énergétique et stockage
- Les aspects économiques de l’utilisation et de la production énergétiques.
- Durabilité énergétique

Méthodes d'enseignement et d'apprentissage

Cours frontal, exposés, séminaires, étude de cas, classe inversée

Bibliographie

- “Fundamentals of Engineering Thermodynamics”
  Michael J. Moran, Howard N. Shapiro
  Wiley
- “Energy Science: Principles, Technologies, and Impacts”
  John Andrews, Nick Jelley
  Oxford University Press

Evaluation

Évaluation supplémentaire pendant le semestre

Le module ne comprend pas d'évaluation supplémentaire pendant le semestre

Principe pour les examens

En règle générale, tous les examens réguliers de fin de module se déroulent sous forme écrite. Concernant les examens de répétition, leur format (écrit ou oral) sera communiqué par l’enseignant-e en même temps que le calendrier des examens.

Examen de fin de module régulier et examen écrit de répétition

Type de l'examen

Examen écrit

Durée de l'examen

120 minutes

Aides autorisées

Les aides suivantes sont autorisées:

Aides électroniques autorisées

Calculatrice

WiFi off

Autres aides autorisées

Spécifiés avant l'examen

Exception : En cas d'examen électronique sur Moodle, des modifications des aides autorisées peuvent survenir. Dans ce cas, les aides autorisées seront annoncées par les enseignant-e-s avant l'examen.

Cas spécial: examen de répétition oral

Type de l'examen

Examen oral

Durée de l'examen

30 minutes

Aides autorisées

Les aides suivantes sont autorisées:

Aides électroniques autorisées

Calculatrice

Autres aides

Spécifiés avant l'examen

Modulbeschreibung, verfügbar in: DE, FR

Raumplanungs-, Bau- und Umweltrecht

Allgemeine Angaben

Anzahl ECTS-Credits

3

Modulkürzel

FTP_EnviPlan

Gültig für akademisches Jahr

2026-27

Letzte Änderung

2024-09-28

Modul-Koordinator/in

Antonio Frigerio (OST, antonio.frigerio@ost.ch)

Erläuterungen zu den Sprachdefinitionen je Standort:

- Der Unterricht findet in der pro Standort und Durchführung definierten Sprache statt.
- Die Unterlagen sind in den pro Standort und Durchführung definierten Sprachen verfügbar. Bei Mehrsprachigkeit ist die prozentuale Verteilung angegeben (100% = komplette Unterlagen).
- Die Prüfungsfragen und -antworten sind in jeder pro Standort und Durchführung definierten Sprache. Die Prüfung wird vor Ort durchgeführt.

	Lausanne			Lugano	Zurich		
Unterricht		**X** F 100%				**X** D 100%	
Dokumentation		**X** F 100%				**X** D 100%	
Prüfung		**X** F 100%				**X** D 100%	

Modulkategorie

FTP Erweiterte theoretische Grundlagen

Profilempfehlungen

Dieses Modul wird für die folgenden Profile empfohlen:

	Lausanne	Zurich
Profil	CE, EnEn	BT, Geo, ReLa

Lektionen

2 Lektionen und 1 Übungslektion pro Woche

Eintrittskompetenzen

Vorkenntnisse, Eingangskompetenzen

Verständnis der Lehrinhalte aus den in BSc Studiengängen vermittelten Rechtsgebieten (ZGB / OR)

Kurzbeschreibung der Inhalte und Ziele

Im Modul werden ArchitektInnen, BauingenieurInnen, GeomatikingenieurInnen, RaumplanerInnen, Umweltingenieurinnen und weitere mit Projekten mit öffentlichen Aufgaben konfrontierte Personen die rechtlichen Grundsätze, gesetzlichen Regeln und Ausführungsbestimmungen vermittelt. Sie sollen befähigt werden, ihr Projekt (Neubau, Umbau, Rückbau, Erweiterung, Entwicklungen und Gestaltungen des Lebensraumes, usw.) rechtskonform und verfahrensrechtlich richtig zu realisieren und mit rechtlichen Friktionen umzugehen.

Ziele, Inhalte, Methoden

Lernziele und zu erwerbende Kompetenzen

Die Studierenden kennen und verstehen die wichtigsten raum-, bau- und umweltrelevanten Gesetzesbestimmungen und deren Ziele im Hinblick auf die Erreichung einer nachhaltigen Weiterentwicklung des Lebensraums.

Die Studierenden können die sich daraus ergebenden Konsequenzen ableiten und in konkreten Einzelfällen einer Lösung zuführen.

Die Studierenden sind in der Lage, komplexe Probleme in der öffentlichen Rechtsprechung zu erfassen und relevante verwaltungs- und verfahrensrechtliche Abläufe einzuordnen.

Modulinhalt mit Gewichtung der Lehrinhalte

Die Inhalte des Moduls werden in den folgenden thematischen Blöcken vermittelt:

Raumplanungsrecht

- System und Grundsätze der Raumplanung
- Bundesplanung und kantonale Richtplanung
- Nutzungsplanung und Nutzungsplan
- Sondernutzungsplan, Landumlegung, Sicherung der Ausgangslage für künftige Planungen (Planungszonen)
- Umsetzung der Rechts- und Planungsvorgaben (insbes. Förderung der Verfügbarkeit von Bauland, Mehrwertausgleich)

Öffentliches und privates Baurecht

- Baubewilligung / Zonenkonformität und Erschliessung
- Bauvorschriften und Ausnahmebewilligung
- Baurechtliche Verfahren, Baukontrolle und Sanktionen im Baurecht
- Privates Baurecht: Eigentum, Nachbarrecht, Grundbuchrecht (ZGB)
- Privates Baurecht: Bauvertragsrecht (Planerverträge, Bauwerkvertrag, Auftrag, SIA-Norm 118)

Umweltrecht

- Grundsätze des Umweltrechts
- Immissionsschutz, Gewässerschutz, Natur- und Heimatschutz und Walderhaltung
- Die Umweltverträglichkeitsprüfung - Rechtsschutz und Verfahren

Lehr- und Lernmethoden

- Vorlesung/Kolloquium
- Projektbezogenes Lernen
- Betreute Übungen mit Fallstudien
- Selbststudium

Bibliografie

- Baumann Marc: Repetitorium Planungs-, Bau- und Umweltrecht. Zürich: Orell Füssli, 2012.
- Basler Kommentar zum Schweizerischen Zivilgesetzbuch, kommentiert von Jürg Schmid und Heinz Rey/Lorenz Bösch, 5. Aufl. Basel 2015
- BR/DC Zeitschrift für Baurecht und Vergabewesen/Revue du droit de la construction et des marchés public. Institut für Schweizerisches und Internationales Baurecht der Universität Fribourg (Hrsg.). URL: www.unifr.ch [Stand: 02.01.2015].
- Fritzsche Christoph/Bösch Peter/Wipf Thomas/Kunz Daniel, Hrsg.: Zürcher Planungs- und Baurecht. Band 1: Planungsrecht, Verfahren und Rechtsschutz. 7. Aufl. Zürich 2024
- Fritzsche Christoph/Bösch Peter/Wipf Thomas/Kunz Daniel, Hrsg.: Zürcher Planungs- und Baurecht. Band 2: Bau- und Umweltrecht. 7. Aufl. Zürich 2024.
- Griffel Alain: Raumplanungs- und Baurecht in a nutshell. St. Gallen: 2014
- Hänni Peter: Planungs-, Bau- und besonderes Umweltrecht. Bern: Stämpfli; 2016.
- Haller Walter; Karlen Peter; Thurnherr Daniela (Mitarb.): Raumplanungs-, Bau- und Umweltrecht. Band I: Grundlagen, Raumplanungsrecht, Baurecht. 3., neu bearbeitete Auflage. Zürich: Schulthess Juristische Medien AG;
  dazu: Ergänzungen (Stand der Nachführung per 18.08.08).
- Huser Meinrad, Baubeschränkungen und Grundbuch, in BR/DC 4/2016, S. 197 ff.
- Huser Meinrad, Planen in der Landwirtschaftszone, in Blätter für Agrarrecht H. 2, 2015, S. 63 ff.
- Huser Meinrad: Schweizerisches Vermessungsrecht. Unter besonderer Berücksichtigung des Geoinformations-rechts und des

Grundbuchrechts. Beiträge aus dem Institut für Schweizerisches und Internationales Baurecht der Universität Freiburg Schweiz. Band 28. 3., ergänzte und erweiterte Auflage. Freiburg, 2014.
- Huser Meinrad, Publikation von Eigentumsbeschränkungen, neue Regeln, in BR/DC 4/2010 S. 169
- Huser Meinrad: Geo-Informationsrecht. Rechtlicher Rahmen für Geoinformationssysteme Zürich 2005
- Kurer Martin et.al. (Hrsg.): Handbuch zum Bauwesen. Zürich-St. Gallen 2012.
- Rausch Heribert; Marti Arnold; Griffel Alain; Haller Walter (Hrsg.): Umweltrecht. Ein Lehrbuch. Bern: 2004.
- Stöckli Hubert/Siegenthaler Thomas. (Hrsg.) : Die Planerverträge. Verträge mit Architekten und Ingenieuren. Zürich 2019.
- Vito Roberto / Hrubesch-Millauer Stephanie: Sachenrecht. 4. Aufl. Bern 2014.
- Skripte der Dozierenden

Bewertung

Zusätzliche Leistungsbewertung während des Semesters

Das Modul beinhaltet keine zusätzliche Leistungsbewertung während des Semesters.

Grundsatz Prüfungen

Grundsätzlich werden alle regulären Abschlussprüfungen in schriftlicher Form durchgeführt. Bei den Wiederholungsprüfungen teilen die Dozierenden das Prüfungsformat (schriftlich/mündlich) zusammen mit dem Prüfungsplan mit.

Reguläre Modulschlussprüfung und schriftliche Wiederholungsprüfung

Art der Prüfung

Schriftliche Prüfung

Prüfungsdauer

120 Minuten

Erlaubte Hilfsmittel

Erlaubt sind die aufgeführten Hilfsmittel:

Zulässige elektronische Hilfsmittel

Keine elektronischen Hilfsmittel zulässig

Weitere erlaubte Hilfsmittel

Open book: Gesetzestexte, Skripte, Literatur, Notizen, etc

Ausnahme: Im Falle einer elektronischen Moodle-Prüfung können Änderungen der Hilfsmittel vorkommen. Dozierende werden die endgültig zulässigen Hilfsmittel vor der Prüfung bekanntgeben.

Spezialfall: Wiederholungsprüfung als mündliches Examen

Art der Prüfung

Mündliche Prüfung

Prüfungsdauer

30 Minuten

Erlaubte Hilfsmittel

Ohne Hilfsmittel

Description du module, disponible en: DE, FR

Droit de la construction, de l'aménagement du territoire et de l'environnement

Informations générales

Nombre de crédits ECTS

3

Code du module

FTP_EnviPlan

Valable pour l'année académique

2026-27

Dernière modification

2024-09-28

Coordinateur/coordinatrice du module

Antonio Frigerio (OST, antonio.frigerio@ost.ch)

Explications concernant les langues d'enseignement par site :

- L'enseignement est dispensé dans la langue indiquée ci-dessous pour chaque site et chaque exécution du module.
- Les supports de cours sont disponibles dans les langues indiquées ci-dessous pour chaque site et chaque exécution du module. Lorsque plusieurs langues sont utilisées, la proportion de contenu disponible dans chaque langue est précisée (100 % = ensemble des supports de cours).
- Les examens (questions et réponses) sont entièrement rédigés dans la langue indiquée ci-dessous pour le site et l'exécution du module concernés. Ils se déroulent en présentiel.

	Lausanne			Lugano	Zurich		
Leçons		**X** F 100%				**X** D 100%	
Documentation		**X** F 100%				**X** D 100%	
Examen		**X** F 100%				**X** D 100%	

Catégorie de module

FTP bases théoriques élargies

Recommandations de profil

Ce module est recommandé pour les profils suivants :

	Lausanne	Zurich
Profil	CE, EnEn	BT, Geo, ReLa

Leçons

2 leçons et 1 leçon de pratique par semaine

Compétences préalables

Connaissances préalables, compétences initiales

Compréhension des contenus juridiques traités dans les filières BSc (Code Civil / Code des Obligations)

Brève description du contenu et des objectifs

Ce module destiné à des architectes, ingénieur-e-s en génie civil, géomaticien-ne-s, urbanistes, ingénieur-e-s en environnement et autres chargé-e-s de missions publiques et donne un aperçu des grands principes juridiques ainsi que des lois et ordonnances applicables. Le public visé doit être en mesure de réaliser son projet (construction neuve, rénovation, démolition, agrandissement, développement et aménagement du territoire, etc.) en conformité avec les règlementations et pouvoir gérer les problèmes juridiques associés.

Objectifs, contenus, méthodes

Objectifs d'apprentissage, compétences à acquérir

Les étudiant-e-s connaissent et sont capables de comprendre les principales dispositions légales relatives à l'aménagement du territoire et au droit de la construction ainsi que leurs objectifs en termes de développement durable des zones habitables.
Les étudiants sont à même d'en déduire les conséquences qui en résultent et de proposer une solution sur des études de cas concrets.
Les étudiants sont en mesure de situer des problèmes complexes par rapport aux règles de droit communément admises, et d'en déduire les procédures administratives et juridiques pertinentes.

Contenu des modules avec pondération du contenu des cours

Le contenu du module est structuré en trois blocs thématiques :

Droit de l'aménagement du territoire

- Système et principes d'aménagement du territoire
- Plan directeur fédéral et plans directeurs cantonaux
- Plans d'affectations
- Plans d'affectations spécifiques, remembrement, sécurisation de la situation initiale pour la planification future (zones d'affectation)
- Mise en œuvre des exigences légales et de planification (en particulier promotion et disponibilité des terrains constructibles, dédommagement pour l'aménagement du territoire)

Droit public et privé de la construction

- Permis de construire / conformité à l'affection des zones et aménagement du territoire
- Règlementations d'urbanisme et permis dérogatoire
- Procédure en droit de la construction, contrôle de la construction et sanctions prévues par le droit de la construction
- Droit civil et droit pénal en construction, propriété, rapport de voisinage, registre foncier (CC)
- Contrats de construction (contrat pour prestations de mandataire, contrat d'entreprise dans la construction, mandat simple, Norme SIA 118)

Droit de l'environnement

- Principes du droit de l'environnement
- Protection contre les émmissions, protection des eaux, des forêts, de la biodiversité et du paysage.
- Étude d'impact sur l'environnement, procédure et voies de droit

Méthodes d'enseignement et d'apprentissage

- Enseignement frontal/ Colloque
- Apprentissage axé sur des projets
- Travaux dirigés avec études de cas
- Etude autonome

Bibliographie

- Baumann Marc: Repetitorium Planungs-, Bau- und Umweltrecht. Zürich: Orell Füssli, 2012.
- Basler Kommentar zum Schweizerischen Zivilgesetzbuch, kommentiert von Jürg Schmid und Heinz Rey/Lorenz Bösch, 5. Aufl. Basel 2015 BR/DC Zeitschrift für Baurecht und Vergabewesen/Revue du droit de la construction et des marchés public. Institut für Schweizerisches und Internationales Baurecht der Universität Fribourg (Hrsg.). URL: www.unifr.ch [Stand: 02.01.2015].
- Fritzsche Christoph/Bösch Peter/Wipf Thomas/Kunz Daniel, Hrsg.: Zürcher Planungs- und Baurecht. Band 1: Planungsrecht, Verfahren und Rechtsschutz. 7 Aufl. Zürich 2024
- Fritzsche Christoph/Bösch Peter/Wipf Thomas/Kunz Daniel, Hrsg.: Zürcher Planungs- und Baurecht. Band 2: Bau- und Umweltrecht. 6. Aufl. Zürich 2024.
- Griffel Alain: Raumplanungs- und Baurecht in a nutshell. St. Gallen: 2014
- Hänni Peter: Planungs-, Bau- und besonderes Umweltrecht. Bern: Stämpfli; 2016.
- Haller Walter; Karlen Peter; Thurnherr Daniela (Mitarb.): Raumplanungs-, Bau- und Umweltrecht. Band I: Grundlagen, Raumplanungsrecht, Baurecht. 3., neu bearbeitete Auflage. Zürich: Schulthess Juristische Medien AG;
- dazu: Ergänzungen (Stand der Nachführung per 18.08.08).
- Huser Meinrad, Baubeschränkungen und Grundbuch, in BR/DC 4/2016, S. 197 ff.
- Huser Meinrad, Planen in der Landwirtschaftszone, in Blätter für Agrarrecht H. 2, 2015, S. 63 ff.
- Huser Meinrad: Schweizerisches Vermessungsrecht. Unter besonderer Berücksichtigung des Geoinformations-rechts und des Grundbuchrechts. Beiträge aus dem Institut für Schweizerisches und Internationales Baurecht der Universität Freiburg Schweiz. Band 28. 3., ergänzte und erweiterte Auflage. Freiburg, 2014.
- Huser Meinrad, Publikation von Eigentumsbeschränkungen, neue Regeln, in BR/DC 4/2010 S. 169 Huser Meinrad: Geo-Informationsrecht. Rechtlicher Rahmen für Geoinformationssysteme Zürich 2005 Kurer Martin et.al. (Hrsg.): Handbuch zum Bauwesen. Zürich-St. Gallen 2012.
- Rausch Heribert; Marti Arnold; Griffel Alain; Haller Walter (Hrsg.): Umweltrecht. Ein Lehrbuch. Bern: 2004.
- Stöckli Hubert/Siegenthaler Thomas. (Hrsg.) : Die Planerverträge. Verträge mit Architekten und Ingenieuren. Zürich 2019.
- Vito Roberto / Hrubesch-Millauer Stephanie: Sachenrecht. 4. Aufl. Bern 2014.
- Notes des enseignants

Evaluation

Évaluation supplémentaire pendant le semestre

Le module ne comprend pas d'évaluation supplémentaire pendant le semestre

Principe pour les examens

En règle générale, tous les examens réguliers de fin de module se déroulent sous forme écrite. Concernant les examens de répétition, leur format (écrit ou oral) sera communiqué par l'enseignant-e en même temps que le calendrier des examens.

Examen de fin de module régulier et examen écrit de répétition

Type de l'examen

Examen écrit

Durée de l'examen

120 minutes

Aides autorisées

Les aides suivantes sont autorisées:

Aides électroniques autorisées

Aucune aide électronique autorisée

Autres aides autorisées

Open book: textes des lois, scripts, bibliographie, notes, etc

Exception : En cas d'examen électronique sur Moodle, des modifications des aides autorisées peuvent survenir. Dans ce cas, les aides autorisées seront annoncées par les enseignant-e-s avant l'examen.

Cas spécial: examen de répétition oral

Type de l'examen

Examen oral

Durée de l'examen

30 minutes

Aides autorisées

Sans aides

Module Description, available in: EN

Lifecycle Management of Infrastructures

General Information

Number of ECTS Credits

3

Module code

FTP_Life

Valid for academic year

2026-27

Last modification

2025-10-07

Coordinator of the module

Thomas Herrmann (ZHAW, hemm@zhaw.ch)

Explanations regarding the language definitions for each location:

- Instruction is given in the language specified for each location and module execution.
- Documentation is available in the language(s) listed for each location and module execution. If the documentation is in multiple languages, the percentage distributed is indicated (100% = all documentation provided).
- The examination, including both questions and answers, is provided entirely (100%) in the language(s) specified for each location and module execution. The exams are on-site.

	Lausanne			Lugano	Zurich		
Instruction					**X** E 100%		
Documentation					**X** E 100%		
Examination					**X** E 100%		

Module Category

FTP Fundamental theoretical principles

Profile Recommendations

This module is recommended for the following profiles:

	Zurich
Profile	BE, CE

Lessons

2 lecture periods and 1 tutorial period per week

Entry level competences

Prerequisites, previous knowledge

Basic knowledge in mathemetics (introductory lecture in analysis and linear algebra), basic knowledge in probability theory (e.g. exponential distribution)

MS Excel (implementation of formulae, graphs)

Brief course description of module objectives and content

In today's rapidly evolving world, infrastructure assumes a crucial role in shaping the way societies function and progress. Roads, railways, bridges, energy grids, machines, and digital networks all contribute to the foundation of modern society. Managing the lifecycle of these infrastructures becomes a critical discipline, ensuring their reliability, sustainability, and adaptability over time. Various stakeholders face complex relationships and goals when making decisions related to infrastructure management. This module introduces students to the multifaceted and strategic aspects of planning, building, operating, and maintaining these essential systems.We discuss established models for analyzing construction and maintenance strategies of technical infrastructures, aiming to develop sustainable measures.

We learn how each phase of infrastructure lifecycle contributes to the overall success and sustainability of infrastructure projects. We first present basic cost-based methods for assessing cost-efficient maintenance and replacement strategies. With the introduction of benefits, we are then able to conduct comprehensive cost-benefit analyses (CBA) - the basis of life-cycle cost analysis (LCC). Life Cycle Assessment (LCA) methods complement these methodologies by focusing on environmental sustainability, energy efficiency, and resilience concepts - challenging aspects of every infrastructure manager today.

In the second part, we introduce fundamental maintenance concepts, including Reliability, Availability, and Maintainability (RAM). We delve into topics such as the behavior of systems and components regarding failure and degradation, as well as the concept of hazard rates. We examine maintenance strategies to provide insights into optimal decision-making and replacement strategies. Additionally, we explore predictive maintenance concepts using Remaining Useful Life (RUL) to maximize asset reliability. We learn about methods that are applied within large asset portfolios, and we explore methodologies like Reliability Centered Maintenance (RCM) and Risk-based maintenance.

Aims, content, methods

Learning objectives and competencies to be acquired

- the students understand the function and the benefit of infrastructures, and their effect on society, economy, and environment
- the students are familiar with the challenges for sustainable development of infrastructures and strategic decision-making
- the students are familiar with the most important methods for decision-making in infrastructure management
- the students are able to assess the financial viability of potential investments, projects, or initiatives by quantifying their costs and benefits over a specified time frame; including the calculation of Net Present Values (NPV), annuities, and Internal Rate of Return (IRR)
- the students are able to conduct basic assessment methods such as cost-benefit analysis (CBA) and they are able to understand comprehensive analyses for decision-making support.
- the students are familiar with the different maintenance strategies (reactive, preventive, condition-based)
- the students know different models of failure and wear behavior, and can apply them
- students know the concepts of reliability theory
- the students are familiar with the method of risk-based maintenance, and can apply this method for maintenance management
- the students are able to apply all those methods in concrete cases; for example the calculation of life cycle costs or socio-economic impact, or the simultaneous minimization of costs and risks.

Module content with weighting of different components

- Basic concepts
  - introduction into the infrastructure networks of electricty, water, road, and rail
  - concepts of cost and benefit assessment
  - standards for life cycle management
- Infrastructure costs
  - life cycle costing
  - maintenance and replacement strategies for cost minimization
- Assessment methods
  - cost-benefit analyses
  - monetary models of benefit and their limits
  - utility analysis and cost effectiveness analysis
- Basic concepts of Maintenance - RAM
  - Reliability, Availability and Maintainability (RAM) models and calculations
  - Failure and degradation behavior of systems and components, Hazard rate, Weibull distribution and its application in reliability
- Maintenance management
  - Optimal decision making and replacement strategies in maintenance
  - Maintenance management in large asset portfolios
  - Reliability Centered Maintenance (RCM)
  - Risk based maintenance
- Maintenance Strategies
  - Corrective, preventive maintenance approaches
  - Condition based maintenance and approaches to fault detection (Anomaly detection) with multivariate datasets
  - Predictive Maintenance concepts using Remaining useful life (RUL)

Teaching and learning methods

Lecture: Introduction in the relevant concepts with examples

Exercises: applications and use cases

Literature

Supplementary publications. No book that we follow

Note: Since part of the module content is based on Swiss standards, some literature is provided in German/French only (not exam relevant).

Assessment

Additional performance assessment during the semester

The module does not contain an additional performance assessment during the semester

Basic principle for exams

As a rule, all standard final exams are conducted in written form. For resit exams, lecturers will communicate the exam format (written/oral) together with the exam schedule.

Standard final exam for a module and written resit exam

Kind of exam

Written exam

Duration of exam

120 minutes

Permissible aids

Aids permitted as specified below:

Permissible electronic aids

- Laptop (incl. charging cable, mouse), calculator; Moodle access
- Any communication programs (e.g. email, chats), AI (like ChatGPT, Gemini, Perplexity, ...) have to be disabled, switched off and must not be accessed. Make sure that no communication program is running which might create pop-up windows on your screen.
- Additional devices, like tablets (iPad, etc.), mobile phones, second screens, printers, ear phones, smart watches ... are **not** allowed

Other permissible aids

- Open Book - you have basically access to any resource, including online resources (e.g. for translation). However, communication programs are forbidden (see above)
- Course slides and exercises (paper or electronic)
- Personal notes
- Any other document that has been created before the beginning of the exam, including Excel files or similar.

Exception: In case of an electronic Moodle exam, adjustments to the permissible aids may occur. Lecturers will announce the final permissible aids prior to the exam session.

Special case: Resit exam as oral exam

Kind of exam

Oral exam

Duration of exam

30 minutes

Permissible aids

Aids permitted as specified below:

Permissible electronic aids

- Oral exams focus on contextual understanding, key principles and concepts and not on complex calculations or memorizing all details. You should thus be able to explain formulae and Excel sheets, draw sketches of function graphs, interpret figures in the given context, show masterplans how to approach and solve an assignment, etc. You are allowed to use your Excel-Workbooks (or similar) and a calculator, if we ask you to calculate a figure.
- You are allowed to look up in your notes and worksheets (electronical or paparbased). Be aware: Searching consumes a lot of time. This is only a backup!

Other permissible aids

No other aids permitted

Module Description, available in: EN

Machine Learning

General Information

Number of ECTS Credits

3

Module code

FTP_MachLe

Valid for academic year

2026-27

Last modification

2024-11-08

Coordinator of the module

Christoph Würsch (OST, christoph.wuersch@ost.ch)

Explanations regarding the language definitions for each location:

- Instruction is given in the language specified for each location and module execution.
- Documentation is available in the language(s) listed for each location and module execution. If the documentation is in multiple languages, the percentage distributed is indicated (100% = all documentation provided).
- The examination, including both questions and answers, is provided entirely (100%) in the language(s) specified for each location and module execution. The exams are on-site.

	Lausanne			Lugano	Zurich		
Instruction	**X** E 100%				**X** E 100%		
Documentation	**X** E 100%				**X** E 100%		
Examination	**X** E 100%				**X** E 100%		

Module Category

FTP Fundamental theoretical principles

Profile Recommendations

This module is recommended for the following profiles:

	Lausanne	Zurich
Profile	CS, DS, ICS	EIE, ICS, Med, Avi

Lessons

2 lecture periods and 1 tutorial period per week

Entry level competences

Prerequisites, previous knowledge

- **Math**: basic calculus / linear algebra / probability calculus (e.g., derivatives, matrix multiplication, normal distribution)
- **Statistics**: basic descriptive statistics (e.g., mean, variance, co-variance, histograms, box plots)
- **Programming**: good command of any structured programming language (e.g., Python, Matlab, R, Java, C, C++)
- **Analytics**: basic data analysis methods (data pre-processing, linear & logistic regression)

Brief course description of module objectives and content

Machine learning (ML) emerged out of artificial intelligence and computer science as the academic discipline concerned with “giving computers the ability to learn without being explicitly programmed” (A. Samuel, 1959). Today, it is the methodological driver behind the mega-trend of digitalization. ML experts are highly sought after in industry and academia alike.

This course builds upon basic knowledge in math, programming and analytics/statistics as is typically gained in respective undergraduate courses of diverse engineering disciplines. From there, it teaches the foundations of modern machine learning techniques in a way that focuses on practical applicability to real-world problems. The complete process of building a learning system is considered:

- formulating the task at hand as a learning problem;
- extracting useful features from the available data;
- choosing and parameterizing a suitable learning algorithm.

Covered topics include cross-cutting concerns like ML system design and debugging (how to get intuition into learned models and results) as well as feature engineering; covered algorithms include (amongst others) Support Vector Machines (SVM) and ensemble methods.

Aims, content, methods

Learning objectives and competencies to be acquired

- Students **know** the **background and taxonomy** of machine learning methods
- On this basis, they **formulate** given problems as l**earning tasks** and **select** a **proper learning method**
- Students **are able to convert** a data set into a proper **feature set** fitting for a task at hand
- They **evaluate** the chosen **approach** in a structured way using proper design of experiment
- Students **know how** to select models, and „**debug**“ features and learning algorithms if results do not fit expectations
- Students are able to leverage on the evaluation framework to **tune the parameters** of a given system and **optimize** its performances
- Students **have seen examples of different data** sources / problem types and **are able to acquire additional expert knowledge** from the scientific literature

Module content with weighting of different components

- **Introduction** (ca. 2 weeks): Convergence for participants with different backgrounds
- **Supervised learning** (ca. 7 weeks): Learn from labeled data
  Cross-cutting topics: such as feature engineering; ensemble learning; instance vs. model-based approaches, debugging ML systems
  Algorithms: e.g. kNN, decision tree, SVM, ensemble learning (bagging, boosting), graphical models (Bayesian networks), gradient based approaches
  bias-variance tradeoff: hyperparameter tuning, cross-validation, performance metrics
- **Unsupervised learning** (ca. 3 weeks): Learning without labels
  Algorithms: e.g., clustering, dimensionality reduction, anomaly detection, archetypal analysis
- **Special chapters** (ca. 2 weeks):
  Algorithms: e.g., reinforcement learning, recommender systems, hidden Markov / Gaussian mixture models

Teaching and learning methods

Classroom teaching; programming exercises (e.g., in Python 3, Jupyter notebooks, Orange)

Literature

- Aurélien Géron: "*Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow*", Concepts, Tools, and Techniques to Build Intelligent Systems, O’Reilley Media, 2022
- T. Mitchell, “*Machine Learning*”, 1997
- C. M. Bishop, “*Pattern Recognition and Machine Learning*”, 2006
- Simon Rogers, Mark Girolami: “*A First Course in Machine Learning*”, ISBN-13: 978-0367574642, Chapman and Hall/CRC; 2. Edition, 2016
- G. James et al., “*An Introduction to Statistical Learning*”, 2014

Assessment

Additional performance assessment during the semester

The module does not contain an additional performance assessment during the semester

Basic principle for exams

As a rule, all standard final exams are conducted in written form. For resit exams, lecturers will communicate the exam format (written/oral) together with the exam schedule.

Standard final exam for a module and written resit exam

Kind of exam

Written exam

Duration of exam

120 minutes

Permissible aids

Aids permitted as specified below:

Permissible electronic aids

No electronic aids permitted

Other permissible aids

1 A4 page (front and back) of personally compiled notes (no book, no slides, no further notes)

Exception: In case of an electronic Moodle exam, adjustments to the permissible aids may occur. Lecturers will announce the final permissible aids prior to the exam session.

Special case: Resit exam as oral exam

Kind of exam

Oral exam

Duration of exam

30 minutes

Permissible aids

Aids permitted as specified below:

Permissible electronic aids

No electronic aids permitted

Other permissible aids

1 A4 page (front and back) of personally compiled notes (no book, no slides, no further notes)

Module Description, available in: EN, FR

Modelling Simulation and Optimisation

General Information

Number of ECTS Credits

3

Module code

FTP_ModSim

Valid for academic year

2026-27

Last modification

2024-10-03

Coordinator of the module

Andrea-Emilio Rizzoli (SUPSI, andrea.rizzoli@supsi.ch)

Explanations regarding the language definitions for each location:

- Instruction is given in the language specified for each location and module execution.
- Documentation is available in the language(s) listed for each location and module execution. If the documentation is in multiple languages, the percentage distributed is indicated (100% = all documentation provided).
- The examination, including both questions and answers, is provided entirely (100%) in the language(s) specified for each location and module execution. The exams are on-site.

	Lausanne			Lugano	Zurich		
Instruction		**X** F 100%		**X** E 100%	**X** E 100%		
Documentation		**X** F 70%	**X** E 30%	**X** E 100%	**X** E 100%		
Examination		**X** F 100%		**X** E 100%	**X** E 100%		

Module Category

FTP Fundamental theoretical principles

Profile Recommendations

This module is recommended for the following profiles:

	Lausanne	Lugano	Zurich
Profile	EIE, EnEn	BE, CS, ME, MA	BE

Lessons

2 lecture periods and 1 tutorial period per week

Entry level competences

Prerequisites, previous knowledge

Basic knowledge of

- Calculus (differential and difference equations)
- Linear Algebra (vectors, matrices, change of basis, matrix inversion, computation of eigenvalues)
- Probability (random variables, probability distributions, conditional probability)
- A tool for engineering calculus such as Matlab, Python or R

Brief course description of module objectives and content

Modelling, simulation and optimization are fundamental to solving problems in a number of fields of science, technology and life. Students will learn to design, implement, simulate, and optimize a model of dynamic system. First we will focus on the analysis of how different model structures can generate different behaviours, reproducing growth processes, but also goal seeking and oscillating behaviours. Then we focus on how systems can be analysed, controlled and optimised thanks to systems theory to obtain desired behaviours. Finally, modelling the behaviour of discrete-event systems is considered and techniques for their simulation and optimisation are discussed.

Aims, content, methods

Learning objectives and competencies to be acquired

The main aim of the course is to understand the pervasive feedback principles that rule the world we live in. Thanks to the acquired competencies, the successful student is expected to be able to tackle problems where temporal dynamics plays a major role. The student will learn about alternative and complementary modelling paradigms: from difference and differential equations for continuous time modelling to queuing systems and discrete event systems for discrete event modelling. The student will be then able to formalise the problem thanks to a dynamical model formulation, implement a simulation of the model, and explore the space of alternative behaviours of the system in order to synthesise a possibly optimal management and control strategy.

Module content with weighting of different components

- Tools for systems thinking: introduction to modelling with causal loop diagrams and stock and flows diagrams
- Models of feedback dynamics in dynamic systems: growth and collapse, delays and oscillations
- Elements of systems theory from linear and regular systems to non linear systems: analysis of equilibrium and stability
- Optimisation and control of continuous state and time systems: concept of feedback control, state estimation with the Kalman filter and Optimal Control
- Modelling with discrete event systems: elements of queuing systems.
- Building discrete event systems: modelling input data and analysing output of simulations
- Simulation as an optimisation design tool: design of experiments, metamodelling and the response surface methodology

Teaching and learning methods

Frontal lectures (3h/week) during which the students also perform hands-on exercises with modelling and simulation tools in order to acquire the key applications of the presented theory.

Literature

Business Dynamics - Systems Thinking and Modeling for a Complex World, John D Sterman, McGraw-Hill, 2000. ISBN: 007238915X Introduction to Dynamic Systems, David G. Luenberger, John Wiley & Sons, 1979. ISBN: 0471025941 Introduction to Discrete Event Systems - 2nd Edition. C.G. Cassandras and S. Lafortune.Springer 2008. ISBN 978-0-387-33332-8Simulation Modeling and Analysis 3rd Edition, Averill M Law and W David Kelton, McGraw-Hill, 2000. ISBN 0-07-116537-1 *Simio and Simulation - Modeling, Analysis and Applications*, W.David Kelton, Jeffrey S. Smith, David T. Sturrock, Alexander Verbraeck. McGraw-Hill. 2010. ISBN 0-07-340888-3 Simulation with ARENA - 4th Edition, W. David Kelton and Randall P. Sadowski and David T. Sturrock, McGraw-Hill International Edition 2007. ISBN 0-07-110685-5

Assessment

Additional performance assessment during the semester

The module does not contain an additional performance assessment during the semester

Basic principle for exams

As a rule, all standard final exams are conducted in written form. For resit exams, lecturers will communicate the exam format (written/oral) together with the exam schedule.

Standard final exam for a module and written resit exam

Kind of exam

Written exam

Duration of exam

120 minutes

Permissible aids

Aids permitted as specified below:

Permissible electronic aids

Laptops and tablets are allowed to access the course documentation, but cannot be used to communicate with other students or with the external world.

Other permissible aids

The exam is an "open book" exam. The students may access all material presented during the lectures.

Exception: In case of an electronic Moodle exam, adjustments to the permissible aids may occur. Lecturers will announce the final permissible aids prior to the exam session.

Special case: Resit exam as oral exam

Kind of exam

Oral exam

Duration of exam

30 minutes

Permissible aids

No aids permitted

Description du module, disponible en: EN, FR

Modelling Simulation and Optimisation

Informations générales

Nombre de crédits ECTS

3

Code du module

FTP_ModSim

Valable pour l'année académique

2026-27

Dernière modification

2024-10-03

Coordinateur/coordinatrice du module

Andrea-Emilio Rizzoli (SUPSI, andrea.rizzoli@supsi.ch)

Explications concernant les langues d'enseignement par site :

- L'enseignement est dispensé dans la langue indiquée ci-dessous pour chaque site et chaque exécution du module.
- Les supports de cours sont disponibles dans les langues indiquées ci-dessous pour chaque site et chaque exécution du module. Lorsque plusieurs langues sont utilisées, la proportion de contenu disponible dans chaque langue est précisée (100 % = ensemble des supports de cours).
- Les examens (questions et réponses) sont entièrement rédigés dans la langue indiquée ci-dessous pour le site et l'exécution du module concernés. Ils se déroulent en présentiel.

	Lausanne			Lugano	Zurich		
Leçons		**X** F 100%		**X** E 100%	**X** E 100%		
Documentation		**X** F 70%	**X** E 30%	**X** E 100%	**X** E 100%		
Examen		**X** F 100%		**X** E 100%	**X** E 100%		

Catégorie de module

FTP bases théoriques élargies

Recommandations de profil

Ce module est recommandé pour les profils suivants :

	Lausanne	Lugano	Zurich
Profil	EIE, EnEn	BE, CS, ME, MA	BE

Leçons

2 leçons et 1 leçon de pratique par semaine

Compétences préalables

Connaissances préalables, compétences initiales

Connaissance de base de

- Calcul (équations différentielles et de différence)
- Algèbre linéaire (vecteurs, matrices, changement de base, inversion de matrice, calcul des valeurs propres)
- Probabilité (variables aléatoires, distributions de probabilité, probabilité conditionnelle)
- Un outil de calcul technique tel que Matlab, Python ou R

Brève description du contenu et des objectifs

La modélisation, la simulation et l'optimisation sont fondamentales pour résoudre les problèmes dans un certain nombre de domaines de la science, de la technologie et de la vie. Les étudiant-e-s apprendront à concevoir, mettre en œuvre, simuler et optimiser un modèle de système dynamique. La simulation, l'exploration du comportement dynamique du modèle dans le temps et l'espace seront traités pour les systèmes à événements continus et discrets. La simulation d'un modèle permet d'évaluer les indicateurs de performance du système modélisé, améliorant ainsi notre compréhension de son comportement et de sa complexité dynamique.

Objectifs, contenus, méthodes

Objectifs d'apprentissage, compétences à acquérir

L'objectif principal du cours consiste à comprendre les principes de rétroaction systématiques qui gouvernent le monde dans lequel nous vivons. Grâce aux compétences acquises, l'étudiant-e sera capable d'aborder des problèmes dans lesquelles la dynamique temporelle joue un rôle majeur. L'étudiant-e se familiarisera avec des paradigmes de modélisation alternatifs et complémentaires : des équations différentielles et de différence pour la modélisation du temps continu aux systèmes de file d'attente et aux systèmes d'événements discrets pour la modélisation d'événements discrets. L'étudiant-e sera ensuite capable de formaliser le problème grâce à la formulation d'un modèle dynamique, de mettre en œuvre une simulation du modèle et d'explorer l'espace des comportements alternatifs du système afin de synthétiser une stratégie de gestion et de contrôle optimisée.

Contenu des modules avec pondération du contenu des cours

- Outils pour la pensée systémique : introduction à la modélisation avec des diagrammes de boucles causales et des diagrammes de stocks et de flux
- Modèles de dynamique de feedback dans les systèmes dynamiques : croissance et effondrement, retards et oscillations
- Éléments de la théorie des systèmes, des systèmes linéaires et réguliers aux systèmes non linéaires : analyse de l'équilibre et de la stabilité
- Optimisation et contrôle des systèmes d'état et de temps continus : concept de contrôle par feedback, estimation de l'état avec le filtre de Kalman et contrôle optimal
- Modélisation avec des systèmes à événements discrets : éléments des systèmes de mise en file d'attente.
- Construction de systèmes à événements discrets : modélisation des données d'entrée et analyse des résultats des simulations
- La simulation comme outil de conception d'optimisation : plan d'expériences, métamodélisation et méthodologie de la surface de réponse

Méthodes d'enseignement et d'apprentissage

Cours magistrales (3h/semaine) au cours desquelles les étudiants effectuent également des exercices pratiques avec des outils de modélisation et de simulation afin d'acquérir les principales applications de la théorie présentée.

Bibliographie

Business Dynamics - Systems Thinking and Modeling for a Complex World, John D Sterman, McGraw-Hill, 2000. ISBN: 007238915X Introduction to Dynamic Systems, David G. Luenberger, John Wiley & Sons, 1979. ISBN: 0471025941 Introduction to Discrete Event Systems - 2nd Edition. C.G. Cassandras and S. Lafortune.Springer 2008. ISBN 978-0-387-33332-8Simulation Modeling and Analysis 3rd Edition, Averill M Law and W David Kelton, McGraw-Hill, 2000. ISBN 0-07-116537-1 *Simio and Simulation - Modeling, Analysis and Applications*, W.David Kelton, Jeffrey S. Smith, David T. Sturrock, Alexander Verbraeck. McGraw-Hill. 2010. ISBN 0-07-340888-3 Simulation with ARENA - 4th Edition, W. David Kelton and Randall P. Sadowski and David T. Sturrock, McGraw-Hill International Edition 2007. ISBN 0-07-110685-5

Evaluation

Évaluation supplémentaire pendant le semestre

Le module ne comprend pas d'évaluation supplémentaire pendant le semestre

Principe pour les examens

En règle générale, tous les examens réguliers de fin de module se déroulent sous forme écrite. Concernant les examens de répétition, leur format (écrit ou oral) sera communiqué par l'enseignant-e en même temps que le calendrier des examens.

Examen de fin de module régulier et examen écrit de répétition

Type de l'examen

Examen écrit

Durée de l'examen

120 minutes

Aides autorisées

Les aides suivantes sont autorisées:

Aides électroniques autorisées

Les ordinateurs portables et les tablettes sont autorisés pour accéder à la documentation du cours, mais ne peuvent pas être utilisés pour communiquer avec d'autres étudiants ou avec le monde extérieur.

Autres aides autorisées

L'examen est un examen "à livre ouvert". Les étudiants peuvent accéder à tout le matériel présenté pendant les cours.

Exception : En cas d'examen électronique sur Moodle, des modifications des aides autorisées peuvent survenir. Dans ce cas, les aides autorisées seront annoncées par les enseignant-e-s avant l'examen.

Cas spécial: examen de répétition oral

Type de l'examen

Examen oral

Durée de l'examen

30 minutes

Aides autorisées

Sans aides

Module Description, available in: EN

Multi-Agent Systems

General Information

Number of ECTS Credits

3

Module code

FTP_MultiASys

Valid for academic year

2026-27

Last modification

2024-10-15

Coordinator of the module

Loris Cannelli (SUPSI, loris.cannelli@supsi.ch)

Explanations regarding the language definitions for each location:

- Instruction is given in the language specified for each location and module execution.
- Documentation is available in the language(s) listed for each location and module execution. If the documentation is in multiple languages, the percentage distributed is indicated (100% = all documentation provided).
- The examination, including both questions and answers, is provided entirely (100%) in the language(s) specified for each location and module execution. The exams are on-site.

	Lausanne			Lugano	Zurich		
Instruction				**X** E 100%			
Documentation				**X** E 100%			
Examination				**X** E 100%			

Module Category

FTP Fundamental theoretical principles

Profile Recommendations

This module is recommended for the following profiles:

	Lugano
Profile	BE, CS, DS, ME, MA

Lessons

2 lecture periods and 1 tutorial period per week

Entry level competences

Prerequisites, previous knowledge

Basic knowledge of probability, algebra, calculus and differential equations. Basics of procedural programming and ability to implement small programs in an arbitrary language, e.g. Python, Matlab, R, Java, C#, C++, C, etc.

Brief course description of module objectives and content

Natural, social, and engineered complex systems can be modelled as being composed of agents interacting with one another and their environment. This course introduces students to the theory, tools and techniques for understanding and solving problems related to such systems.

The course is composed of two parts. In the first one, both cooperative and selfish agents and interactions between them will be discussed. The methodological support will be provided by game theory.

In the second part, the focus will be on the study and analysis of models of systems in the aim of understanding the conditions under which certain properties can emerge and agent might learn certain strategies or behaviours by interacting with the environment and themselves.

Throughout the course, several application areas such as cooperation and competition, social influence and reinforcement learning will be discussed.

Aims, content, methods

Learning objectives and competencies to be acquired

A successful participant of this course is able to

- understand the rationale of multi-agent systems and their modelling.
- model scenarios with multiple interacting agents in the language of game theory
- evaluate the feasibility of achieving goals with agents using game theory
- understand the basic approaches to multi-agent learning, their peculiarities and their differences
- learn to choose the appropriate class of models with agents to characterise different complex systems
- implement in an efficient way a model of a system, then understand and analyse the corresponding outputs

Module content with weighting of different components

- Review of single-agent decision making and learning
- Multi-agent interaction:
    - games in normal form, dominant strategies,
    - Nash equilibria, Pareto optimality,
    - partial observability,
    - cooperative and coalition games, Shapley value,
    - repeated games,
- Multi-agent learning:
    - model based approaches: fictitious and rational learning
    - model-free approaches: no regret and reinforcement learning

Teaching and learning methods

- Lectures

- Exercises and homework

- Practical work with appropriate tools

- Literature studies

Literature

- *A Concise Introduction to Multi-Agent Systems and Distributed Artificial Intelligence*. Nikos Vlassis. Morgan & Claypool Publishers, 2007.

- *Introduction to Multi-Agent Systems* - 2nd Edition. Michael Wooldridge. John Wiley & Sons, 2009.

- *Multi-Agent Systems*. Yoav Shoham and Kevin Leyton-Brown. Cambridge University Press, 2009.

- *Artificial Intelligence, A Modern Approach* (4th Edition). Stuart Russell and Peter Norvig. Pearson. 2021

Assessment

Additional performance assessment during the semester

The module does not contain an additional performance assessment during the semester

Basic principle for exams

As a rule, all standard final exams are conducted in written form. For resit exams, lecturers will communicate the exam format (written/oral)

together with the exam schedule.

Standard final exam for a module and written resit exam

Kind of exam

Written exam

Duration of exam

120 minutes

Permissible aids

Aids permitted as specified below:

Permissible electronic aids

Calculator.

Other permissible aids

3 handwritten A4 sheets (both sides). The use of a paper-based dictionary is permitted.

Exception: In case of an electronic Moodle exam, adjustments to the permissible aids may occur. Lecturers will announce the final permissible aids prior to the exam session.

Special case: Resit exam as oral exam

Kind of exam

Oral exam

Duration of exam

30 minutes

Permissible aids

Aids permitted as specified below:

Permissible electronic aids

No electronic aids permitted

Other permissible aids

The use of a paper-based dictionary is permitted.

Module Description, available in: EN, FR

Multiphysics

General Information

Number of ECTS Credits

3

Module code

FTP_Multiphy

Valid for academic year

2026-27

Last modification

2024-10-17

Coordinator of the module

Jürgen Schumacher (ZHAW, juergen.schumacher@zhaw.ch)

Explanations regarding the language definitions for each location:

- Instruction is given in the language specified for each location and module execution.
- Documentation is available in the language(s) listed for each location and module execution. If the documentation is in multiple languages, the percentage distributed is indicated (100% = all documentation provided).
- The examination, including both questions and answers, is provided entirely (100%) in the language(s) specified for each location and module execution. The exams are on-site.

	Lausanne			Lugano	Zurich		
Instruction		**X** F 100%			**X** E 100%		
Documentation		**X** F 100%			**X** E 100%		
Examination		**X** F 100%			**X** E 100%		

Module Category

FTP Fundamental theoretical principles

Profile Recommendations

This module is recommended for the following profiles:

	Lausanne	Zurich
Profile	EIE, Mic	EnEn, MA

Lessons

2 lecture periods and 1 tutorial period per week

Entry level competences

Prerequisites, previous knowledge

- Bachelor level in physics and mathematics (Newtonian mechanics, ordinary differential equations, elementary knowledge in vector and matrix calculation).
- Elementary knowledge of MatLab or similar software packages

Brief course description of module objectives and content

The module gives students insight into the modeling and simulation of coupled effects (multiphysics). The module provides an overview on the different application fields of multiphysics modeling and simulation in industry. Students learn the methodical procedures that are necessary for successfully solving modeling and simulation problems in the different areas of engineering and physics. The consolidation and deepening of the theoretical knowledge is achieved on the basis of specific problems that are solved with the appropriate methods and programs (MATLAB, Comsol Multiphysics).

Aims, content, methods

Learning objectives and competencies to be acquired

Students are in a position to model and simulate local and spatially distributed systems of the type that are encountered in the engineering sciences.

Students are in a position to describe a real problem in physical and mathematical terms. They are able to recognize symmetries and to benefit from them. They are aware of which simplifications can be made and what influence they have on the results. The students know different numerical solution methods and the available equation solvers and finite element packages for solving coupled partial differential equations.

Students learn how to develop reliable models, to validate these and to designate their validity limits.

Students are in a position to critically interpret simulation results.

Module content with weighting of different components

- Modeling uncoupled physical phenomena through the application of conservation equations and material laws: transport of mass, energy, charge, momentum. Structural mechanics and flow mechanics are similarly covered in the course.
- Introduction to electromagnetic field modelling (Maxwell’s equations).
- Numerical discretization methods for solving partial differential equations: finite differences, finite elements, finite volumes and time discretization.
- Analysis of a multiphysics problem which is formulated analytically and can be solved with paper and pencil, e.g. coupling charge and energy transport in a single dimension.
- Introduction to the modeling of multiphysics problems that are solved with the finite element method. Exercises on the computer: input of the model geometry, generating a discretization grid, specification of physical material properties in the model.
- Case studies and exercises on the modeling of coupled problems: thermoelectric transport, coupled nonlinear PDE problems, structural mechanics, coupling an incompressible flow with energy transport, industrial application examples on electromagnetics, modeling of a fuel cell to convert chemical energy (hydrogen) into electrical energy.
- Advanced multiphysics modeling: "coefficient form" of a scalar conservation equation, conversion of a partial differential equation into the weak form. The weak form constitutes the basis for the finite element method.
- Model validation and recognition of the validity limits of a model.

Teaching and learning methods

- Frontal teaching
- Practical work with suitable software packages
- Exercises
- Private study and literature study
- Individual and group assignments

Literature

Jose Alberty, Josef Bürgler, Sven Friedel, Paul Ledger, Jürgen Schumacher, "Multiphysics Modeling and Simulation", course handout, Master of Science in Engineering (MSE).

Assessment

Additional performance assessment during the semester

The module does not contain an additional performance assessment during the semester

Basic principle for exams

As a rule, all standard final exams are conducted in written form. For resit exams, lecturers will communicate the exam format (written/oral) together with the exam schedule.

Standard final exam for a module and written resit exam

Kind of exam

Written exam

Duration of exam

120 minutes

Permissible aids

No aids permitted

Exception: In case of an electronic Moodle exam, adjustments to the permissible aids may occur. Lecturers will announce the final permissible aids prior to the exam session.

Special case: Resit exam as oral exam

Kind of exam

Oral exam

Duration of exam

30 minutes

Permissible aids

No aids permitted

Description du module, disponible en: EN, FR

Modélisation et Simulation Multiphysiques

Informations générales

Nombre de crédits ECTS

3

Code du module

FTP_Multiphy

Valable pour l'année académique

2026-27

Dernière modification

2024-10-17

Coordinateur/coordinatrice du module

Jürgen Schumacher (ZHAW, juergen.schumacher@zhaw.ch)

Explications concernant les langues d'enseignement par site :

- L'enseignement est dispensé dans la langue indiquée ci-dessous pour chaque site et chaque exécution du module.
- Les supports de cours sont disponibles dans les langues indiquées ci-dessous pour chaque site et chaque exécution du module. Lorsque plusieurs langues sont utilisées, la proportion de contenu disponible dans chaque langue est précisée (100 % = ensemble des supports de cours).
- Les examens (questions et réponses) sont entièrement rédigés dans la langue indiquée ci-dessous pour le site et l'exécution du module concernés. Ils se déroulent en présentiel.

	Lausanne			Lugano	Zurich		
Leçons		**X** F 100%			**X** E 100%		
Documentation		**X** F 100%			**X** E 100%		
Examen		**X** F 100%			**X** E 100%		

Catégorie de module

FTP bases théoriques élargies

Recommandations de profil

Ce module est recommandé pour les profils suivants :

	Lausanne	Zurich
Profil	EIE, Mic	EnEn, MA

Leçons

2 leçons et 1 leçon de pratique par semaine

Compétences préalables

Connaissances préalables, compétences initiales

- Niveau Bachelor en physique et mathématiques (mécanique newtonienne, équations différentielles ordinaires, connaissances élémentaires en calcul vectoriel et à l'aide de matrices)
- Connaissances élémentaires de MatLab ou de logiciels semblables.

Brève description du contenu et des objectifs

Le module donne un aperçu de la modélisation et de la simulation d'effets couplés (multiphysique). Ce module donne un apercu des différents domaines d'application de la modölisation et de la simulation multiphysique dans l'industrie. Les étudiants apprennent les procédures méthodiques nécessaires à la résolution de problèmes liés à la modélisation et à la simulation dans les divers domaines de la technique et de la physique. La consolidation et l'approfondissement du savoir théorique se fait au moyen de quatre problèmes concrets qui seront résolus avec les méthodes et les programmes adéquats (MATLAB, Comsol Multiphysics).

Objectifs, contenus, méthodes

Objectifs d'apprentissage, compétences à acquérir

Les étudiant-e-s savent modéliser et simuler des systèmes locaux et des systèmes spatialement étendus tels qu'ils apparaissent dans les sciences de l'ingénierie. Ils savent en outre décrire un problème réel de manière physique et mathématique. Ils reconnaissent les symétries et sont en mesure de les mettre à profit. Ils sont conscients des simplifications possibles et de leur influence sur les résultats.

Les étudiant-e-s savent utiliser les différentes méthodes, les algorithmes et les progiciels d'éléments finis disponibles pour résoudre les équations différentielles, couplées et aux dérivées partielles. Ils apprennent à développer des modèles fiables, à les valider et à en déterminer les limites.Ils sont également en mesure de critiquer les résultats de simulation et d'en définir le domaine de validité.

Contenu des modules avec pondération du contenu des cours

- Modélisation de phénomènes physiques non reliés par application des principes de conservation et lois des matériaux: transport de masse, d'énergie, de charge et d'impulsion. La mécanique des structures et la mécanique des fluides sont également traitées durant le cours.
- Introduction à la modélisation des champs électromagnétiques (équations de Maxwell).
- Méthodes de discrétisation numériques pour résoudre les équations différentielles: méthode de la différence finie, méthode des éléments finis, méthode du volume fini et discrétisation de temps.
- Analyse d'un problème multiphysique qui peut être formulé et résolu analytiquement par des calculs manuels, par exemple transfert de charge et transport d'énergie dans une seule dimension).
- Introduction à la modélisation des problèmes multiphysiques à l'aide de l'approche FEM. Exercices pratiques sur ordinateur: description géométrique, maillage pour éléments finis, spécification des propriétés matérielles physiques.
- Etudes de cas et exercices de modélisation de problèmes reliés: conducteur thermoélectrique, mécanique structurelle, problèmes non linéaires couplés d'EDP, relier un flux incompressible au transport d'énergie, exemples d'applications industrielles dans le domaine de l'électromagnétisme, modélisation d'une pile à combustible pour convertir l'énergie chimique (hydrogène) en énergie électrique.
- Modélisation multiphysique avancée: "formule du coefficient générique" d'une loi de conservation scalaire, transformation faible d'une équation aux dérivées partielles. La formulation faible est un des fondements de la méthode des éléments finis.
- Modèle de validation et reconnaissance des limites.

Méthodes d'enseignement et d'apprentissage

- Cours magistral
- Travail pratique avec des progiciels appropriés
- Exercices
- Etude autonome et bibliographie
- Travaux individuels et en groupe

Bibliographie

Jose Alberty, Josef Bürgler, Sven Friedel, Paul Ledger, Jürgen Schumacher, "Multiphysics Modeling and Simulation", document de cours, Master of Science in Engineering (MSE).

Evaluation

Évaluation supplémentaire pendant le semestre

Le module ne comprend pas d'évaluation supplémentaire pendant le semestre

Principe pour les examens

En règle générale, tous les examens réguliers de fin de module se déroulent sous forme écrite. Concernant les examens de répétition, leur format (écrit ou oral) sera communiqué par l'enseignant-e en même temps que le calendrier des examens.

Examen de fin de module régulier et examen écrit de répétition

Type de l'examen

Examen écrit

Durée de l'examen

120 minutes

Aides autorisées

Sans aides

Exception : En cas d'examen électronique sur Moodle, des modifications des aides autorisées peuvent survenir. Dans ce cas, les aides autorisées seront annoncées par les enseignant-e-s avant l'examen.

Cas spécial: examen de répétition oral

Type de l'examen

Examen oral

Durée de l'examen

30 minutes

Aides autorisées

Sans aides

Module Description, available in: EN, FR

Optimization

General Information

Number of ECTS Credits

3

Module code

FTP_Optimiz

Valid for academic year

2026-27

Last modification

2021-02-05

Coordinator of the module

Peter Fusek (ZHAW, fuse@zhaw.ch)

Explanations regarding the language definitions for each location:

- Instruction is given in the language specified for each location and module execution.
- Documentation is available in the language(s) listed for each location and module execution. If the documentation is in multiple languages, the percentage distributed is indicated (100% = all documentation provided).
- The examination, including both questions and answers, is provided entirely (100%) in the language(s) specified for each location and module execution. The exams are on-site.

	Lausanne			Lugano	Zurich		
Instruction		**X** F 100%			**X** E 100%		
Documentation		**X** F 70%	**X** E 30%		**X** E 100%		
Examination		**X** F 100%			**X** E 100%		

Module Category

FTP Fundamental theoretical principles

Profile Recommendations

This module is recommended for the following profiles:

	Lausanne	Zurich
Profile	DS, ICS, ME	BE, DS, EnEn, ME, MA, Avi, Pho

Lessons

2 lecture periods and 1 tutorial period per week

Entry level competences

Prerequisites, previous knowledge

Linear algebra:

- Systems of linear equations, Gauss algorithm
- Basics of vector and matrix algebra, linear spaces

Analysis:

- Calculus with functions of one variable

- Zeros of functions (Newton algorithm)

Programming:

- Basics of procedural programming and ability to implement small programs in an arbitrary language, e.g. Python, Matlab, R, Java, C#, C++, C, etc.

Brief course description of module objectives and content

This course offers an introduction to optimization, emphasizing basic methodologies and underlying mathematical structures. Optimization refers to the application of mathematical models and algorithms to decision making. A large number of quantitative real-world problems can be formulated and solved in this general framework. Applications of optimization comprise, for instance, decision problems in production planning, supply chain management, transportation networks, machine and workforce scheduling, blending of components, telecommunication network design, airline fleet assignment, and revenue management.

Aims, content, methods

Learning objectives and competencies to be acquired

- The student has an overview of the various fields and approaches to optimization.
- The student has a basic mathematical and algorithmic understanding of the major optimization methods used in practice (Linear Programming (LP), Integer Programming (ILP), Nonlinear Programming, Optimization in Graphs, Metaheuristics).
- The student is able to analyze basic real-world decision problems and formulate appropriate optimization models.
- The student is able to implement and solve basic LP/ILP models in a spreadsheet.
- The student has developed a certain intuition on how to approach and analyze real-world optimization problems, to correctly estimate their complexity, and to choose appropriate modeling approaches and implementation tools.

Module content with weighting of different components

Week	Topics
1	**PART 1:**
2	**Introduction to Optimization** • Basic concepts: models, variables, parameters, constraints, objective, optima • Examples of problems and models of different types: linear/nonlinear, discrete/continuous, deterministic/stochastic, constrained/unconstrained • Solution methods: exact algorithms, constructive heuristics, improvement heuristics • Global vs. local optima, basic ideas of convex optimization
3	**Linear Programming** • Mathematical formulation and terminology, canonical and standard form, transformations • Geometry: linear inequalities, polyhedra, graphical representation, examples • Simplex algorithm
4	
5	
6	**Integer Programming** • Basic concepts • Branch-and-Bound method • Cutting Planes method • Various applications and modeling techniques
7	
8	**PART 2:** **Nonlinear Optimization** • Unconstrained multidimensional optimization: optimality conditions, Gradient- and Newton-methods
9	**Graphs and Networks** • Optimization in graphs • Paths and cycles • Network flows

10	• Selected combinatorial optimization problems
11	
12	**Heuristics and Metaheuristics** • Trajectory-based methods: hill climbing, tabu search, simulated annealing, ... • Population-based methods: evolutionary algorithms, ant colony optimization, ...
13	
14	

Teaching and learning methods

Lectures and exercises

Literature

Assessment

Additional performance assessment during the semester

The module does not contain an additional performance assessment during the semester

Basic principle for exams

As a rule, all standard final exams are conducted in written form. For resit exams, lecturers will communicate the exam format (written/oral) together with the exam schedule.

Standard final exam for a module and written resit exam

Kind of exam

Written exam

Duration of exam

120 minutes

Permissible aids

Aids permitted as specified below:

Permissible electronic aids

None.
In particular: Pocket calculators are not allowed.

Other permissible aids

Exam "open book": Any written documents are allowed.
Exception: In case of an electronic Moodle exam, adjustments to the permissible aids may occur. Lecturers will announce the final permissible aids prior to the exam session.

Special case: Resit exam as oral exam

Kind of exam

Oral exam

Duration of exam

30 minutes

Permissible aids

No aids permitted

Description du module, disponible en: EN, FR

Optimisation

Informations générales

Nombre de crédits ECTS

3

Code du module

FTP_Optimiz

Valable pour l'année académique

2026-27

Dernière modification

2021-02-05

Coordinateur/coordinatrice du module

Peter Fusek (ZHAW, fuse@zhaw.ch)

Explications concernant les langues d'enseignement par site :

- L'enseignement est dispensé dans la langue indiquée ci-dessous pour chaque site et chaque exécution du module.
- Les supports de cours sont disponibles dans les langues indiquées ci-dessous pour chaque site et chaque exécution du module. Lorsque plusieurs langues sont utilisées, la proportion de contenu disponible dans chaque langue est précisée (100 % = ensemble des supports de cours).
- Les examens (questions et réponses) sont entièrement rédigés dans la langue indiquée ci-dessous pour le site et l'exécution du module concernés. Ils se déroulent en présentiel.

	Lausanne			Lugano	Zurich		
Leçons		**X** F 100%			**X** E 100%		
Documentation		**X** F 70%	**X** E 30%		**X** E 100%		
Examen		**X** F 100%			**X** E 100%		

Catégorie de module

FTP bases théoriques élargies

Recommandations de profil

Ce module est recommandé pour les profils suivants :

	Lausanne	Zurich
Profil	DS, ICS, ME	BE, DS, EnEn, ME, MA, Avi, Pho

Leçons

2 leçons et 1 leçon de pratique par semaine

Compétences préalables

Connaissances préalables, compétences initiales

Algèbre linéaire:

- Systèmes d'équations linéaires, algorithme de Gauss
- Calcul vectoriel et matriciel de base, espaces linéaires

Analyse:

- Calcul différentiel avec des fonctions à une variable
- Recherches de zéros (algorithme de Newton)

Programmation:
- Concepts de bases de la programmation procédurale et la capacité de formuler des petits programmes dans un langage quelconque, par exemple Python, Matlab, R, Java, C#, C++, C, etc.

Brève description du contenu et des objectifs

Ce cours offre une introduction à l'optimisation, en mettant l'accent sur les méthodologies de base et les structures mathématiques sous-jacentes. L'optimisation fait référence à l'application de techniques et de méthodes mathématiques aux problèmes de prise de décision. Un grand nombre de problèmes quantitatifs réels peuvent être modélisés et résolus dans cette structure générale. Planification de production, supply chain management, réseaux de transport, ordonnancement de machines et de personnel, design de réseaux de télécommunication, airline fleet assignment, et revenue management sont des exemples d'applications parmi d'autres.

Objectifs, contenus, méthodes

Objectifs d'apprentissage, compétences à acquérir

- L'étudiant a une vue d'ensemble des différents domaines et des différentes approches d'optimisation.
- L'étudiant comprend les bases mathématiques et algorithmiques des principales méthodes d'optimisation utilisées dans la pratique (Linear Programming (LP), Integer Programming (ILP), Nonlinear Programming, optimisation dans les graphes, métaheuristiques).
- L'étudiant est capable d'analyser des problèmes simples de prise de décision réels et de formuler des modèles d'optimisation appropriés.
- L'étudiant et capable de mettre en place et de résoudre des modèles LP/ILP de base à l'aide d'un tableur.
- L'étudiant a développé une certaine intuition lui permettant d'aborder et d'analyser des problèmes réels, d'estimer leur complexité et de choisir une approche de modélisation et les outils d'implémentation appropriés.

Contenu des modules avec pondération du contenu des cours

Semaine	Sujets
1	**PARTIE 1:** **Introduction à l'optimisation** • Idées de base: modèles, variables, paramètres, contraintes, objectifs, optima • Exemples de problèmes et de modèles de différents types: linéaires/non linéaires, discrets/continus, déterministes/stochastiques, avec contraintes/sans contraintes • Méthodes de résolution: algorithmes exactes, heuristiques constructives, heuristiques d'amélioration • Optima globals vs. locals, concepts de base de l'optimisation convexe
2	
3	**Programmation linéaire** • Formulation mathématique et terminologie, forme canonique et standard, transformations • Géométrie: inéquation linéaires, polyèdres, représentation graphique, exemples • Algorithme du simplexe
4	
5	
6	**Programmation linéaire entière** • Concepts de base • Méthode Branch-and-Bound • Méthode Cutting Planes • Applications et techniques de modélisation diverses
7	
8	**PARTIE 2:** **Optimisation non linéaire** • Optimisation multidimensionnelle sans contraintes: conditions d'optimalité, algorithme de gradient et algorithme de Newton

9	**Graphes et réseaux** • Optimization dans les graphes • Cycles et chemins • Flots de réseau • Problèmes sélectionnés d'optimisation combinatoire
10	
11	
12	**Heuristiques et métaheuristiques** • Méthodes de trajectoire: grimpeur, recherche tabou, recuit simulé, ... • Méthodes basées sur une population: algorithmes évolutionnistes, colonies de fourmis, ...
13	
14	

Méthodes d'enseignement et d'apprentissage

Cours magistral et travaux dirigés

Bibliographie

Evaluation

Évaluation supplémentaire pendant le semestre

Le module ne comprend pas d'évaluation supplémentaire pendant le semestre

Principe pour les examens

En règle générale, tous les examens réguliers de fin de module se déroulent sous forme écrite. Concernant les examens de répétition, leur format (écrit ou oral) sera communiqué par l'enseignant-e en même temps que le calendrier des examens.

Examen de fin de module régulier et examen écrit de répétition

Type de l'examen

Examen écrit

Durée de l'examen

120 minutes

Aides autorisées

Les aides suivantes sont autorisées:

Aides électroniques autorisées

Aucun.
Notamment: Les calculatrices ne sont pas autorisées.

Autres aides autorisées

Examen "à livre ouvert" ("open book"): Tous les moyens écrits sont autorisés.

Exception : En cas d'examen électronique sur Moodle, des modifications des aides autorisées peuvent survenir. Dans ce cas, les aides autorisées seront annoncées par les enseignant-e-s avant l'examen.

Cas spécial: examen de répétition oral

Type de l'examen

Examen oral

Durée de l'examen

30 minutes

Aides autorisées

Sans aides

Module Description, available in: EN, FR

Ordinary Differential Equations and Dynamical Systems

General Information

Number of ECTS Credits

3

Module code

FTP_OrdDiff

Valid for academic year

2026-27

Last modification

2018-11-06

Coordinator of the module

Olivier Mermoud (BFH, olivier.mermoud@bfh.ch)

Explanations regarding the language definitions for each location:

- Instruction is given in the language specified for each location and module execution.
- Documentation is available in the language(s) listed for each location and module execution. If the documentation is in multiple languages, the percentage distributed is indicated (100% = all documentation provided).
- The examination, including both questions and answers, is provided entirely (100%) in the language(s) specified for each location and module execution. The exams are on-site.

	Lausanne			Lugano	Zurich		
Instruction		**X** F 100%		**X** E 100%	**X** E 100%		
Documentation		**X** F 100%		**X** E 100%	**X** E 100%		
Examination		**X** F 100%		**X** E 100%	**X** E 100%		

Module Category

FTP Fundamental theoretical principles

Profile Recommendations

This module is recommended for the following profiles:

	Lausanne	Lugano	Zurich
Profile	CE, EIE, ME	BE, CE, ME, MA	CE, ME, MA, Avi

Lessons

2 lecture periods and 1 tutorial period per week

Entry level competences

Prerequisites, previous knowledge

Knowledge and abilities at the level of a completed Bachelor's degree in:

- Differential and integral calculus
- Ordinary differential equations
- Matrix calculus
- Complex numbers

Brief course description of module objectives and content

In this module, students learn which class of dynamical phenomena can be described with systems of ordinary differential equations. They learn to recognize the fundamental behavior patterns of these systems and also to develop simulation models for them.

Aims, content, methods

Learning objectives and competencies to be acquired

- Description of dynamical phenomena with differential equations
- Analysis of system behavior
- Knowledge of fundamental behavior patterns, understanding the connection with system structure
- Development and simulation of models for dynamical systems
- Knowledge of numerical methods for solving systems of differential equations

Module content with weighting of different components

- Topic 1: Modeling physical systems with differential equations, analysis of dynamical systems by way of example
- Topic 2: Analytical and numerical methods
- Topic 3: Systems of differential equations, state diagram, block diagrams
- Topic 4: Trajectories, equilibria, linear stability analysis, eigenmodes, the example of linear, time-invariant (LTI) systems
- Topic 5: Non-linear systems, bifurcation, chaos, discrete dynamical systems

Teaching and learning methods

Lecture units: lecture, working on and discussing short exercises
Tutorial units: working on and discussing set exercises
Private study: study of the literature, working on assignments and exercises

Literature

[1] Differential Equations, An Introduction to Modern Methods and Applications, J. R. Brannan and W. E. Boyce,John Wiley and Sons, 2015

[2] Nonlinear Dynamics and Chaos, S.H. Strogatz, Westview press, 2014

[3] Differential Equations, Dynamical Systems, and an Introduction to Chaos, M. W. Hirsch, S. Smale, R. L. Devaney. Academic Press, 2012

[4] Differential Equations, A Dynamical Systems Approach, J.H. Hubbard, B.H. West, Springer,1997

Assessment

Additional performance assessment during the semester

The module does not contain an additional performance assessment during the semester

Basic principle for exams

As a rule, all standard final exams are conducted in written form. For resit exams, lecturers will communicate the exam format (written/oral) together with the exam schedule.

Standard final exam for a module and written resit exam

Kind of exam

Written exam

Duration of exam

120 minutes

Permissible aids

Aids permitted as specified below:

Permissible electronic aids

a pocket calculator (with a CAS and graphics capability)

Other permissible aids

1 formula book
summary on 5 A4 sheets (= 10 A4 pages) compiled by the student

Exception: In case of an electronic Moodle exam, adjustments to the permissible aids may occur. Lecturers will announce the final permissible aids prior to the exam session.

Special case: Resit exam as oral exam

Kind of exam

Oral exam

Duration of exam

30 minutes

Permissible aids

No aids permitted

Description du module, disponible en: EN, FR

Equations différentielles ordinaires et systèmes dynamiques

Informations générales

Nombre de crédits ECTS

3

Code du module

FTP_OrdDiff

Valable pour l'année académique

2026-27

Dernière modification

2018-11-06

Coordinateur/coordinatrice du module

Olivier Mermoud (BFH, olivier.mermoud@bfh.ch)

Explications concernant les langues d'enseignement par site :

- L'enseignement est dispensé dans la langue indiquée ci-dessous pour chaque site et chaque exécution du module.
- Les supports de cours sont disponibles dans les langues indiquées ci-dessous pour chaque site et chaque exécution du module. Lorsque plusieurs langues sont utilisées, la proportion de contenu disponible dans chaque langue est précisée (100 % = ensemble des supports de cours).
- Les examens (questions et réponses) sont entièrement rédigés dans la langue indiquée ci-dessous pour le site et l'exécution du module concernés. Ils se déroulent en présentiel.

	Lausanne			Lugano	Zurich		
Leçons		**X** F 100%		**X** E 100%	**X** E 100%		
Documentation		**X** F 100%		**X** E 100%	**X** E 100%		
Examen		**X** F 100%		**X** E 100%	**X** E 100%		

Catégorie de module

FTP bases théoriques élargies

Recommandations de profil

Ce module est recommandé pour les profils suivants :

	Lausanne	Lugano	Zurich
Profil	CE, EIE, ME	BE, CE, ME, MA	CE, ME, MA, Avi

Leçons

2 leçons et 1 leçon de pratique par semaine

Compétences préalables

Connaissances préalables, compétences initiales

Connaissances et aptitudes de niveau Bachelor accomplies dans les domaines suivants:

- Calcul différentiel et intégral
- Equations différentielles ordinaires
- Calcul matriciel
- Nombres complexes

Brève description du contenu et des objectifs

Ce module présente aux étudiants les types de phénomènes dynamiques que les équations différentielles ordinaires (EDO) permettent de décrire. Les étudiants analysent les modèles de comportement élémentaires de ces systèmes pour lesquels ils développent des modèles de simulation.

Objectifs, contenus, méthodes

Objectifs d'apprentissage, compétences à acquérir

- Savoir décrire des phénomènes dynamiques à l'aide des EDO
- Savoir analyser le comportement des systèmes
- Connaître les modèles de comportement élémentaires et comprendre le rapport avec la structure du système
- Savoir développer et simuler des modèles de systèmes dynamiques
- Connaître les approches numériques de la résolution de systèmes d'EDO

Contenu des modules avec pondération du contenu des cours

- Thème 1: Modélisation de systèmes physiques à l'aide des EDO, exemple d'analyse de systèmes dynamiques
- Thème 2: Méthodes analytiques et numériques
- Thème 3: Systèmes d'EDO, diagrammes de phase, histogrammes
- Thème 4: Trajectoires, équilibres, analyse de stabilité linéaire, modes propres, exemple des systèmes linéaires invariants dans le temps
- Thème 5: Systèmes non linéaires, bifurcation, chaos, systèmes dynamiques discrets

Méthodes d'enseignement et d'apprentissage

Cours magistral: cours, résolution et discussion d'exercices courts
Séances d'exercices: résolutions et discussions d'exercices
Etude autonome: étude de la littérature, résolutions d'exercices

Bibliographie

[1] Differential Equations, An Introduction to Modern Methods and Applications, J. R. Brannan and W. E. Boyce, John Wiley and Sons, 2015

[2] Nonlinear Dynamics and Chaos, S.H. Strogatz, Westview press, 2014

[3] Differential Equations, Dynamical Systems, and an Introduction to Chaos, M. W. Hirsch, S. Smale, R. L. Devaney. Academic Press, 2012

[4] Differential Equations, A Dynamical Systems Approach, J.H. Hubbard, B.H. West, Springer,1997

Evaluation

Évaluation supplémentaire pendant le semestre

Le module ne comprend pas d'évaluation supplémentaire pendant le semestre

Principe pour les examens

En règle générale, tous les examens réguliers de fin de module se déroulent sous forme écrite. Concernant les examens de répétition, leur format (écrit ou oral) sera communiqué par l'enseignant-e en même temps que le calendrier des examens.

Examen de fin de module régulier et examen écrit de répétition

Type de l'examen

Examen écrit

Durée de l'examen

120 minutes

Aides autorisées

Les aides suivantes sont autorisées:

Aides électroniques autorisées

une calculatrice (graphique, dotée d'un système de calcul formel)

Autres aides autorisées

1 formulaire et tables
Résumé personnel de 5 feuilles A4 (=10 pages A4)

Exception : En cas d'examen électronique sur Moodle, des modifications des aides autorisées peuvent survenir. Dans ce cas, les aides autorisées seront annoncées par les enseignant-e-s avant l'examen.

Cas spécial: examen de répétition oral

Type de l'examen

Examen oral

Durée de l'examen

30 minutes

Aides autorisées

Sans aides

Module Description, available in: EN, FR

Partial differential equations in engineering applications

General Information

Number of ECTS Credits

3

Module code

FTP_PartDiff

Valid for academic year

2026-27

Last modification

2021-02-05

Coordinator of the module

Andreas Müller (OST, andreas.mueller@ost.ch)

Explanations regarding the language definitions for each location:

- Instruction is given in the language specified for each location and module execution.
- Documentation is available in the language(s) listed for each location and module execution. If the documentation is in multiple languages, the percentage distributed is indicated (100% = all documentation provided).
- The examination, including both questions and answers, is provided entirely (100%) in the language(s) specified for each location and module execution. The exams are on-site.

	Lausanne			Lugano	Zurich		
Instruction		**X** F 100%			**X** E 100%		
Documentation		**X** F 70%	**X** E 30%		**X** E 100%		
Examination		**X** F 100%			**X** E 100%		

Module Category

FTP Fundamental theoretical principles

Profile Recommendations

This module is recommended for the following profiles:

	Lausanne	Zurich
Profile	ElE, EnEn	CE, EnEn, Pho

Lessons

2 lecture periods and 1 tutorial period per week

Entry level competences

Prerequisites, previous knowledge

The course links topics well known from bachelor mathematics courses and extends them, in particular linear algebra, analysis and numerical mathematics. Expected competences: Linear algebra: systems of equations, matrices, numerical methods Analysis: partial derivatives, gradient, concept of ordinary differential equation, linear differential equations, separable differential equation, concept of fourier series.

Brief course description of module objectives and content

Foundations of the theory of partial differential equations relevant in engineering applications and their numerical solution.

Aims, content, methods

Learning objectives and competencies to be acquired

The student knows the basic geometric, analytic and numeric aspects of partial differential equations. He/she knows the basic methods to successfully solve partial differential equations analytically and numerically as well as a set of typical examples that allow to better understand the theoretical concepts.

Module content with weighting of different components

Part 1: General theory

Goals of part 1:

- understand how partial differential equations naturally appear in applications
- be able to solve selected examples using the separation method
- understand the kinds of boundary conditions necessary, Dirichlet and Neumann boundary conditions
- create a collection of examples to illustrate the basic theoretical principles

Lesson plan for part 1:

1. From ordinary to partial differential equations: three applied examples: wave equation, Laplace equation and heat equation. Goal: understand how partial differential equations naturally appear in applications
2. Quasilinear partial differential equations of first order, solutions using characteristics.
3. Solution of partial differential equations using separation of variables.
4. Solution of partial differential equations using the Laplace- or Fourier-transforms.
5. Elliptic partial differential equation with the Laplace equation as the prime example. Poisson formula, maximum principle, uniqueness of solutions.
6. Parabolic differential equations with the heat equation as prime example. Maximum principle and kernel function, Green's function.
7. Hyperbolic partial differential equations with the wave equation as prime example. d'Alembert solution and method of characteristics.

Part 2: Numerical methods for partial differential equations

1. Analysis of finite difference methods in the example of the two point boundary problem:
    - condition
    - stability

   Analysis of finite difference methods in the model problem transport equation.
   Goal: understand some central ideas and concepts of the analysis of numerical methods in general and finite difference methods in particular.
2. Finite volume methods for the Poisson-equation:
    - Example of a cell centered finite volume difference method
    - Example of a node centered finite volume element method

   Boundary elements for the Laplace equation.ıkes
   Goal: construct a collection of numerical methods that represent the broadness of possible approximation techniques.
3. Finite element method in the example of the stationary heat equation:
    - differential, variational and integral formulation
    - global and local ansatz functions
    - elements and element types
4. General perspective: weighted residues.
   Goal: concise introduction into the methodology of finite elements.
5. Problems of finite element methods in the example of the beam equation. Solution strategies and their numerical background:
    - p-strategies
    - h-strategies

   Example based introduction to adaptive step size control.
   Goal: show limitations of finite element methods
6. Finite elements in the example of the nonstationary heat equation:
    - semidiscrete schemata
    - completely discrete schemata
7. Eigenvalue determination using finite elements in the example of the beam oscillation equation.
   Goal: illustrate additional fields of application for finite elements.

This module does not intend to teach the use of any particular software product for the solution of partial differential equations. Instead it strives to teach the foundations for their successful use. The students should become capable to judge the potential and limitations of such a software system und the precision and reliability of the results that can be expected from such a system.

Teaching and learning methods

Literature

Assessment

Additional performance assessment during the semester

The module does not contain an additional performance assessment during the semester

Basic principle for exams

As a rule, all standard final exams are conducted in written form. For resit exams, lecturers will communicate the exam format (written/oral) together with the exam schedule.

Standard final exam for a module and written resit exam

Kind of exam

Written exam

Duration of exam

120 minutes

Permissible aids

Aids permitted as specified below:

Permissible electronic aids

Pocket calculator

Other permissible aids

Summary of 10 pages size A4 for each part of the course (total 20 pages).

Exception: In case of an electronic Moodle exam, adjustments to the permissible aids may occur. Lecturers will announce the final permissible aids prior to the exam session.

Special case: Resit exam as oral exam

Kind of exam

Oral exam

Duration of exam

30 minutes

Permissible aids

No aids permitted

Description du module, disponible en: EN, FR

Equations aux dérivées partielles dans l'ingénierie

Informations générales

Nombre de crédits ECTS

3

Code du module

FTP_PartDiff

Valable pour l'année académique

2026-27

Dernière modification

2021-02-05

Coordinateur/coordinatrice du module

Andreas Müller (OST, andreas.mueller@ost.ch)

Explications concernant les langues d'enseignement par site :

- L'enseignement est dispensé dans la langue indiquée ci-dessous pour chaque site et chaque exécution du module.
- Les supports de cours sont disponibles dans les langues indiquées ci-dessous pour chaque site et chaque exécution du module. Lorsque plusieurs langues sont utilisées, la proportion de contenu disponible dans chaque langue est précisée (100 % = ensemble des supports de cours).
- Les examens (questions et réponses) sont entièrement rédigés dans la langue indiquée ci-dessous pour le site et l'exécution du module concernés. Ils se déroulent en présentiel.

	Lausanne			Lugano	Zurich		
Leçons		**X** F 100%			**X** E 100%		
Documentation		**X** F 70%	**X** E 30%		**X** E 100%		
Examen		**X** F 100%			**X** E 100%		

Catégorie de module

FTP bases théoriques élargies

Recommandations de profil

Ce module est recommandé pour les profils suivants :

	Lausanne	Zurich
Profil	ElE, EnEn	CE, EnEn, Pho

Leçons

2 leçons et 1 leçon de pratique par semaine

Compétences préalables

Connaissances préalables, compétences initiales

Le cours permet de faire le lien avec les études de Bachelor et d'approfondir des théories mathématiques connues, et en particulier l'algèbre linéaire, l'analyse et la numérique. Des connaissances dans certains domaines constituent un prérequis et plus précisément :
Algèbre linéaire: systèmes d'équation, matrices, exercices numériques
Analyse: dérivées partielles, gradient, notion d'équations différentielles ordinaires, équations différentielles linéaires, équations différentielles à variables séparables, notion de la série de Fourier

Brève description du contenu et des objectifs

Principes de l'utilisation théorique et numérique d'équations aux dérivées partielles pertinentes pour l'ingénierie

Objectifs, contenus, méthodes

Objectifs d'apprentissage, compétences à acquérir

Les étudiants connaissent les aspects de base géométriques, analytiques et numériques des équations aux dérivées partielles et disposent d'un savoir élémentaire nécessaire pour assurer l'utilisation de celles-ci dans le domaine de l'ingénierie. Ils connaissent également une sélection d'exemples modèles facilitant l'approfondissement de la théorie.

Contenu des modules avec pondération du contenu des cours

Partie 1: Théorie des équations aux dérivées partielles

Objectifs de la 1ere partie:

- Comprendre comment les équations différentielles partielles apparaissent naturellement dans les applications
- Être capable de résoudre des exemples sélectionnés en utilisant la méthode de séparation
- comprendre les types de conditions aux limites nécessaires, les conditions aux limites de Dirichlet et Neumann
- créer une collection d'exemples pour illustrer les principes théoriques de base

Plan des lessons de la 1ere partie:

1. Des équations différentielles ordinaires aux dérivées partielles: trois exemples appliqués: équation d'onde, équation de Laplace et équation de chaleur. Objectif: comprendre comment les équations aux dérivées partielles apparaissent naturellement dans les applications
2. Equations aux dérivées partielles quasi-linéaires de premier ordre, solutions utilisant des caractéristiques.Résolution analytique par la méthode de séparation à l'aide d'exemples sélectionnés
3. Solution d'équations aux dérivées partielles en utilisant la séparation des variables.
4. Solutions avec les transformées de Laplace ou de Fourier
5. Equation elliptique à l'aide de l'équation de Laplace: formule de Poisson, principe du maximum et unicité de la solution
6. Equations paraboliques expliquées à l'aide de l'équation de la chaleur: principe du maximum, fonction fondamentale
7. Equations hyperboliques expliquées à l'aide de l'équation d'onde: solutions d'Alembert, méthode des caractéristiques

Partie 2: Calcul numérique des équations aux dérivées partielles

1. Analyse des méthodes des différences finies à l'aide d'un problème de conditions aux limites (deux paramètres)
    - Analyse de condition
    - Analyse de stabilité

   Analyse des méthodes des différences finies à l'aide du problème de l'équation de transport
   L'objectif consiste à expliciter certaines des idées et des notions centrales de l'approche numérique en général et des différences finies en particulier.
2. Méthode de volumes finis expliquée à l'aide de l'équation de Poisson:
    - exemple d'une approche volumes finis/différences finies par la méthode centrée aux cellules
    - exemple d'une approche aux volumes/éléments finis par la méthode centrée aux nœuds

   Méthode des éléments aux limites expliquée à l'aide de l'équation de Laplace
   L'objectif consiste à avoir une sélection de méthodes numériques permettant de saisir l'importance des approches approximatives.
3. Méthode des éléments finis expliquée à l'aide de l'équation de la chaleur stationnaire
    - formulations différentielles, variationnelles et intégrales
    - approches globales et locales
    - éléments et types d'éléments
4. Une vue d'ensemble: résidus pondérés.
   L'objectif consiste à présenter une introduction concise à la méthodologie des éléments finis.
5. Problématiques des méthodes des éléments finis expliquées à l'aide de l'équation des poutre:
   Quelques stratégies de résolution ainsi que leur arrière-plan numérique:
    - stratégies p
    - stratégies h

   Exemple d'introduction au contrôle des intervalles
   L'objectif consiste à illustrer les limites de la méthodologie des éléments finis.
6. Méthode des éléments finis expliquée à l'aide de l'équation de la chaleur instationnaire
    - schémas semi-discrets
    - schémas discrets
7. Détermination de la valeur propre par les éléments finis à l'aide de l'équation des poutres
   L'objectif consiste à présenter d'autres domaines d'application de la méthode des éléments finis.

L'objectif de ce module ne consiste pas à former l'étudiant à l'utilisation d'un quelconque logiciel de traitement des équations aux dérivées partielles. Il s'agit en revanche de lui transmettre les principes de base permettant une utilisation réussie de ces outils. Le but est donc de permettre aux étudiants de comprendre les différentes possibilités offertes par un tel logiciel et ses conséquences en termes de fiabilité et de précision des solutions obtenues.

Méthodes d'enseignement et d'apprentissage

Bibliographie

Evaluation

Évaluation supplémentaire pendant le semestre

Le module ne comprend pas d'évaluation supplémentaire pendant le semestre

Principe pour les examens

En règle générale, tous les examens réguliers de fin de module se déroulent sous forme écrite. Concernant les examens de répétition, leur format (écrit ou oral) sera communiqué par l'enseignant-e en même temps que le calendrier des examens.

Examen de fin de module régulier et examen écrit de répétition

Type de l'examen

Examen écrit

Durée de l'examen

120 minutes

Aides autorisées

Les aides suivantes sont autorisées:

Aides électroniques autorisées

Calculatrice

Autres aides autorisées

Résumé de 10 pages A4 pour chaque partie du cours (20 pages au total)

Exception : En cas d'examen électronique sur Moodle, des modifications des aides autorisées peuvent survenir. Dans ce cas, les aides autorisées seront annoncées par les enseignant-e-s avant l'examen.

Cas spécial: examen de répétition oral

Type de l'examen

Examen oral

Durée de l'examen

30 minutes

Aides autorisées

Sans aides

Module Description, available in: EN

Physics on micro and nano scale

General Information

Number of ECTS Credits

3

Module code

FTP_PhyMNS

Valid for academic year

2026-27

Last modification

2024-10-21

Coordinator of the module

Wolfgang Tress (ZHAW, trew@zhaw.ch)

Explanations regarding the language definitions for each location:

- Instruction is given in the language specified for each location and module execution.
- Documentation is available in the language(s) listed for each location and module execution. If the documentation is in multiple languages, the percentage distributed is indicated (100% = all documentation provided).
- The examination, including both questions and answers, is provided entirely (100%) in the language(s) specified for each location and module execution. The exams are on-site.

	Lausanne			Lugano	Zurich		
Instruction					**X** E 100%		
Documentation					**X** E 100%		
Examination					**X** E 100%		

Module Category

FTP Fundamental theoretical principles

Profile Recommendations

This module is recommended for the following profiles:

	Zurich
Profile	EIE, Med, Pho

Lessons

2 lecture periods and 1 tutorial period per week

Entry level competences

Prerequisites, previous knowledge

- Optics: Basics of wave optics;
- Physics: The students are able to solve simple differential equations, know linear algebra and can handle electromagnetic forces and fields.
- Mathematics: Basics for engineers (bachelor level)

Brief course description of module objectives and content

The module “Physics on micro and nano scale” focuses on physical effects and their applications in photonics, electrical engineering, medical engineering and mechanical engineering which become relevant, when technical systems get miniaturized. In the first step of miniaturization - from macro to micro – the principal physics remains unchanged, but the dominant physical effects change due to a changed surface to volume ratio. Surface related effects become dominant. With further miniaturization – from micro to nano - quantum phenomena become dominant and lead to completely new physical concepts. When the typical size of objects is between several nanometers and a few micrometres, we can observe a wealth of fascinating effects that today are the basis for applications from advanced sensing to medical applications, ultrasmall mechanical devices, nanophotonics etc.

A first topic of this module relates to surface effects. Microstructured surfaces and surface functionalization play an important role in mechanical systems in terms of nano-roughness and nanotribological properties. The functionalization can be designed to reduce e.g. wear, corrosion, ice-formation or bio-fouling, and finds application in biosensors. In nature, such microstructures lead e.g. to the Lotus effect or to different colour effects, and in medicine, micro and nanostructured surfaces help to significantly improve the acceptance of implants by the human organism.

A second topic deals with quantum effects that are related to spatial confinement in physical systems. The discretization of energy levels in atomic systems, for example, forms the basis for the understanding of light-matter interaction. Prohibited states in periodic solids lead to band gaps in semiconductors, which provide the basis for modern electronics. In a similar way, "forbidden" states can also be generated in dielectric periodic structures. The so called photonics band gaps enable completely new forms of light guidance in photonic crystals. Quantum dots and quantum wires are further quantum objects that play an important role in modern electronics.

Finally, advanced concepts such as quantum entanglement are touched upon, which is one of the key concepts for future quantum computing systems. Currently, such systems are being intensively explored as the most promising next generation of computers, data centers and telecommunication systems for artificial intelligence (AI) and multiple other applications.

Whereas the fundamentals are the focus of this course, the application of new material structures on the micro and nanoscale including 2-dimensional materials are covered as well, e.g. in organic light emitting diodes, ion-sensitive transistors, and nanophotonic systems exploiting plasmonic effects.

Aims, content, methods

Learning objectives and competencies to be acquired

After completion of this module the students will:

- know the fundamental aspects of quantum mechanics and understand the quantum nature of the nanoworld
- know the phenomena of nano-and microstructures influencing surface and material properties (e.g. structural colors, interferencial colors, tribo-mechanical and wetting behaviour)
- know the fundamental quantum mechanical concept of discretization and resulting consequences such as discrete energy states, electronic and photonic band gaps, quantum dots and quantum wires and their applications in modern photonics, electronics, and medicine
- know the basics of quantum entanglement and quantum computing
- know the interaction of light with dielectric, semiconductor and metallic nanoparticles (incl. plasmonics)

Module content with weighting of different components

- From macro to micro to nano: scaling of physical systems and the consequences (3 lessons)
- Nano- and microstructured surfaces: Surface Physics, Nucleation, Nano Tribology, Structural and interferencial colors, (6 lessons)
- Nanophotonics: Interaction of light with nanoparticles and nanostructures (dielectric, metallic, semiconductor) (3 lessons)
- Quantum mechanics and Quantum Nature of the Nanoworld: Particle-wave duality, Schrödinger equation, discrete energy levels, sizing effects (9 lessons)
- Quantum entanglement and quantum computing (3 lessons).
- Molecules, quantum dots and wires: OLEDs (organic light emitting diodes) and QLEDs for optoelectronics and ISFETs (ion-sensitive field-effect transistors) for biotechnology (6 lessons)
- Electronic and photonic bandgaps: Physical basics and applications (6 lessons)
- Photonic crystal and hollow core fibers (3 lessons)
- Origin of light and laser polarization (3 lessons)

Teaching and learning methods

Lectures and self-study

Practical exercises

Literature

Lecture notes, application oriented summary articles or slides with indication of sources for further reading will be distributed.

Introductory physics textbooks

Introduction to Nanoscience & Nanotechnology, Gabor L Hornyak et al. , CRC Press, 2009.

Nanophysik und Nanotechnologie, Edward Wolf, Wiley-VCH, 2014

Assessment

Additional performance assessment during the semester

The module does not contain an additional performance assessment during the semester

Basic principle for exams

As a rule, all standard final exams are conducted in written form. For resit exams, lecturers will communicate the exam format (written/oral) together with the exam schedule.

Standard final exam for a module and written resit exam

Kind of exam

Written exam

Duration of exam

120 minutes

Permissible aids

Aids permitted as specified below:

Permissible electronic aids

No electronic aids permitted

Other permissible aids

Personal formulary: four A4 pages (2 sheets doublesided or 4 sheets singlesided)

Exception: In case of an electronic Moodle exam, adjustments to the permissible aids may occur. Lecturers will announce the final permissible aids prior to the exam session.

Special case: Resit exam as oral exam

Kind of exam

Oral exam

Duration of exam

30 minutes

Permissible aids

Aids permitted as specified below:

Permissible electronic aids

No electronic aids permitted

Other permissible aids

Personal formulary: four A4 pages (2 sheets doublesided or 4 sheets singlesided)

Description du module, disponible en: FR

Physique des matériaux et des dispositifs électroniques

Informations générales

Nombre de crédits ECTS

3

Code du module

FTP_Physics

Valable pour l'année académique

2026-27

Dernière modification

2025-09-25

Coordinateur/coordinatrice du module

Stefan Hengsberger (HES-SO, stefan.hengsberger@hefr.ch)

Explications concernant les langues d'enseignement par site :

- L'enseignement est dispensé dans la langue indiquée ci-dessous pour chaque site et chaque exécution du module.
- Les supports de cours sont disponibles dans les langues indiquées ci-dessous pour chaque site et chaque exécution du module. Lorsque plusieurs langues sont utilisées, la proportion de contenu disponible dans chaque langue est précisée (100 % = ensemble des supports de cours).
- Les examens (questions et réponses) sont entièrement rédigés dans la langue indiquée ci-dessous pour le site et l'exécution du module concernés. Ils se déroulent en présentiel.

	Lausanne			Lugano	Zurich		
Leçons		**X** F 100%					
Documentation		**X** F 100%	**X** E 100%				
Examen		**X** F 100%					

Catégorie de module

FTP bases théoriques élargies

Recommandations de profil

Ce module est recommandé pour les profils suivants :

	Lausanne
Profil	Mic

Leçons

2 leçons et 1 leçon de pratique par semaine

Compétences préalables

Connaissances préalables, compétences initiales

Les étudiants-e-s connaissent les bases de la physique. Notamment les concepts comme l'énergie, la force, l'énergie thermique k_BT, la chaleur spécifique, les oscillations, la fréquence de résonance, les ondes, les vecteurs du champ électromagnétique: **E**, **D**, **B** and **H**, la capacité électrique C, la constante diélectrique eps_r , le model de Bohr des atomes ainsi que la notion des orbitales atomiques sont obligatoires. De plus, des simples équations différentielles et les nombres complexes, en particulier e^{-iwt} sont aussi nécessaires.

Brève description du contenu et des objectifs

Les étudiants-e-s comprennent et savent appliquer les principes de base des composants électroniques et des dispositifs techniques importants, en faisant appel aux propriétés des matériaux et en appliquant des concepts microscopiques. Ces concepts comprennent les électrons et les trous dans les solides, les bandes d'énergie des métaux et semi-conducteurs, le mécanisme de polarisation dans les matériaux piézoélectriques et diélectriques, les dipôles élémentaires dans la matière magnétique et l'accouplage des électrons dans les supraconducteurs (paires de Cooper). Ces concepts permettront de discuter des applications actuelles, notamment les thermocouples, les cellules solaires photovoltaïques, les diodes luminescentes (LED), les actuateurs piézo-électriques, les capteurs et les systèmes de stockage de données magnétiques. Le module permettra aux étudiant-e-s de comprendre des concepts modernes dans le domaine des technologies innovatrices et de les utiliser à l'avenir.

Objectifs, contenus, méthodes

Objectifs d'apprentissage, compétences à acquérir

Les étudiants-e-s

- connaissent les principes de base de la cristallographie, les réseaux de Bravais ainsi que les différents défaut au sein des cristaux.
- comprennent la conductivité thermique et électrique dans les solides sur la base de la description cinétique des particules
- connaissent les principes de base de la mécanique quantique et savent appliquer l'équation de Schrödinger
- savent mettre en relation la conductivité thermique et électrique par le biais des modèles microscopiques
- sont capables d'expliquer les principes des thermocouples, des diodes et des Lasers en utilisant les notions de bandes d'énergie, énergie de Fermi, potentiel de contact et l'émission stimulée.
- savent expliquer l'origine physique et la réalisation technique de la résolution nanométrique des microscopes à balayage de surface (microscope à force atomique et microscope à effet tunnel)
- connaissent la classification des matériaux magnétiques et des exemples de leurs applications techniques
- comprennent la différence entre l'effet Meissner d'un supraconducteur et le comportement de la matière parfaitement diamagnétique
- sont capables de résoudre des problèmes quantitatifs exemplaires en relation avec toute la matière du module

Contenu des modules avec pondération du contenu des cours

Sont étudiés des concepts élémentaires concernant les propriétés des matériaux, en mettant l'accent sur les applications.

Le module se divise en cinq parties avec une pondération équivalente:

1. Cristallographie et mécanique quantique
    - Principes de base de la cristallographie, réseaux de Bravais
    - Défauts dans les cristaux
    - Principes de base de la mécanique quantique, effet photoélectrique et Compton
    - Application de l'équation de Schrödinger
2. Concept de la conductivité thermique et électrique dans les solides
    - Fluctuation thermique, bruit et activation thermique (diagrammes d'Arrhenius)
    - Conductivité thermique (loi de Wiedemann-Franz)
    - Conductivité électrique (modèle de Drude, vitesse de dérive, temps de relaxation)
    - Dépendance de la température de la résistivité des métaux parfaits
3. Concept des bandes énergétiques dans les semi-conducteurs, métaux et isolants
    - Electrons et trous, masse effective de l'électron
    - Dopage: type n, type p
    - Ensembles de particules, statistique de Fermi-Dirac
    - Contacts: jonction idéale p-n (diode), contact entre métaux pures, thermocouples
    - Dispositifs techniques: cellule solaire photovoltaïque, diode luminescente (LED), laser semi-conducteur
4. Matériaux piézoélectriques et diélectriques
    - Mécanismes de polarisation
    - Piézoélectricité, actuateurs et capteurs, microscope à effet tunnel et microscope à force atomique (STM/AFM)
    - Constante diélectrique et sa dépendance de la fréquence
    - Indice de réfraction et dispersion
    - Absorption de lumière
5. Propriétés magnétiques et supraconductivité
    - Magnétisation et perméabilité magnétique
    - Classification des matériaux magnétiques: diamagnétiques, paramagnétiques, ferromagnétiques, antiferromagnétiques, ferrimagnétiques
    - Domaines magnétiques et stockage de données par voie magnétique
    - Supraconductivité: résistance zéro et densité de courant critique, applications des champs magnétiques importants
    - Mesure du champ magnétique: effet de Hall, quantification du flux magnétique et SQUID (Superconducting Quantum Interference Device)

Méthodes d'enseignement et d'apprentissage

Enseignement direct: présentation et discussion des concepts fondamentaux

Exercices: résolution quantitative de problèmes et analyse des concepts physiques des dispositifs d'application technologique

Etudes autonomes en utilisant un livre défini

Bibliographie

Principles of Electronic Materials and Devices, Safa O. Kasap, McGraw Hill

Evaluation

Évaluation supplémentaire pendant le semestre

Le module ne comprend pas d'évaluation supplémentaire pendant le semestre

Principe pour les examens

En règle générale, tous les examens réguliers de fin de module se déroulent sous forme écrite. Concernant les examens de répétition, leur format (écrit ou oral) sera communiqué par l'enseignant-e en même temps que le calendrier des examens.

Examen de fin de module régulier et examen écrit de répétition

Type de l'examen

Examen écrit

Durée de l'examen

120 minutes

Aides autorisées

Les aides suivantes sont autorisées:

Aides électroniques autorisées

Calculatrice et livre de référence (imprimée ou pdf)

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appareils de télécommunication

conditions particulières pour les examens online: pas de restriction

Autres aides autorisées

Calculatrice, papier, crayon et dictionnaire (en forme de livre).

conditions particulières pour les examens online: pas de restriction

Exception : En cas d'examen électronique sur Moodle, des modifications des aides autorisées peuvent survenir. Dans ce cas, les aides autorisées seront annoncées par les enseignant-e-s avant l'examen.

Cas spécial: examen de répétition oral

Type de l'examen

Examen oral

Durée de l'examen

30 minutes

Aides autorisées

Sans aides

Module Description, available in: EN

Predictive Modelling

General Information

Number of ECTS Credits

3

Module code

FTP_PredMod

Valid for academic year

2026-27

Last modification

2025-10-20

Coordinator of the module

Mirko Birbaumer (HSLU, mirko.birbaumer@hslu.ch)

Explanations regarding the language definitions for each location:

- Instruction is given in the language specified for each location and module execution.
- Documentation is available in the language(s) listed for each location and module execution. If the documentation is in multiple languages, the percentage distributed is indicated (100% = all documentation provided).
- The examination, including both questions and answers, is provided entirely (100%) in the language(s) specified for each location and module execution. The exams are on-site.

	Lausanne			Lugano	Zurich		
Instruction					**X** E 100%		
Documentation					**X** E 100%		
Examination					**X** E 100%		

Module Category

FTP Fundamental theoretical principles

Profile Recommendations

This module is recommended for the following profiles:

	Zurich
Profile	BE, DS, Geo

Lessons

2 lecture periods and 1 tutorial period per week

Entry level competences

Prerequisites, previous knowledge

Basic knowledge of statistics on the level of an introductory stochastics course. Linear algebra: matrix-vector calculations. Basic Calculus. Familiarity and experience with programming, in particular with scripting languages like Matlab, Python or R. We will provide the students with a self-test to assess their prior knowledge in statistics and scripting.

Brief course description of module objectives and content

This course will provide a self-study introductory review of the basic concepts of probability and statistics to understand probability distributions and to produce rigorous statistical analysis including estimation, hypothesis testing, and confidence intervals. Students will be introduced to the basic concepts of predictive modelling which by definition is the analysis of current and historical facts to make predictions about future events. Students will learn several techniques that account for many business and engineering applications of predictive modelling. These include regression techniques, and time series models. Applicability and limitations of these methods will be illustrated in the light of data sets and analyses using the statistical software R or Python.

Please note: An MSE cursus may not contain both similar statistics modules FTP_AppStat and FTP_PredMod. Students can only choose one of these modules.

Aims, content, methods

Learning objectives and competencies to be acquired

Students are able to analyze data by means of regression and time series analysis. They are familiar with important statistical forecasting methods and are able to calculate, evaluate and interpret predictions. They are able to choose an appropriate statistical method for a regression, or time series problem. They are able to evaluate and compare statistical models.

Module content with weighting of different components

Regression analysis: Simple linear regression with parameter estimation, graphical model validation, transformation of variables, confidence and prediction intervals for parameters. Multiple linear regression with parameter estimation, statistical tests and confidence intervals for parameters, variable selection, feature importance analysis, and regularization methods.

Time series analysis: STL decomposition; ARMA, seasonal and non-seasonal ARIMA, confidence and prediction bands, (partial) autocorrelation, model selection, model validation metrics, and applications across economics, finance, and engineering.

Optional advanced time series analysis topics: Spectral analysis, Bayesian structural time series, Kalman filtering, and anomaly detection.

Teaching and learning methods

Lecture and practical work on computer with the statistics software R or Python.

Literature

Lecture notes will be available in addition to recommended book chapters.

Assessment

Additional performance assessment during the semester

The module does not contain an additional performance assessment during the semester

Basic principle for exams

As a rule, all standard final exams are conducted in written form. For resit exams, lecturers will communicate the exam format (written/oral) together with the exam schedule.

Standard final exam for a module and written resit exam

Kind of exam

Written exam

Duration of exam

120 minutes

Permissible aids

Aids permitted as specified below:

Permissible electronic aids

Statistical software R or Python and calculator.

Other permissible aids

No other aids permitted

Exception: In case of an electronic Moodle exam, adjustments to the permissible aids may occur. Lecturers will announce the final permissible aids prior to the exam session.

Special case: Resit exam as oral exam

Kind of exam

Oral exam

Duration of exam

30 minutes

Permissible aids

No aids permitted

Description du module, disponible en: FR

Intelligent and Hyperconnected Machine

Informations générales

Nombre de crédits ECTS

3

Code du module

FTP_SmartMach

Valable pour l'année académique

2026-27

Dernière modification

2023-08-31

Coordinateur/coordinatrice du module

Stefano Carrino (HES-SO, stefano.carrino@hes-so.ch)

Explications concernant les langues d'enseignement par site :

- L'enseignement est dispensé dans la langue indiquée ci-dessous pour chaque site et chaque exécution du module.
- Les supports de cours sont disponibles dans les langues indiquées ci-dessous pour chaque site et chaque exécution du module. Lorsque plusieurs langues sont utilisées, la proportion de contenu disponible dans chaque langue est précisée (100 % = ensemble des supports de cours).
- Les examens (questions et réponses) sont entièrement rédigés dans la langue indiquée ci-dessous pour le site et l'exécution du module concernés. Ils se déroulent en présentiel.

	Lausanne			Lugano	Zurich		
Leçons		**X** F 100%					
Documentation		**X** F 100%					
Examen		**X** F 100%					

Catégorie de module

FTP bases théoriques élargies

Recommandations de profil

Ce module est recommandé pour les profils suivants :

	Lausanne
Profil	ME, Mic

Leçons

2 leçons et 1 leçon de pratique par semaine

Compétences préalables

Connaissances préalables, compétences initiales

- Concepts de bases sur les principes de mécanique
- Concepts de bases sur les technologies informatiques

Brève description du contenu et des objectifs

Les étudiants apprennent et expérimentent une approche avancée pour concevoir un système de monitoring de processus en temps réel et autonome (système cyber-physique).

Objectifs, contenus, méthodes

Objectifs d'apprentissage, compétences à acquérir

Les étudiants apprennent et expérimentent une approche avancée pour concevoir un s**ystème de surveillance de processus en temps réel autonome**.

Cela leur permet de vivre un projet de développement en intégrant directement une réflexion experte sur l'autonomie numérique attendue des mécanismes automatisés dans le monde de l'**Industrie 4.0**.

Ils seront également initiés aux rôles multidisciplinaires que l'ingénieur de demain devra assumer face aux **défis de la numérisation** et à l'avènement des machines intelligentes et autonomes.

Ce cours utilise comme fil conducteur l'**éco-démonstrateur Micro5**, développé dans le cadre des programmes thématiques de la HES-SO (2013-2016) et récemment équipé d'un système cognitif unique et très avancé.

Contenu des modules avec pondération du contenu des cours

Les objectifs d'apprentissage visent à permettre à l'étudiant de développer un sens critique et d'expérimenter les étapes et difficultés liées à la définition et au développement d'un système d'intelligence artificielle sur un outil de production.

Le cours est donc organisé en trois macro-sujets :

- 33% - Machine-Outil à Commande Numérique (MOCN)
- 33% - IoT & Data Acquisition
- 34% - Intelligence Artificielle

Les étapes suivantes seront abordées :

- Positionnement et rôle de l'ingénieur dans la numérisation des moyens de production.
- Définition d'un système mécatronique cognitif : de l'usinage au programme de contrôle.
- Définition des objectifs et des méthodes du système à développer sur la base d'un cas spécifique (par exemple, micro-fraiseuse, détection d'usure, etc.).
- Introduction des connaissances préalables dans le système cyber-physique.
- Développement d'un jumeau numérique.
- Définition des outils nécessaires pour automatiser une machine (capteurs, base de données, IA et rétroaction).
- Développement d'un système de production et de gestion cyber-physique (sélection de données, traitement des signaux, rétroaction, traitement en temps réel, stockage des données, SPC).
- Analyse et traitement des données.

Méthodes d'enseignement et d'apprentissage

Présentation par les professeurs des concepts et thèmes principaux, illustrés par des exemples concrets et appliqués.

Semaine après semaine, les étudiants concevront une machine intelligente simulée.

Organisés en équipes, les étudiants appliqueront les concepts et thèmes à des cas pratiques. Les scénarios d'application pourront varier entre une étude de cas et la réalisation d'un mini-projet en équipe.

Bibliographie

Evaluation

Évaluation supplémentaire pendant le semestre

Le module comprend une ou des évaluation(s) supplémentaire(s) pendant le semestre. La note obtenue pour la ou les évaluation(s) supplémentaire(s) est valable à la fois pour l'examen final et pour l'examen de répétition.

Description de l'évaluation supplémentaire pendant le semestre

Travaux pratiques (labos et mini-projet).

30% sur la note finale.

Principe pour les examens

En règle générale, tous les examens réguliers de fin de module se déroulent sous forme écrite. Concernant les examens de répétition, leur format (écrit ou oral) sera communiqué par l'enseignant-e en même temps que le calendrier des examens.

Examen de fin de module régulier et examen écrit de répétition

Type de l'examen

Examen écrit

Durée de l'examen

120 minutes

Aides autorisées

Les aides suivantes sont autorisées:

Aides électroniques autorisées

Aucune aide électronique autorisée

Autres aides autorisées

1 feuille A4 manuscrite à rendre

Exception : En cas d'examen électronique sur Moodle, des modifications des aides autorisées peuvent survenir. Dans ce cas, les aides autorisées seront annoncées par les enseignant-e-s avant l'examen.

Cas spécial: examen de répétition oral

Type de l'examen

Examen oral

Durée de l'examen

30 minutes

Aides autorisées

Sans aides

Modulbeschreibung, verfügbar in: DE

Planungsmethodik

Allgemeine Angaben

Anzahl ECTS-Credits

3

Modulkürzel

FTP_StatPlan

Gültig für akademisches Jahr

2026-27

Letzte Änderung

2020-12-11

Modul-Koordinator/in

Dirk Engelke (OST, dirk.engelke@ost.ch)

Erläuterungen zu den Sprachdefinitionen je Standort:

- Der Unterricht findet in der pro Standort und Durchführung definierten Sprache statt.
- Die Unterlagen sind in den pro Standort und Durchführung definierten Sprachen verfügbar. Bei Mehrsprachigkeit ist die prozentuale Verteilung angegeben (100% = komplette Unterlagen).
- Die Prüfungsfragen und -antworten sind in jeder pro Standort und Durchführung definierten Sprache. Die Prüfung wird vor Ort durchgeführt.

	Lausanne			Lugano	Zurich		
Unterricht						**X** D 100%	
Dokumentation						**X** D 100%	
Prüfung						**X** D 100%	

Modulkategorie

FTP Erweiterte theoretische Grundlagen

Profilempfehlungen

Dieses Modul wird für die folgenden Profile empfohlen:

	Zurich
Profil	Geo, ReLa

Lektionen

2 Lektionen und 1 Übungslektion pro Woche

Eintrittskompetenzen

Vorkenntnisse, Eingangskompetenzen

Fundiertes Methodenwissen in der eigenen Disziplin, Grundkenntnisse in Projektmanagement

Kurzbeschreibung der Inhalte und Ziele

Die Fähigkeit über die eigene Disziplingrenzen hinweg erfolgreich mit Anderen zusammenzuarbeiten ist eine geforderte Kompetenz von Masterstudierenden. Wie geht die eigene Disziplin, wie gehen andere Disziplinen an Planungsaufgaben heran? Wie lassen sich Unterschiede in der Denk- und Arbeitsweise benennen, wie die Zusammenarbeit über Kultur-, Fach- und Disziplingrenzen hinweg produktiv gestalten?
Diese Zusammenarbeit wird im Rahmen der erweiterten theoretischen Grundlagen im Modul Planungsmethodik in der Theorie vermittelt und die Anwendung in einem Semesterprojekt trainiert.

Ziele, Inhalte, Methoden

Lernziele und zu erwerbende Kompetenzen

Reflektieren der spezifischen Herangehensweise der eigenen Disziplin und anderer Disziplinen an Planungsaufgaben (interdisziplinärere Zusammenarbeit).
Kennen und Verstehen der Transfermechanismen zwischen verschiedenen Disziplinen sowie zwischen Wissenschaft und Praxis (transdisziplinäre Planungsmethoden).

Modulinhalt mit Gewichtung der Lehrinhalte

- Planungsmethodische Grundlagen und Techniken
- Interkulturelle Kompetenzen
- Vorgehensmodelle in inter- und transdisziplinären Projekten
- Analyse- und Prognosemethoden
- Wissensmanagement
- Prinzipielle Gesamtlösungen
- Aushandlungsprozesse
- Modelle und Indikatoren
- Semesterprojekt Planungsmethodik

Lehr- und Lernmethoden

Vorlesungen, Semesterprojekt sowie Selbststudium

Bibliografie

Bewertung

Zusätzliche Leistungsbewertung während des Semesters

Das Modul beinhaltet eine oder mehrere zusätzliche Leistungsbewertung(en) während des Semesters. Die erzielte Note der zusätzlichen Leistungsbewertung(en) gilt sowohl für die reguläre als auch für die Wiederholungsprüfung.

Beschreibung zusätzliche Leistungsbewertung während des Semesters

Semesterprojekt (Gewichtung 20%)

Grundsatz Prüfungen

Grundsätzlich werden alle regulären Abschlussprüfungen in schriftlicher Form durchgeführt. Bei den Wiederholungsprüfungen teilen die Dozierenden das Prüfungsformat (schriftlich/mündlich) zusammen mit dem Prüfungsplan mit.

Reguläre Modulschlussprüfung und schriftliche Wiederholungsprüfung

Art der Prüfung

Schriftliche Prüfung

Prüfungsdauer

120 Minuten

Erlaubte Hilfsmittel

Erlaubt sind die aufgeführten Hilfsmittel:

Zulässige elektronische Hilfsmittel

Keine elektronischen Hilfsmittel zulässig

Weitere erlaubte Hilfsmittel

Eigene Notizen: max. 5-seitige Zusammenfassung (A4 einseitig)

Ausnahme: Im Falle einer elektronischen Moodle-Prüfung können Änderungen der Hilfsmittel vorkommen. Dozierende werden die endgültig

zulässigen Hilfsmittel vor der Prüfung bekanntgeben.

Spezialfall: Wiederholungsprüfung als mündliches Examen

Art der Prüfung

Mündliche Prüfung

Prüfungsdauer

30 Minuten

Erlaubte Hilfsmittel

Ohne Hilfsmittel

Module Description, available in: EN

Stochastic Modeling

General Information

Number of ECTS Credits

3

Module code

FTP_StochMod

Valid for academic year

2026-27

Last modification

2020-04-01

Coordinator of the module

Erich Baur (BFH, erich.baur@bfh.ch)

Explanations regarding the language definitions for each location:

- Instruction is given in the language specified for each location and module execution.
- Documentation is available in the language(s) listed for each location and module execution. If the documentation is in multiple languages, the percentage distributed is indicated (100% = all documentation provided).
- The examination, including both questions and answers, is provided entirely (100%) in the language(s) specified for each location and module execution. The exams are on-site.

	Lausanne			Lugano	Zurich		
Instruction					**X** E 100%		
Documentation					**X** E 100%		
Examination					**X** E 100%		

Module Category

FTP Fundamental theoretical principles

Profile Recommendations

This module is recommended for the following profiles:

	Zurich
Profile	CS, BT

Lessons

2 lecture periods and 1 tutorial period per week

Entry level competences

Prerequisites, previous knowledge

1. Basis calculus (integration, differentiation, ordinary differential equations, complex numbers, Fourier transform)
2. Basic probability theory (probability, conditional probability, Bayes' theorem, expectation, variance, random variables)
3. Linear algebra (matrix algebra, system of linear equations, eigenvectors, eigenvalues)

Brief course description of module objectives and content

The ubiquitous presence of uncertainty and noise in the engineering sciences and the importance of randomized algorithms in computer and data science make it mandatory to understand and quantify random phenomena. To achieve this goal the course will provide a solid review of probability theory and an introduction to the theory of stochastic processes. Special attention is given to applications, including examples from various fields such as communications and vision, signal processing and control, queuing theory or physics of small systems (Brownian motion).

Aims, content, methods

Learning objectives and competencies to be acquired

The student is familiar with the main working tools and concepts of stochastic modeling (expectation, variance, covariance, autocorrelation, power spectral density). He/She is able to explain properties and limitations of stochastic processes as a modeling tool for noisy systems. He/She will be able to model and analyze simple random phenomena through adaptation of proposed stochastic models.

Module content with weighting of different components

- Probability review: random variables, conditional probabilities, theorem of large numbers, central limit theorem.
- General introduction to discrete and continuous stochastic processes. Applications, e.g., communications, Kalman filtering.
- Discrete, continuous and hidden Markov chains. Applications, e.g., page rank algorithm, queuing systems, pattern recognition, speech recognition.
- Bernoulli, Poisson, Gaussian processes, Brownian motion, white and colored noise.

Teaching and learning methods

Ex cathedra teaching
Presentation of simulation results and case studies

Literature

The script is, in principle, sufficient. Further readings are:

1. Sheldon M. Ross, Probability Models, Elsevier.
2. John A. Gubner, Probability and Random Processes for Electrical and Computer Engineers, Cambridge University Press.
3. Mario Lefebvre, Applied Stochastic Processes, Springer.
4. Bassel Solaiman, Processus stochastiques pour l'ingénieur, PPUR.

Assessment

Additional performance assessment during the semester

The module does not contain an additional performance assessment during the semester

Basic principle for exams

As a rule, all standard final exams are conducted in written form. For resit exams, lecturers will communicate the exam format (written/oral) together with the exam schedule.

Standard final exam for a module and written resit exam

Kind of exam

Written exam

Duration of exam

120 minutes

Permissible aids

Aids permitted as specified below:

Permissible electronic aids

No electronic aids permitted

Other permissible aids

Handwritten summary of five A4 sheets (=ten pages in total), compiled by the student.

Exception: In case of an electronic Moodle exam, adjustments to the permissible aids may occur. Lecturers will announce the final

permissible aids prior to the exam session.

Special case: Resit exam as oral exam

Kind of exam

Oral exam

Duration of exam

30 minutes

Permissible aids

No aids permitted

Module Description, available in: EN

Vectors and Tensors in Engineering Physics

General Information

Number of ECTS Credits

3

Module code

FTP_Tensors

Valid for academic year

2026-27

Last modification

2025-01-07

Coordinator of the module

Lorenz Martin (BFH, lorenz.martin@bfh.ch)

Explanations regarding the language definitions for each location:

- Instruction is given in the language specified for each location and module execution.
- Documentation is available in the language(s) listed for each location and module execution. If the documentation is in multiple languages, the percentage distributed is indicated (100% = all documentation provided).
- The examination, including both questions and answers, is provided entirely (100%) in the language(s) specified for each location and module execution. The exams are on-site.

	Lausanne			Lugano	Zurich		
Instruction					**X** E 100%		
Documentation					**X** E 100%		
Examination					**X** E 100%		

Module Category

FTP Fundamental theoretical principles

Profile Recommendations

This module is recommended for the following profiles:

	Zurich
Profile	EnEn

Lessons

2 lecture periods and 1 tutorial period per week

Entry level competences

Prerequisites, previous knowledge

Physics, analysis and linear algebra at Bachelor's level

Brief course description of module objectives and content

The course starts with an overview of classical engineering physics with special emphasis on balance and constitutive equations (i.e. continuity equations and material laws). The concepts of vector analysis are introduced and then applied to describe spacial phenomena in electrodynamics and thermodynamics. In a next step, this knowledge is extended towards tensors algebra. Tensors enable the description of typical anisotropic effects of solid state physics and modern materials such as stress and strain, double refraction and layered structures. Some of the topics in the course are also treated using mathematical software such as Matlab with the goal to facilitate the student's understanding and application of numerical simulation methods (e.g., FEA, multiphysics).

Aims, content, methods

Learning objectives and competencies to be acquired

- Students are familiar with the most important basic laws of engineering physics for isotropic materials in general form, recognise analogies between different application areas and exploit these for analyzing systems
- Students know about the generalization of the laws for anisotropic materials and can interpret these, especially with regard to application in numerical simulation
- Students master vector analysis and the algebra of tensors together with the standard notation conventions
- Students understand the basics of electrodynamics and thermodynamics transport phenomena in anisotropic systems
- Students understand mechanical elasticity with 3D strain and stress states and are familiar with the material laws in general form for isotropic and anisotropic bodies
- Students understand the piezo-electric effect and its applications in engineering (sensors and actuators)

Module content with weighting of different components

- Recapitulation of isotropic material laws (Ohm, Hooke, Fourier, etc.)
- Introduction to vector and tensor calculation: scalar, vectorial and tensorial parameters, tensor algebra,
- Transformation behavior of vectors and tensors
- Hands-on calculation of vector analysis and tensor algebra: electrodynamics, thermodynamics and anisotropic transport phenomena
- Elasticity theory with emphasis on 3D stress states
- Piezo-effect: physical fundamentals

Teaching and learning methods

Frontal teaching (approx. 60 %)
Presentation and discussion of case studies and problems, individual problem solving (approx. 40 %)

Literature

[1] R.E. Newham, Properties of Materials, Oxford, 2005

[2] J.F. Nye, Physical Properties of Crystals, Oxford Science Publication, 2004

[3] J. Tichy, Fundamentals of Piezoelectric Sensorics, Springer 2010

[4] E. Kreszig, Advanced Engineering Mathematics, 10th edition, Wiley, 2011

Assessment

Additional performance assessment during the semester

The module does not contain an additional performance assessment during the semester

Basic principle for exams

As a rule, all standard final exams are conducted in written form. For resit exams, lecturers will communicate the exam format (written/oral) together with the exam schedule.

Standard final exam for a module and written resit exam

Kind of exam

Written exam

Duration of exam

120 minutes

Permissible aids

Aids permitted as specified below:

Permissible electronic aids

Written matter (open book), pocket calculator

Other permissible aids

No other aids permitted

Exception: In case of an electronic Moodle exam, adjustments to the permissible aids may occur. Lecturers will announce the final permissible aids prior to the exam session.

Special case: Resit exam as oral exam

Kind of exam

Oral exam

Duration of exam

30 minutes

Permissible aids

No aids permitted

Module Description, available in: EN

Theoretical Computer Science

General Information

Number of ECTS Credits

3

Module code

FTP_TheoComp

Valid for academic year

2026-27

Last modification

2023-09-26

Coordinator of the module

Olivier Biberstein (BFH, olivier.biberstein@bfh.ch)

Explanations regarding the language definitions for each location:

- Instruction is given in the language specified for each location and module execution.
- Documentation is available in the language(s) listed for each location and module execution. If the documentation is in multiple languages, the percentage distributed is indicated (100% = all documentation provided).
- The examination, including both questions and answers, is provided entirely (100%) in the language(s) specified for each location and module execution. The exams are on-site.

	Lausanne			Lugano	Zurich		
Instruction					**X** E 100%		
Documentation					**X** E 100%		
Examination					**X** E 100%		

Module Category

FTP Fundamental theoretical principles

Profile Recommendations

This module is recommended for the following profiles:

	Zurich
Profile	CS

Lessons

2 lecture periods and 1 tutorial period per week

Entry level competences

Prerequisites, previous knowledge

Good knowledge of programming, algorithms and discrete mathematics.

Brief course description of module objectives and content

The aim of this module is to deepen some basic theoretical aspects of computer science. The master students will learn that ...

- formal languages and automata are essential concepts to describe different types of problems and computations;
- Computability/decidability are central to explain that for many problems seem to have an intuitive solution, although they can not be solved by algorithms;
- Complexity deals with the amount of time required to solve a problem, and there are many very practical problems that can not be solved in reasonable time or space.

Aims, content, methods

Learning objectives and competencies to be acquired

- The students understand that three different mathematical formalisms (finite state automata, regular grammars, regular expressions) are equivalent and define the set of regular languages. Finite state automata and regular expressions are widely used and will be explained using examples from lexical analysis, modeling of simple state-based systems, telecommunications protocols and program verification.
- The students realize that programming languages with regular languages can not be fully described. Context-free grammars, on the other hand, are suitable for developing all modern programming languages. Parsing is closely linked to the context-free languages. Using parser generators, students can explain top-down and bottom-up parsing.
- The students know that many problems are undecidable, i.e. that there are no algorithms to solve them, or rather that not everything is predictable. Such intuitively difficult to understand problems occur e.g. in the case of operating systems (deadlock problem), object-oriented programming languages (subtype decision) or program verification.
- The students understand that decidable problems are classified according to the resources needed to solve them (time or space) and know the major complexity classes (P, NP, EXP, PSPACE), their differences, and interrelationships (e.g., hierarchy).
- The students understand the concept of nondeterminism, which plays an essential role in the study of complexity. The complexity class NP (nondeterministic polynomial time) includes a subclass of very practical problems that are not solvable in reasonable time. Cryptology, machine vision, various optimization problems and many other areas are affected by such problems. Students can demonstrate that such problems are indeed unsolvable in reasonable time, and know some ways to circumvent this limitation through approximation techniques.Many problems known as NP-complete are presented and investigated.

Module content with weighting of different components

The module is divided into three parts:

1. Languages and automata (about 36 %)
    1. Alphabets, words, formal languages, grammars
    2. Finite state automata, regular languages/grammars, regular expressions, nondeterminism
    3. Pushdown automata, context-free languages/grammar
    4. Turing machines
2. Computability/decidability (about 21 %)
    1. Various computation models, Church-Turing thesis
    2. Reduction of a problem to another
    3. Decidable/undecidable problems
    4. Computable/uncomputable functions
3. Complexity (about 43 %)
    1. Types of complexity (time, space)
    2. Complexity classes, polynomial time complexity, NP, polynomial time reductions, NP-completeness
    3. Approximation methods

Teaching and learning methods

- Frontal teaching
- Presentation and discussion of theoretical topics
- Discussion of practical examples to reduce the gap between theory and practice
- Exercises and self-study of selected topics

Literature

Introduction to the Theory of Computation, Michael Sipser, Cengage Learning, 3rd International Edition, 2013.
Reference: http://www-math.mit.edu/~sipser/book.html (Homepage of author of the book)

Computers Ltd.: What They Really Can't Do, David Harel, Oxford University Press, 2000.

Introduction to automata theory, languages, and computation, J.E. Hopcroft and J.D. Ullman, Addison-Wesley Publishing Company, Reading, MA, 1979.

Assessment

Additional performance assessment during the semester

The module does not contain an additional performance assessment during the semester

Basic principle for exams

As a rule, all standard final exams are conducted in written form. For resit exams, lecturers will communicate the exam format (written/oral) together with the exam schedule.

Standard final exam for a module and written resit exam

Kind of exam

Written exam

Duration of exam

120 minutes

Permissible aids

Aids permitted as specified below:

Permissible electronic aids

Summary (10 pages)

Other permissible aids

No other aids permitted

Exception: In case of an electronic Moodle exam, adjustments to the permissible aids may occur. Lecturers will announce the final permissible aids prior to the exam session.

Special case: Resit exam as oral exam

Kind of exam

Oral exam

Duration of exam

30 minutes

Permissible aids

No aids permitted

Module Description, available in: EN

Advanced Aircraft System Design

General Information

Number of ECTS Credits

3

Module code

TSM_AdvAirDes

Valid for academic year

2026-27

Last modification

2024-01-10

Coordinator of the module

Michel Guillaume (ZHAW, michel.guillaume@zhaw.ch)

Explanations regarding the language definitions for each location:

- Instruction is given in the language specified for each location and module execution.
- Documentation is available in the language(s) listed for each location and module execution. If the documentation is in multiple languages, the percentage distributed is indicated (100% = all documentation provided).
- The examination, including both questions and answers, is provided entirely (100%) in the language(s) specified for each location and module execution. The exams are on-site.

	Winterthur			
Instruction	**X** E 100%			
Documentation	**X** E 100%			
Examination	**X** E 100%			

Module Category

TSM Technical scientific module

Profile Recommendations

This module is recommended for the following profiles:

	Zurich
Profile	Avi

Lessons

2 lecture periods and 1 tutorial period per week

Entry level competences

Prerequisites, previous knowledge

The students are expected to have knowledge of the basics of Fluid Dynamics / Aerodynamics, Structural Mechanics, Thermodynamics (Gas Turbines), and Systems Engineering.

An interest in Aircraft Systems is important.

The knowledge of simulation tools (Matlab, Simulink, Modelica, Comsol, etc.) and performance calculations or optimization calculations is an

advantage.

Brief course description of module objectives and content

The course will focus on the design of advanced aircraft systems, aiming towards more electric types of aircraft for a new generation beyond the Airbus A380 and Boeing 787.

Today, aircraft design is more than just aerodynamics, flight dynamics, propulsion, structures,and equipment. The new technologies require a systems engineering approach, which guides the way towards a sustainable aircraft. New methods for system engineering towards collaborative engineering will be presented.

The whole design process will be discussed and the students will learn to do a conceptual and preliminary design.

In this module, the whole design process of a complex system such as an aircraft will be discussed and the students will learn how to do a conceptual and preliminary design. The course is structured in lectures as well as with small case studies (practise), which will be done in groups.

3 lectures will take place at FFA Altenrhein Museum with practical visit at Jet & Prop Heritage.

Outside of the course a visit of CatAviation is planned to look into design details of an advanced Falcon Business Jet.

Aims, content, methods

Learning objectives and competencies to be acquired

The students will learn how the design process of a complex system such as an aircraft is done, with a focus on the early stages between concept and the preliminary design stage.

All important disciplines, which play a key role in aircraft design, will be addressed: weight distribution estimation, performance, propulsion, on the basis of systems engineering.

The students will be able to understand the architecture of modern aircraft, focussing on the advancing system integration with the trend towards electric and more environmentally sustainable aircraft.

The students can apply the current design standards and analyze the design of new aircraft for the efficiency and performance of the operation.

Learning experience working in a design team to define an aircraft concept (airliner fuselage concept).

Module content with weighting of different components

The course will start with an introduction to aircraft conceptual design.

The aerodynamics for wing design, propulsion technology, and engine integration and the electrical, hydraulic and pneumatic systems will be discussed to provide an aircraft architecture from the system point of view.

The available methods of aircraft design optimization will be discussed in the light of perfect design or an illusion of the existence of such.

The concept of increasingly electrical aircraft and the concept of hybrid propulsion for new aircraft layouts will be discussed at the end of the course.

The course will deliver the knowledge to the design of new aircraft generations to meet the reduction of CO2 and noise footprint towards greener aviation.

Teaching and learning methods

- Lectures with focus on practical cases for commercial airplanes
- Self study and performance of literature research
- Performance of small case studies for an aircraft design working together with teams which cover different design aspects

Literature

- Aircraft Design: A Conceptual Approach, Daniel P. Raymer, AIAA Education Series
- Fundamental of Aerodynamics, John D. Anderson Jr., McGraw-Hill Series in Aeronautical and Aerospace Engineering
- Airframe Structural Design, Practical Design Information and Data on Aircraft Structures, Michael C. Y. Niu, Hong Kong Conmilit Pres Ltd.

Assessment

Additional performance assessment during the semester

The module contains additional performance assessment(s) during the semester. The achieved mark of the additional performance assessment(s) applies to both the regular and the resit exam.

Description of additional performance assessment during the semester

A group work will be done for the dsign task of fuselage with focus of PAX and Cargo arrangement. The result must be presented n PowerPoint during the course.

The perfrmance assessment will ranked as 1/3 of the final module mark.

Basic principle for exams

As a rule, all standard final exams are conducted in written form. For resit exams, lecturers will communicate the exam format (written/oral) together with the exam schedule.

Standard final exam for a module and written resit exam

Kind of exam

Written exam

Duration of exam

120 minutes

Permissible aids

Aids permitted as specified below:

Permissible electronic aids

- No programmable calculator

Other permissible aids

- Open book
- No AI tools
- No mobile phones

Exception: In case of an electronic Moodle exam, adjustments to the permissible aids may occur. Lecturers will announce the final permissible aids prior to the exam session.

Special case: Resit exam as oral exam

Kind of exam

Oral exam

Duration of exam

30 minutes

Permissible aids

No aids permitted

Module Description, available in: EN

Advanced Alpine Risk Management

General Information

Number of ECTS Credits

3

Module code

TSM_AdvAlpRsk

Valid for academic year

2026-27 DRAFT

Last modification

2026-06-18

Coordinator of the module

Christian Ambrosi (SUPSI, christian.ambrosi@supsi.ch)

Explanations regarding the language definitions for each location:

- Instruction is given in the language specified for each location and module execution.
- Documentation is available in the language(s) listed for each location and module execution. If the documentation is in multiple languages, the percentage distributed is indicated (100% = all documentation provided).
- The examination, including both questions and answers, is provided entirely (100%) in the language(s) specified for each location and module execution. The exams are on-site.

	Lausanne			Lugano	Zurich		
Instruction				**X** E 100%			
Documentation				**X** E 100%			
Examination				**X** E 100%			

Module Category

TSM Technical scientific module

Profile Recommendations

This module is recommended for the following profiles:

	Lugano
Profile	CE

Lessons

2 lecture periods and 1 tutorial period per week

Entry level competences

Prerequisites, previous knowledge

- Knowledge of applied geology, hydrology and natural hazard assessment.
- Basic knowledge of slope stability analysis, geotechnical engineering, hydraulic processes and Geographic Information Systems (GIS) is recommended.
- Students should also be able to interpret topographic, geological and hazard maps.

Brief course description of module objectives and content

Contents:

The module provides advanced knowledge and practical skills for assessing and managing natural hazards in Alpine environments. It focuses on slope instability, high-altitude cryosphere hazards, floods and debris flows, including their evolution under climate change.

The course combines process analysis, field and remote-sensing data, numerical modelling, hazard and risk mapping, vulnerability assessment and the evaluation of mitigation measures. Swiss standards and guidelines, particularly SIA 261/1, are applied through lectures, practical exercises, real case studies and a site-specific field investigation.

Objectives:

After completing the module, students should be able to analyse complex Alpine hazard processes, select and apply suitable investigation and modelling methods, interpret model and field data, and translate the results into hazard and risk assessments. Students should also be able to evaluate protective measures and develop technically appropriate, cost-effective and risk-informed solutions, taking into account uncertainty and the effects of climate change.

Aims, content, methods

Learning objectives and competencies to be acquired

- After completing this module, students should be able to:
- Understand and interpret slope failure mechanisms in soil and rock slopes;
- Delineate hazard-prone areas using advanced digital surveying and geospatial mapping techniques;
- Apply numerical modelling approaches to evaluate slope stability and landslide dynamics;
- Assess the performance of stabilization and mitigation measures under varying environmental and loading conditions;
- Carrying out complex case studies based on real examples and field data.
- Conducting a study and complying with specifications according to the client's instructions.
- Proposing technical solutions that are appropriate to the context and cost-effective.
- Interpreting and apply federal directives and norms for the dimensioning and construction of protective measures and structures.

Module content with weighting of different components

PART 1: Slope stability from modelling to hazard assessment, 12h (4 lectures)

This part of the course provides a detailed and integrated framework for the **analysis and management of slope-related natural hazards in alpine environments**, forming the methodological foundation for the subsequent modules on avalanches, debris flows, floods, permafrost and high-altitude hazards.

The module combines **mechanical principles, advanced numerical modelling, hazard dynamics**, and **territorial protection strategies**, with a strong focus on **decision-oriented risk management** under climate-change-driven conditions.

PART 2: Complex high-altitude cryosphere hazards, 12h (4 lectures)

In the context of climate change, the Alpine cryosphere is particularly affected by the temperature increase and the modification in rain/snow regimes, leading to **enhanced debris production** by rapid glacier retreat, **increasing permafrost degradation**, and **more intense precipitation** (by rain and snow).

By adopting an **integrative view** of the three components of the Alpine cryosphere (snow, ice, and permafrost), this second part of the course has the **objective to develop competences in the assessment of complex high-altitude hazards and risks**.

PART 3: Floods and debris flows hazards, 12h (4 lectures)

The third part of the course focuses on flood and debris flow hazards and risk management, integrating advanced concepts of hydrology and flood discharge estimation in order to develop competences in the hazard and risk mapping technique for floods and debris flows. Focus will be given to the hydrological extremes and debris flow generation in the context of climate change.

PART 4: SITE-SPECIFIC ANALYSIS ON THE FIELD (1 day)

Teaching and learning methods

- Lectures
- Independent exercises
- a site-specific field investigation based on a real case study in the Southern Swiss Alps

Literature

Teaching materials and selected scientific and technical references provided during the lectures.

Assessment

Additional performance assessment during the semester

The module does not contain an additional performance assessment during the semester

Basic principle for exams

As a rule, all standard final exams are conducted in written form. For resit exams, lecturers will communicate the exam format (written/oral) together with the exam schedule.

Standard final exam for a module and written resit exam

Kind of exam

Written exam

Duration of exam

120 minutes

Permissible aids

Aids permitted as specified below:

Permissible electronic aids

No electronic aids are permitted, except for a non-programmable pocket calculator.

Other permissible aids

Permitted aids as agreed upon with the instructor.

Exception: In case of an electronic Moodle exam, adjustments to the permissible aids may occur. Lecturers will announce the final permissible aids prior to the exam session.

Special case: Resit exam as oral exam

Kind of exam

Oral exam

Duration of exam

30 minutes

Permissible aids

Aids permitted as specified below:

Permissible electronic aids

No electronic aids are permitted, except for a non-programmable pocket calculator.

Other permissible aids

Permitted aids as agreed upon with the instructor.

Description du module, disponible en: FR

Advanced Communication Architectures

Informations générales

Nombre de crédits ECTS

3

Code du module

TSM_AdvComArc

Valable pour l'année académique

2026-27

Dernière modification

2024-10-16

Coordinateur/coordinatrice du module

Tewfiq El Maliki (HES-SO, tewfiq.elmaliki@hesge.ch)

Explications concernant les langues d'enseignement par site :

- L'enseignement est dispensé dans la langue indiquée ci-dessous pour chaque site et chaque exécution du module.
- Les supports de cours sont disponibles dans les langues indiquées ci-dessous pour chaque site et chaque exécution du module. Lorsque plusieurs langues sont utilisées, la proportion de contenu disponible dans chaque langue est précisée (100 % = ensemble des supports de cours).
- Les examens (questions et réponses) sont entièrement rédigés dans la langue indiquée ci-dessous pour le site et l'exécution du module concernés. Ils se déroulent en présentiel.

	Lausanne			Lugano	Zurich		
Leçons		**X** F 100%					
Documentation		**X** F 10%	**X** E 90%				
Examen		**X** F 100%					

Catégorie de module

TSM approfondissement technico-scientifique

Recommandations de profil

Ce module est recommandé pour les profils suivants :

	Lausanne
Profil	CS

Leçons

2 leçons et 1 leçon de pratique par semaine

Compétences préalables

Connaissances préalables, compétences initiales

- Connaissance des piles protocolaires IP et de tous les protocoles correspondants (Ethernet, IP, TCP/UDP et application actuelle comme).
- Connaissance approfondie des principes de transmission des données et des protocoles, principalement des réseaux mobiles de base.

Brève description du contenu et des objectifs

Le cours commencera par la révision de certaines connaissances de base comme la sécurité, les réseaux mobiles et sans fil et le contexte de la mobilité des réseaux. Sur cette base, le module définira un fil rouge qui commencera par un ensemble d'exigences en matière de disponibilité des services utilisées pour définir les architectures. L'exploration de différentes solutions d'architectures sera l'objectif suivant qui permettra à l'étudiant d'avoir un aperçu complet de la façon dont un réseau moderne et complexe fournit des services avancés. Une attention particulière sera accordée à la sécurité des réseaux mobiles et sans fil. La troisième section décrit des concepts prospectifs tels que le réseau de nouvelle génération (NGN), le réseau défini par logiciel (SDN) et les fonctions de virtualisation du réseau (NVF) qui sont actuellement déployés par les opérateurs. Le cours est complété par des exercices pratiques et des mesures sur une infrastructure d'opérateur IMS (IP Multimedia subsystem) réelle située dans un centre de données.

Le cours couvre les sujets principaux suivants :

- Rappel des connaissances de base
- Architecture moderne
- Sécurité des réseaux sans fil et mobiles.
- Technologies à large bande.

Objectifs, contenus, méthodes

Objectifs d'apprentissage, compétences à acquérir

A la fin du module, l'étudiant en MSE sera capable de :

- Décrire la complexité des réseaux de communication et les architectures correspondantes, principalement les réseaux mobiles et sans fil
- Décrire les conditions de gestion d'un réseau complexe et moderne
- Décrire et comprendre les origines des pannes et des perturbations
- Décrire et comprendre les mécanismes de sécurité dans les réseaux modernes
- Interpréter et comprendre les différentes conditions d'exploitation des réseaux

Contenu des modules avec pondération du contenu des cours

- Notions de base :
  Protocoles de réseau (AAA, Diameter, SCTP, etc.)
  Réseaux mobiles
  Mobilité pour IP (MIP)
  Qualité de service (QoS) et accord de niveau de service (SLA)
  Signalisation et orchestration des couches (plan de contrôle)
  Introduction à la sécurité des réseaux

- Architectures :
  Ensemble d'exigences en matière de disponibilité des services utilisé pour définir les architectures
  Alternatives et solutions
  Interaction avec les technologies à large bande
  Sécurité des réseaux sans fil

- Solutions avancées :
  Réseau de nouvelle génération (NGN)
  Réseau défini par logiciel (SDN)
  Fonctions de virtualisation du réseau (NVF)

- Travaux pratiques : Réseaux sans fil

Méthodes d'enseignement et d'apprentissage

Ce cours comprend des présentations théoriques et des exercices pratiques sur les réseaux mobiles et les mesures sur les réseaux sans fil.

Bibliographie

Les diapositives des cours, les références aux ressources Internet et aux livres sont mentionnées lors de l'introduction du module.

Evaluation

Évaluation supplémentaire pendant le semestre

Le module comprend une ou des évaluation(s) supplémentaire(s) pendant le semestre. La note obtenue pour la ou les évaluation(s) supplémentaire(s) est valable à la fois pour l'examen final et pour l'examen de répétition.

Description de l'évaluation supplémentaire pendant le semestre

- Les devoirs individuels corrigés représentent 6 % de la note finale.

-Un projet de groupe noté représente 24% de la note finale et exige l'application de divers concepts couverts en classe aux phases de planification, de conception, de mise en œuvre et de test du projet.

Principe pour les examens

En règle générale, tous les examens réguliers de fin de module se déroulent sous forme écrite. Concernant les examens de répétition, leur format (écrit ou oral) sera communiqué par l'enseignant-e en même temps que le calendrier des examens.

Examen de fin de module régulier et examen écrit de répétition

Type de l'examen

Examen écrit

Durée de l'examen

120 minutes

Aides autorisées

Les aides suivantes sont autorisées:

Aides électroniques autorisées

Aucune aide électronique autorisée

Autres aides autorisées

Un résumé personnel de max. 20 pages A4 (ou 10 feuilles) sur papier, portant le nom de l'étudiant. Il n'est pas nécessaire qu'il soit écrit à la main, mais le contenu du résumé doit être personnel et ne doit pas être une copie de quelqu'un d'autre. Le résumé sera collecté avec l'examen et ne sera pas restitué.

Exception : En cas d'examen électronique sur Moodle, des modifications des aides autorisées peuvent survenir. Dans ce cas, les aides autorisées seront annoncées par les enseignant-e-s avant l'examen.

Cas spécial: examen de répétition oral

Type de l'examen

Examen oral

Durée de l'examen

30 minutes

Aides autorisées

Sans aides

Module Description, available in: EN

Advanced computer graphics

General Information

Number of ECTS Credits

3

Module code

TSM_AdvCompG

Valid for academic year

2026-27

Last modification

2025-10-13

Coordinator of the module

Achille Peternier (SUPSI, achille.peternier@supsi.ch)

Explanations regarding the language definitions for each location:

- Instruction is given in the language specified for each location and module execution.
- Documentation is available in the language(s) listed for each location and module execution. If the documentation is in multiple languages, the percentage distributed is indicated (100% = all documentation provided).
- The examination, including both questions and answers, is provided entirely (100%) in the language(s) specified for each location and module execution. The exams are on-site.

	Lausanne			Lugano	Zurich		
Instruction				**X** E 100%			
Documentation				**X** E 100%			
Examination				**X** E 100%			

Module Category

TSM Technical scientific module

Profile Recommendations

This module is recommended for the following profiles:

	Lugano
Profile	CS

Lessons

2 lecture periods and 1 tutorial period per week

Entry level competences

Prerequisites, previous knowledge

Linear algebra (vectors, matrices, homogeneous coordinates), C/C++ programming, 3D computer graphics (basic real-time rasterization).

This course is ideal in combination and/or as a continuation of the EVA complementary modules Computer Graphics (MS_CompGraph), Virtual Reality (MS_VirtReal), and Game Development (MS_GameDev).

Brief course description of module objectives and content

The objective of this course is to provide both theoretical knowledge and practical expertise in the techniques that enable modern computer games to achieve photorealistic graphics in real time.

You will learn to harness the immense computational power of modern GPUs and use it efficiently to get the highest performance when rendering lifelike scenes in real time. To that end, you will learn all about advanced lighting models using both rasterization and ray tracing. Additionally, the course covers a multitude of GPU-accelerated post-processing effects and techniques to increase the visual fidelity of complex 3D scenes.

Aims, content, methods

Learning objectives and competencies to be acquired

In this course, participants gain a deeper understanding of the ecosystem, technologies, and mathematics that power modern GPUs and enable photorealistic real-time rendering. This provides a solid foundation in cutting-edge techniques, allowing them to further advance in this field independently.

In addition to a strong theoretical background, the learning path includes tutorials and assignments focused on implementing these state-of-the-art technologies, fostering a complete understanding of how to exploit the full potential of GPU architectures.

Thanks to the hands-on experience gained in addressing the complexity of modern GPU programming and selected advanced rendering techniques used in the leading industry, students will be able to implement cutting-edge graphics in their own future projects. By the end of the course, they will have mastered the principles and techniques behind modern real-time graphics, with skills that apply across domains such as games, simulation, virtual reality, and interactive visualization.

Module content with weighting of different components

The module covers the following topics (including the % of weight given to each of them):

- GPU programming and software architecturing via a modern API with particular focus on code design and performance implications (30%).
- Realistic lighting through Physically-Based Rendering (PBR), global illumination, real-time ray tracing, and shadow mapping (30%).
- Deferred rendering: advantages and limitations (15%).
- The problem of correct Order-Independent Transparency (OIT) and its solutions (15%).
- Post-processing effects to enhance image quality: anti-aliasing, High-Dynamic Range (HDR), tone mapping, and ambient occlusion (10%).

Teaching and learning methods

Lectures, tutorials, demos, and practical work on computer and dedicated hardware. Students will be asked to implement selected techniques on their own as assignment.

Literature

Tomas Akenine-Möller et al. 2018. Real-Time Rendering (4th ed.). O'Reilly.

Graham Sellers, Richard S. Wright, and Nicholas Haemel. 2015. OpenGL Superbible: Comprehensive Tutorial and Reference (7th ed.). Addison-Wesley Professional.

Wolfgang Engel et al. 2010-2016. GPU Pro Series (Vol. 1-7). A K Peters/CRC Press.

Assessment

Additional performance assessment during the semester

The module contains additional performance assessment(s) during the semester. The achieved mark of the additional performance assessment(s) applies to both the regular and the resit exam.

Description of additional performance assessment during the semester

A practical group project will be required, contributing 33% to the final grade. Students will work in teams, select a specific topic, and deepen their understanding by implementing a small demonstrator of the chosen technique. By the end of the semester, they will submit the working source code and briefly present their project to the class.

Basic principle for exams

As a rule, all standard final exams are conducted in written form. For resit exams, lecturers will communicate the exam format (written/oral) together with the exam schedule.

Standard final exam for a module and written resit exam

Kind of exam

Written exam

Duration of exam

120 minutes

Permissible aids

Aids permitted as specified below:

Permissible electronic aids

A simple calculator (without any communication feature).

Other permissible aids

Paper-printed slides and lecture notes.

Exception: In case of an electronic Moodle exam, adjustments to the permissible aids may occur. Lecturers will announce the final permissible aids prior to the exam session.

Special case: Resit exam as oral exam

Kind of exam

Oral exam

Duration of exam

30 minutes

Permissible aids

Aids permitted as specified below:

Permissible electronic aids

None

Other permissible aids

The student can bring and consult a short summary during the examination (on maximum one A4 sheet, front and back).

Module Description, available in: EN, FR

Advanced Control

General Information

Number of ECTS Credits

3

Module code

TSM_AdvContr

Valid for academic year

2026-27

Last modification

2018-07-02

Coordinator of the module

Beat Aeschlimann (ZHAW, aesc@zhaw.ch)

Explanations regarding the language definitions for each location:

- Instruction is given in the language specified for each location and module execution.
- Documentation is available in the language(s) listed for each location and module execution. If the documentation is in multiple languages, the percentage distributed is indicated (100% = all documentation provided).
- The examination, including both questions and answers, is provided entirely (100%) in the language(s) specified for each location and module execution. The exams are on-site.

	Lausanne			Lugano	Zurich		
Instruction		**X** F 100%			**X** E 100%		
Documentation		**X** F 0%	**X** E 100%		**X** E 100%		
Examination		**X** F 100%			**X** E 100%		

Module Category

TSM Technical scientific module

Profile Recommendations

This module is recommended for the following profiles:

	Lausanne	Zurich
Profile	EIE	EIE

Lessons

2 lecture periods and 1 tutorial period per week

Entry level competences

Prerequisites, previous knowledge

- Differential equations, transfer functions
- PID-controller design and implementation incl. anti-windup strategies
- Control system structures: feed-forward, cascaded control
- Analysis of feedback control systems (stability, phase/gain margin, performance in time and frequency domain)
- State space models

- Loop shaping controller design
- Linear algebra (Eigenvalue decomposition)
- It is necessary, that the student has successfully completed 2 semester courses in feedback control

Brief course description of module objectives and content

Model-based controller design is a key technology to control systems with complex dynamics. It was the enabling technology for many innovations in the last decade. In this module, the key elements of the development process are addressed: system identification, LQR/LQG controller design and controller implementation. Since there is always model uncertainty, the course introduces robust controller design using the methods LQG/LTR and H-Infinity.

Aims, content, methods

Learning objectives and competencies to be acquired

The student is able to

- completely design a model-based, robust feedback control law, including modelling, parameter estimation, system analysis, controller design and controller implementation
- design a robust H-Infinity optimal controller.

Module content with weighting of different components

- LQR/LQG controller design (5W)
  - State space models and their properties, linearization, singular values, realisation theory, basic state feedback control
  - Observer design
  - LQR/LQG controller design with Loop Transfer Recovery (LTR), SISO and MIMO systems
- Introduction to system identification (4W)
  - Models, design of experiments, signal conditioning
  - Least-squares method, recursive methods
- Important aspects of controller implementation (2W)
  - Controller discretization, sampling time
  - Quantisation effects
- Robust control (3W)
  - H-Infinity controller design

Teaching and learning methods

Lectures, exercises, case studies

A self-evaluation exam is provided to check the skills necessary to follow the course

Literature

Assessment

Additional performance assessment during the semester

The module does not contain an additional performance assessment during the semester

Basic principle for exams

As a rule, all standard final exams are conducted in written form. For resit exams, lecturers will communicate the exam format (written/oral) together with the exam schedule.

Standard final exam for a module and written resit exam

Kind of exam

Written exam

Duration of exam

120 minutes

Permissible aids

Aids permitted as specified below:

Permissible electronic aids

No electronic aids permitted

Other permissible aids

Books, scripts, student’s documents

Exception: In case of an electronic Moodle exam, adjustments to the permissible aids may occur. Lecturers will announce the final permissible aids prior to the exam session.

Special case: Resit exam as oral exam

Kind of exam

Oral exam

Duration of exam

30 minutes

Permissible aids

No aids permitted

Description du module, disponible en: EN, FR

Réglage avancé

Informations générales

Nombre de crédits ECTS

3

Code du module

TSM_AdvContr

Valable pour l'année académique

2026-27

Dernière modification

2018-07-02

Coordinateur/coordinatrice du module

Beat Aeschlimann (ZHAW, aesc@zhaw.ch)

Explications concernant les langues d'enseignement par site :

- L'enseignement est dispensé dans la langue indiquée ci-dessous pour chaque site et chaque exécution du module.
- Les supports de cours sont disponibles dans les langues indiquées ci-dessous pour chaque site et chaque exécution du module. Lorsque plusieurs langues sont utilisées, la proportion de contenu disponible dans chaque langue est précisée (100 % = ensemble des supports de cours).
- Les examens (questions et réponses) sont entièrement rédigés dans la langue indiquée ci-dessous pour le site et l'exécution du module concernés. Ils se déroulent en présentiel.

	Lausanne			Lugano	Zurich		
Leçons		**X** F 100%			**X** E 100%		
Documentation		**X** F 0%	**X** E 100%		**X** E 100%		
Examen		**X** F 100%			**X** E 100%		

Catégorie de module

TSM approfondissement technico-scientifique

Recommandations de profil

Ce module est recommandé pour les profils suivants :

	Lausanne	Zurich
Profil	EIE	EIE

Leçons

2 leçons et 1 leçon de pratique par semaine

Compétences préalables

Connaissances préalables, compétences initiales

- Fonctions de transfert
- Synthèse d'un régulateur PID avec implémentation, méthodes anti-windup incluses
- Structures du systèmes réglés : commande apriori (feedforward), commande en cascade
- Analyse des boucles de réglage (stabilité, marges de phase/gain, performance dans les domaines temporel et fréquentiel)

- Modèles dans l'espace d'état
- Synthèse du réglage par «Loop shaping»
- Algèbre linéaire (décomposition en valeurs propres)
- L'étudiant doit avoir suivi au moins deux cours consécutifs de réglage au niveau Bachelor

Brève description du contenu et des objectifs

La synthèse d'un régulateur basée sur un modèle est une technologie clé pour maîtriser les systèmes dynamiques complexes. D'importantes innovations réalisées ces dernières années relèvent de cette technologie. Dans ce module, des éléments importants du processus de développement de tels systèmes seront traités, notamment l'identification de systèmes dynamiques, la synthèse et l'implémentation de régulateurs LQR/LQG. Une introduction a la synthèse H-infini des régulateurs robustes sera donné à la fin du module.

Objectifs, contenus, méthodes

Objectifs d'apprentissage, compétences à acquérir

L'étudiant est capable de…

- mettre au point un réglage complet basé sur un modèle, incluant la modélisation, l'estimation de paramètres, l'analyse du système, la synthèse et l'implémentation du régulateur;
- mettre au point un réglage robuste H-infini.

Contenu des modules avec pondération du contenu des cours

- Synthèse de régulateur LQR/LQG (5S)
  - modèles dans l'espace d'état et ses propriétés, linéarisation autour d'un point de fonctionnement, valeurs singulières, synthèse et réalisation de régulateurs par retour d'état.
  - Synthèse de l'observateu
  - Synthèse de régulateur LQR/LQG avec «Loop Transfer Recovery», (y compris régulateur avec action intégrale) pour systèmes mono- et multivariables (SISO, MIMO)
- Introduction à l'identification des systèmes dynamiques (4S)
  - types des modèles
  - méthode d'estimation par moindres carrés, méthodes récursives
  - conception de l'expérimentation, conditionnement du signal
- Aspects importants de l'implémentation de régulateurs (2S)
  - discrétisation du régulateur temps continu, choix de la période d'échantillonnage
  - effets de la quantification
- Réglage robuste: (3S)
  - H-infini-synthèse de régulateurs

Méthodes d'enseignement et d'apprentissage

Cours magistraux, exercices, études de cas

Un examen d'auto-évaluation est mis à disposition permettant de valider les prérequis nécessaires

Bibliographie

Evaluation

Évaluation supplémentaire pendant le semestre

Le module ne comprend pas d'évaluation supplémentaire pendant le semestre

Principe pour les examens

En règle générale, tous les examens réguliers de fin de module se déroulent sous forme écrite. Concernant les examens de répétition, leur format (écrit ou oral) sera communiqué par l'enseignant-e en même temps que le calendrier des examens.

Examen de fin de module régulier et examen écrit de répétition

Type de l'examen

Examen écrit

Durée de l'examen

120 minutes

Aides autorisées

Les aides suivantes sont autorisées:

Aides électroniques autorisées

Aucune aide électronique autorisée

Autres aides autorisées

Livres, polycopiés, documents personnels

Exception : En cas d'examen électronique sur Moodle, des modifications des aides autorisées peuvent survenir. Dans ce cas, les aides autorisées seront annoncées par les enseignant-e-s avant l'examen.

Cas spécial: examen de répétition oral

Type de l'examen

Examen oral

Durée de l'examen

30 minutes

Aides autorisées

Sans aides

Description du module, disponible en: FR

Advanced Databases

Informations générales

Nombre de crédits ECTS

3

Code du module

TSM_AdvDaBa

Valable pour l'année académique

2026-27

Dernière modification

2025-10-07

Coordinateur/coordinatrice du module

Marcelo Pasin (HES-SO, marcelo.pasin@he-arc.ch)

Explications concernant les langues d'enseignement par site :

- L'enseignement est dispensé dans la langue indiquée ci-dessous pour chaque site et chaque exécution du module.
- Les supports de cours sont disponibles dans les langues indiquées ci-dessous pour chaque site et chaque exécution du module. Lorsque plusieurs langues sont utilisées, la proportion de contenu disponible dans chaque langue est précisée (100 % = ensemble des supports de cours).
- Les examens (questions et réponses) sont entièrement rédigés dans la langue indiquée ci-dessous pour le site et l'exécution du module concernés. Ils se déroulent en présentiel.

	Lausanne			Lugano	Zurich		
Leçons		**X** F 100%					
Documentation		**X** F 10%	**X** E 90%				
Examen		**X** F 100%	**X** E 100%				

Catégorie de module

TSM approfondissement technico-scientifique

Recommandations de profil

Ce module est recommandé pour les profils suivants :

	Lausanne
Profil	CS

Leçons

2 leçons et 1 leçon de pratique par semaine

Compétences préalables

Connaissances préalables, compétences initiales

- Modèle relationnel, algèbre relationnelle et normalisation
- SQL : modélisation des données, langage de requête, transactions et droits d'accès
- Optimisation des requêtes, index de base de données
- Langages de programmation orientée objet

Brève description du contenu et des objectifs

Les applications modernes reposent sur des systèmes de données capables de traiter des volumes importants d'informations tout en garantissant la fiabilité, la cohérence et la performance. Ce cours propose une exploration approfondie des fondations des systèmes de données et des architectures distribuées.

L'objectif est de comprendre les principes fondamentaux qui sous-tendent les systèmes de données intensifs : fiabilité, passage à l'échelle, tolérance aux pannes, cohérence et consensus. Les étudiant-e-s apprendront à analyser les compromis entre cohérence, disponibilité et latence, et à concevoir des architectures adaptées aux besoins réels des applications distribuées.

Objectifs, contenus, méthodes

Objectifs d'apprentissage, compétences à acquérir

À la fin du module, les étudiant-e-s seront capables de :

- Expliquer les principes de **fiabilité**, **scalabilité** et **maintenabilité** des systèmes de données ;
- Comparer différents **modèles de données et langages de requête** (relationnel, document, graphe, clé-valeur) et comprendre leurs usages ;
- Décrire les **mécanismes internes de stockage et d'indexation** (B-trees, LSM-trees, colonnes, sérialisation, compatibilité ascendante) ;
- Comprendre les **modèles de réplication** (leader-follower, multi-leader, leaderless) et leurs effets sur la cohérence ;
- Mettre en œuvre des **stratégies de partitionnement (sharding)** et de répartition de charge ;
- Expliquer le fonctionnement et les limites des **transactions distribuées**, des protocoles de **verrouillage** et de **commit en deux phases** ;
- Identifier les **défaillances partielles** dans les systèmes distribués et leurs conséquences ;
- Analyser et comparer les **modèles de cohérence** (forte, causale, éventuelle) et les **protocoles de consensus** (Paxos, Raft) ;
- Évaluer les compromis entre **cohérence, disponibilité et tolérance aux pannes** (CAP theorem) ;
- Utiliser ces connaissances pour **concevoir, choisir et configurer** des systèmes de données adaptés à divers contextes.

Contenu des modules avec pondération du contenu des cours

Contenu du cours et pondération

Fondations des systèmes de données (40 %)

- Fiabilité, tolérance aux pannes, passage à l'échelle
- Modèles de données et langages de requête
- Stockage, indexation et sérialisation des données
- Compatibilité et évolution des schémas

Systèmes de données distribués (60 %)

- Réplication et partitionnement
- Transactions distribuées et isolation
- Défaillances partielles, détection et récupération
- Cohérence, consensus et compromis de conception

Méthodes d'enseignement et d'apprentissage

Ce cours se base sur des présentations théoriques et des exercices pratiques, des laboratoires ou des projets de groupe.

Bibliographie

Diapositives des cours, références à des ressources Internet et à des livres.

Martin Kleppmann, *Designing Data-Intensive Applications*, O'Reilly.

Evaluation

Évaluation supplémentaire pendant le semestre

Le module ne comprend pas d'évaluation supplémentaire pendant le semestre

Principe pour les examens

En règle générale, tous les examens réguliers de fin de module se déroulent sous forme écrite. Concernant les examens de répétition, leur format (écrit ou oral) sera communiqué par l'enseignant-e en même temps que le calendrier des examens.

Examen de fin de module régulier et examen écrit de répétition

Type de l'examen

Examen écrit

Durée de l'examen

120 minutes

Aides autorisées

Les aides suivantes sont autorisées:

Aides électroniques autorisées

Aucune aide électronique autorisée

Autres aides autorisées

Résumé écrit à la main, 2 pages A4 maximum.

Exception : En cas d'examen électronique sur Moodle, des modifications des aides autorisées peuvent survenir. Dans ce cas, les aides autorisées seront annoncées par les enseignant-e-s avant l'examen.

Cas spécial: examen de répétition oral

Type de l'examen

Examen oral

Durée de l'examen

30 minutes

Aides autorisées

Sans aides

Module Description, available in: EN

Advanced Data Management – Foundations of data-intensive systems

General Information

Number of ECTS Credits

3

Module code

TSM_AdvDataMgmt

Valid for academic year

2026-27

Last modification

2023-10-24

Coordinator of the module

Roberto Mastropietro (SUPSI, roberto.mastropietro@supsi.ch)

Explanations regarding the language definitions for each location:

- Instruction is given in the language specified for each location and module execution.
- Documentation is available in the language(s) listed for each location and module execution. If the documentation is in multiple languages, the percentage distributed is indicated (100% = all documentation provided).
- The examination, including both questions and answers, is provided entirely (100%) in the language(s) specified for each location and module execution. The exams are on-site.

	Lausanne			Lugano	Zurich		
Instruction				**X** E 100%			
Documentation				**X** E 100%			
Examination				**X** E 100%			

Module Category

TSM Technical scientific module

Profile Recommendations

This module is recommended for the following profiles:

	Lugano
Profile	CS

Lessons

2 lecture periods and 1 tutorial period per week

Entry level competences

Prerequisites, previous knowledge

- Database design
- Relational Model
- Normalization
- SQL
- Object relational database systems

- Object-oriented programming languages

Brief course description of module objectives and content

The course covers the following core topics:

- Distributed and parallel database systems architectures, internals and services such as transaction processing, concurrency control and query processing
- No-SQL Systems
- Data processing architectures

Aims, content, methods

Learning objectives and competencies to be acquired

Students understand how to use database technologies to process and manage large data collections.

- They know databases alternatives beyond Relational and Object Relational systems and are able to decide which database system is appropriate depending on the context, and depending on the kind of data available
- They can design and implement Systems based on different architectures
- They understand the functioning of internal components of a database system
- They can reuse the material acquired in this course in their own working environment and apply them to solve their specific problems
- They know the current research directions of these domains.

Module content with weighting of different components

The Internet, new types of data and applications and new business requirements have driven the development of data management systems having data models and architectures beyond the traditional relational and object-relational systems and centralised architectures.

The module is organised around the following core subject areas:

- Parallel query processing (20%)
- Replication and partitioning (40%)
- Consistency (25%)
- DLT and Blockchain (15%)

Contents:

- Introduction, data intensive architectures, relational vs document-based systems
- Data processing architectures, parallel queries on a single node
- Serializability
- Storage and retrieval, row-oriented vs column-oriented storage
- Partitioning
- Consistent hashing
- Replication
- Distributed consensus (2PC, 3PC, Paxos, Raft)
- Zookeeper (CAP, ZAB, Leader election)
- Batch processing: Distributed storage: block vs object storage
- Stream processing
- Blockchain

Teaching and learning methods

- Lectures with integrated exercises
- Self study of literature
- case studies

Literature

Lecture slides, references to internet resources and books

Assessment

Additional performance assessment during the semester

The module does not contain an additional performance assessment during the semester

Basic principle for exams

As a rule, all standard final exams are conducted in written form. For resit exams, lecturers will communicate the exam format (written/oral)

together with the exam schedule.

Standard final exam for a module and written resit exam

Kind of exam

Written exam

Duration of exam

120 minutes

Permissible aids

No aids permitted

Exception: In case of an electronic Moodle exam, adjustments to the permissible aids may occur. Lecturers will announce the final permissible aids prior to the exam session.

Special case: Resit exam as oral exam

Kind of exam

Oral exam

Duration of exam

30 minutes

Permissible aids

No aids permitted

Module Description, available in: EN

Advanced Topics in Deep Learning

General Information

Number of ECTS Credits

3

Module code

TSM_AdvDeLearn

Valid for academic year

2026-27

Last modification

2023-09-18

Coordinator of the module

Thomas Koller (HSLU, thomas.koller@hslu.ch)

Explanations regarding the language definitions for each location:

- Instruction is given in the language specified for each location and module execution.
- Documentation is available in the language(s) listed for each location and module execution. If the documentation is in multiple languages, the percentage distributed is indicated (100% = all documentation provided).
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	Lausanne			Lugano	Zurich		
Instruction					**X** E 100%		
Documentation					**X** E 100%		
Examination					**X** E 100%		

Module Category

TSM Technical scientific module

Profile Recommendations

This module is recommended for the following profiles:

	Zurich
Profile	DS

Lessons

2 lecture periods and 1 tutorial period per week

Entry level competences

Prerequisites, previous knowledge

Machine Learning Basics, Deep Learning, Programming (Python), Statistics, Linear Algebra

Brief course description of module objectives and content

The purpose of this module is to enhance students' understanding of deep learning techniques.

We will explore significant and current developments in deep learning, including generative models, attention networks, transformers, graph neural networks and other related techniques.

Furthermore, we will examine case studies that pertain to language, speech, or visual processing domains.

Aims, content, methods

Learning objectives and competencies to be acquired

Learning objectives:

- Know the Attention and Transformer architectures and how to use them in different applications.
- Know which architectures are suitable for which kind of machine learning problem
- Know how to apply self-supervised learning and the advantages and disadvantages of this method
- To know and apply the different methods of generative algorithms.
- Know how to interpret and explain results of predictions.

Module content with weighting of different components

- Refresher of basic deep learning methods such as MLP, CNN, RNN, Architectures, Backpropagation etc.
- Attention and transformers: concepts and applications in language and vision domains
- Self-supervised learning: contrastive and non-contrastive methods
- Graph Neural Networks and applications
- Generative models: VAEs, GANs, Diffusion models, Energy models, etc.
- Foundation models, few and zero-shot learning
- Interpretability, Explainability
- Special topics of the year, such as NNs for physical systems, 3D reconstruction, theoretical approaches and other

Teaching and learning methods

- Lectures / presence
- Tutorial / presence
- Exercises / presence
- Self-study

Literature

Assessment

Additional performance assessment during the semester

The module does not contain an additional performance assessment during the semester

Basic principle for exams

As a rule, all standard final exams are conducted in written form. For resit exams, lecturers will communicate the exam format (written/oral) together with the exam schedule.

Standard final exam for a module and written resit exam

Kind of exam

Written exam

Duration of exam

120 minutes

Permissible aids

Aids permitted as specified below:

Permissible electronic aids

Calculator

Other permissible aids

Notes on Paper (10 pages A4, both sides written on)

Exception: In case of an electronic Moodle exam, adjustments to the permissible aids may occur. Lecturers will announce the final permissible aids prior to the exam session.

Special case: Resit exam as oral exam

Kind of exam

Oral exam

Duration of exam

30 minutes

Permissible aids

No aids permitted

Module Description, available in: EN

Advanced Electronic Design

General Information

Number of ECTS Credits

3

Module code

TSM_AdvElDes

Valid for academic year

2026-27

Last modification

2021-05-12

Coordinator of the module

Hanspeter Schmid (FHNW, hanspeter.schmid@fhnw.ch)

Explanations regarding the language definitions for each location:

- Instruction is given in the language specified for each location and module execution.
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	Lausanne			Lugano	Zurich		
Instruction					**X** E 100%		
Documentation					**X** E 100%		
Examination					**X** E 100%		

Module Category

TSM Technical scientific module

Profile Recommendations

This module is recommended for the following profiles:

	Zurich
Profile	EIE

Lessons

2 lecture periods and 1 tutorial period per week

Entry level competences

Prerequisites, previous knowledge

The student must have knowledge and experience in the following areas:

- Circuit analysis, Laplace transfer functions, Bode diagrams
- Active and passive electronic components, operational amplifiers
- AD and DA conversion principle
- Digital circuits

Brief course description of module objectives and content

This Advanced Electronic Design module gives to the students the key elements for the development of high performance electronic systems. These systems are characterized by:

- the presence of sensitive analogue circuits and signals
- the presence of complex and high-speed digital ICs (Integrated Circuits)

Aims, content, methods

Learning objectives and competencies to be acquired

- The student is able to design a high-performance electronic system composed of sensitive analogue, mixed signal and high speed digital circuits.
- The student is able to implement high-speed and high-resolution signal processing chains based on A/D and D/A converters, analogue functions blocks, and complex digital ICs.

Module content with weighting of different components

Course	Title	Weeks	Emphasis
1	High-speed digital electronic design: High-speed digital fundamentals, signal coding/decoding, medium attachment, clock management, power analysis	5	1/3
2	Advanced analogue electronic design: • Advanced operational amplifier applications: low level and sensor signal conditioning, electronic noise, high-speed and low-power amplifiers, frequency response analysis • ADC and DAC applications; signal routing	9	2/3

Teaching and learning methods

- Lectures
- Exercises

Literature

Recommended: Sergio Franco, *Design with Operational Amplifiers and Analog Integrated Circuits*, 4th ed., McGraw-Hill 2016.

Assessment

Additional performance assessment during the semester

The module does not contain an additional performance assessment during the semester

Basic principle for exams

As a rule, all standard final exams are conducted in written form. For resit exams, lecturers will communicate the exam format (written/oral) together with the exam schedule.

Standard final exam for a module and written resit exam

Kind of exam

Written exam

Duration of exam

120 minutes

Permissible aids

Aids permitted as specified below:

Permissible electronic aids

Open book: All course material either on paper or on computer; pocket calculator; tools on computer.

Computer and phones must be offline (WiFi, Bluetooth, ..., switched off)

Other permissible aids

No other aids permitted

Exception: In case of an electronic Moodle exam, adjustments to the permissible aids may occur. Lecturers will announce the final permissible aids prior to the exam session.

Special case: Resit exam as oral exam

Kind of exam

Oral exam

Duration of exam

30 minutes

Permissible aids

No aids permitted

Description du module, disponible en: FR

Informatique embarquée avancée

Informations générales

Nombre de crédits ECTS

3

Code du module

TSM_AdvEmbSof

Valable pour l'année académique

2026-27

Dernière modification

2025-10-14

Coordinateur/coordinatrice du module

Serge Ayer (HES-SO, serge.ayer@hefr.ch)

Explications concernant les langues d'enseignement par site :

- L'enseignement est dispensé dans la langue indiquée ci-dessous pour chaque site et chaque exécution du module.
- Les supports de cours sont disponibles dans les langues indiquées ci-dessous pour chaque site et chaque exécution du module. Lorsque plusieurs langues sont utilisées, la proportion de contenu disponible dans chaque langue est précisée (100 % = ensemble des supports de cours).
- Les examens (questions et réponses) sont entièrement rédigés dans la langue indiquée ci-dessous pour le site et l'exécution du module concernés. Ils se déroulent en présentiel.

	Lausanne			Lugano	Zurich		
Leçons		**X** F 100%					
Documentation		**X** F 100%	**X** E 100%				
Examen		**X** F 100%					

Catégorie de module

TSM approfondissement technico-scientifique

Recommandations de profil

Ce module est recommandé pour les profils suivants :

	Lausanne
Profil	CS

Leçons

2 leçons et 1 leçon de pratique par semaine

Compétences préalables

Connaissances préalables, compétences initiales

- Connaissance du langage de programmation C et d'un langage orienté objet.
- Bonne connaissance de l'architecture des ordinateurs et des microprocesseurs.
- Compréhension des concepts de base des systèmes d'exploitation (ordonnancement, processus/thread).
- Connaissances de base en programmation concurrente

Brève description du contenu et des objectifs

Un système embarqué est un système informatique spécialisé avec du matériel embarqué. Il existe une grande variété de systèmes embarqués, mais en général, ces systèmes sont des systèmes capables de détecter les entrées physiques de leur environnement, d'effectuer certains calculs et de communiquer les résultats. Habituellement, les systèmes embarqués sont conçus pour exécuter des tâches répétitives, périodiquement ou spontanément, pour un faible coût, une faible consommation et des performances optimales.

Dans ce module, nous étudions comment les systèmes embarqués basés sur des microcontrôleurs peuvent être développés, en mettant l'accent sur les points suivants :

- Fournir une approche logicielle flexible avec un système multi-tâches permettant une exploitation efficace des capacités matérielles du système.
- Fournir une extensibilité du système.
- Faciliter la détection des erreurs et les capacités de débogage et de tests.
- Fournir une portabilité avec l'utilisation d'un système d'exploitation embarqué et permettre au programmeur d'abstraire les détails matériels de chaque plate-forme.

Objectifs, contenus, méthodes

Objectifs d'apprentissage, compétences à acquérir

Les étudiant-e-s apprendront les caractéristiques les plus importantes d'un système d'exploitation temps réel (Zephyr RTOS) moderne en mettant en œuvre leur propre scénario sur une plateforme de développement IoT offrant un large éventail de capacités de détection, de traitement et de communication. En partant d'une implémentation basique de type super boucle, les étudiants découvriront rapidement les limites de cette réalisation. Ces limites seront étudiées et des solutions améliorées utilisant l'ordonnancement, le threading et la synchronisation seront mises en place par les étudiants pour le développement d'un logiciel robuste, portable et facilement maintenable. En outre, les étudiant-e-s devront également

- Mettre en œuvre des outils et méthodes pour un contrôle de qualité continu.
- Mettre en œuvre des méthodes d'analyse de l'utilisation du CPU et de la mémoire du système.
- Développer des méthodes pour les tests automatisés, y compris des tests unitaires et des tests d'intégration, dans une perspective CI/CD pour les systèmes embarqués.

A la fin du module, les étudiant-e-s seront capables de :

- Développer une application multi-tâches sur un système embarqué basé sur un microcontrôleur, en utilisant un RTOS.
- Utiliser les capacités de débogage et construire l'environnement de test pour une application embarquée.
- Comprendre l'organisation et l'utilisation de la mémoire de leur application.
- Développer un cadre pour la mise à jour des applications embarquées, y compris une application de bootloader.

Contenu des modules avec pondération du contenu des cours

Introduction aux systèmes et logiciels embarqués

- Applications et attributs des systèmes embarqués
- Options pour la construction de systèmes embarqués
- Systèmes embarqués basés sur des microcontrôleurs
- Systèmes embarqués et systèmes d'exploitation (OS)
- Introduction à un système d'exploitation (RTOS) moderne

Tests

- Niveaux de test
- Test unitaire et d'intégration à l'aide du RTOS
- CI/CD pour les systèmes embarqués

Qualité du software

- Importance, outils et méthodes pour un contrôle continu de la qualité.
- Directives de programmation au travers d'exercices.
- Mise en œuvre à l'aide de différents outils.

Ordonnancement pour les systèmes embarqués

- Modèles de programmation des systèmes embarqués
- Aperçu des algorithmes d'ordonnancement
- Ordonnancement cyclique statique, piloté par événements et préemptif, avec comparaisons.

Tâches et concurrence

- Conception de logiciels embarqués en tâches multiples
- RTOS : multitâches, threads, ordonnancement et mécanismes de synchronisation
- Inversion de priorité et protocoles d'accès aux ressources

Mémoire des systèmes embarqués

- Principes de gestion de la mémoire
- Structure de l'image du programme Cortex-M
- Modèle de mémoire du système d'exploitation
- Unité de protection de la mémoire des processeurs Cortex-M

Bootloader
- Déploiement des mises à jour dans les systèmes embarqués
- Principes du bootloader
- Exigences et modèles de mémoire pour le développement d'une application bootloader
- Réalisation d'un bootloader à l'aide du RTOS

Méthodes d'enseignement et d'apprentissage

Ce module utilise des notes de cours et des exercices pratiques qui sont donnés sous la forme de codelabs. Les étudiant-e-s doivent développer leur propre logiciel sur la base d'une spécification, avec l'aide des notes de cours et du matériel des codelabs, et ils doivent rendre le logiciel développé dans le cadre d'un projet en deux phases.

Bibliographie

Les références sont données dans les notes de cours et dans codelabs

Evaluation

Évaluation supplémentaire pendant le semestre

Le module comprend une ou des évaluation(s) supplémentaire(s) pendant le semestre. La note obtenue pour la ou les évaluation(s) supplémentaire(s) est valable à la fois pour l'examen final et pour l'examen de répétition.

Description de l'évaluation supplémentaire pendant le semestre

Au cours du semestre, les étudiants travaillent par groupes sur un projet. Le projet est organisé en trois étapes, qui sont évaluées séparément. La note finale du projet représente 30 % de la note finale du module.

Principe pour les examens

En règle générale, tous les examens réguliers de fin de module se déroulent sous forme écrite. Concernant les examens de répétition, leur format (écrit ou oral) sera communiqué par l'enseignant-e en même temps que le calendrier des examens.

Examen de fin de module régulier et examen écrit de répétition

Type de l'examen

Examen écrit

Durée de l'examen

120 minutes

Aides autorisées

Les aides suivantes sont autorisées:

Aides électroniques autorisées

Pas d'aide numérique

Autres aides autorisées

Deux pages A4 recto-verso de notes personnelles

Exception : En cas d'examen électronique sur Moodle, des modifications des aides autorisées peuvent survenir. Dans ce cas, les aides autorisées seront annoncées par les enseignant-e-s avant l'examen.

Cas spécial: examen de répétition oral

Type de l'examen

Examen oral

Durée de l'examen

30 minutes

Aides autorisées

Les aides suivantes sont autorisées:

Aides électroniques autorisées

Aucune aide électronique autorisée

Autres aides

Deux pages A4 recto-verso de notes personnelles

Module Description, available in: EN

Advanced structural mechanics

General Information

Number of ECTS Credits

3

Module code

TSM_AdvMech

Valid for academic year

2026-27

Last modification

2025-11-04

Coordinator of the module

Thomas Mayer (ZHAW, thomas.mayer@zhaw.ch)

Explanations regarding the language definitions for each location:

- Instruction is given in the language specified for each location and module execution.
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	Lausanne			Lugano	Zurich		
Instruction	**X** E 100%				**X** E 100%		
Documentation	**X** E 100%				**X** E 100%		
Examination	**X** E 100%				**X** E 100%		

Module Category

TSM Technical scientific module

Profile Recommendations

This module is recommended for the following profiles:

	Lausanne	Zurich
Profile	ME	ME

Lessons

2 lecture periods and 1 tutorial period per week

Entry level competences

Prerequisites, previous knowledge

Basic engineering knowledge of structural mechanics, analysis and linear algebra as well as FE element simulation at Bachelor level of Mechanical Engineering studies.
A brief summary of relevant engineering mechanics concepts will be provided prior to the lecture as a self-study revision course.

Brief course description of module objectives and content

This course provides a comprehensible introduction to basic concepts of continuum mechanics, material modelling and failure assessment for metals and polymers.

The students learn the fundamentals of tensor algebra and gain comprehensible insight into the governing mechanical and thermo-mechanical concepts of continuum mechanics. On this basis, an overview is given of state of the art material models for metals and polymers to empower students to competently select advanced material models as implemented in modern Finite Element tools. Finally, the lecture provides a clear insight into the microstructural foundations of failure in metals as well as an overview of mechanical assessment methods as applied in engineering practice. The course is accompanied by regular exercises and hands-on workshops in which advanced material models and assessment methods are applied to practical problems.

Aims, content, methods

Learning objectives and competencies to be acquired

- **Basic tensor algebra and calculus**
  - Vector and tensor algebra
  - Tensor properties and decompositions
- **Continuum mechanics**
  - Kinematics (deformation measures)
  - Kinetics (stress measures)
  - Equilibrium equations
  - Balance laws
- **Material behaviour & models for metals**
  - Basic modelling principles
  - Elasticity and anisotropy
  - Plasticity
- **Material behaviour & models for polymers**
  - Hyperelasticity
  - Plasticity (influence of hydrostatic pressure)
  - Damage & fracture of adhesives

Module content with weighting of different components

- Students are familiar with basic tensor algebra to understand fundamental continuum mechanical concepts.
- Students are familiar with the building blocks of continuum mechanics such as kinematics and kinetics concepts as well as equilibrium equations and balance laws as governing equations of mechanical problems.
- Students have a broad understanding of the basic material behaviour of metals and polymers including elasticity, hyperelasticity, plasticity, visco-elasticity, visco-plasticity and creep / relaxation as well as isotropy, orthotropy and anisotropy.
- Students are able to appropriately select and deploy linear and non-linear material models in Finite Element simulations.
- Students know the basic failure mechanisms for metals and polymers; they are able to select appropriate mechanical assessment methods and perform basic assessments.

Teaching and learning methods

Frontal Teaching (ca. 60%), exercises and 2 workshops incl. Finite Element application (ca. 40%)

Literature

Script

Further literature (sorted by comprehensiveness and level of difficulty):

- Gross D. et al. (2018) Technische Mechanik 4 – Hydromechanik, Elemente der Höheren Mechanik, Numerische Methoden, 10. Auflage. Springer Vieweg. (https://doi.org/10.1007/978-3-662-55694-8)
- Altenbach H. (2018) Kontinuumsmechanik – Einführung in die materialunabhängigen und materialabhängigen Gleichungen, 4. Auflage. Springer Vieweg. (https://doi.org/10.1007/978-3-662-57504-8)
- Lemaitre J. & Chaboche J.-L. (2000) Mechanics of Solid Materials. Cambridge University Press. (https://doi.org/10.1017/CBO9781139167970)
- Bergström J (2015) Mechanics of Solid Polymers, Theory and Computational Modeling. William Andrew Publishing. (https://doi.org/10.1016/C2013-0-15493-1)
- Ottoson N. & Ristinmaa M. (2005) The Mechanics of Constitutive Modeling, 1st Edition. Elsevier Science. (https://doi.org/10.1016/B978-0-08-044606-6.X5000-0)

Assessment

Additional performance assessment during the semester

The module does not contain an additional performance assessment during the semester

Basic principle for exams

As a rule, all standard final exams are conducted in written form. For resit exams, lecturers will communicate the exam format (written/oral) together with the exam schedule.

Standard final exam for a module and written resit exam

Kind of exam

Written exam

Duration of exam

120 minutes

Permissible aids

Aids permitted as specified below:

Permissible electronic aids

Pocket calculator

Other permissible aids

Open book

Exception: In case of an electronic Moodle exam, adjustments to the permissible aids may occur. Lecturers will announce the final permissible aids prior to the exam session.

Special case: Resit exam as oral exam

Kind of exam

Oral exam

Duration of exam

30 minutes

Permissible aids

Aids permitted as specified below:

Permissible electronic aids

Pocket calculator

Other permissible aids

Open book

Module Description, available in: EN, FR

Advanced Natural Language Processing

General Information

Number of ECTS Credits

3

Module code

TSM_AdvNLP

Valid for academic year

2026-27

Last modification

2024-09-24

Coordinator of the module

Andrei Popescu-Belis (HES-SO, andrei.popescu-belis@heig-vd.ch)

Explanations regarding the language definitions for each location:

- Instruction is given in the language specified for each location and module execution.
- Documentation is available in the language(s) listed for each location and module execution. If the documentation is in multiple languages, the percentage distributed is indicated (100% = all documentation provided).
- The examination, including both questions and answers, is provided entirely (100%) in the language(s) specified for each location and module execution. The exams are on-site.

	Lausanne			Lugano	Zurich		
Instruction		**X** F 100%			**X** E 100%		
Documentation			**X** E 100%		**X** E 100%		
Examination			**X** E 100%		**X** E 100%		

Module Category

TSM Technical scientific module

Profile Recommendations

This module is recommended for the following profiles:

	Lausanne	Zurich
Profile	DS	DS

Lessons

2 lecture periods and 1 tutorial period per week

Entry level competences

Prerequisites, previous knowledge

- Mathematics: basic linear algebra, probability theory (e.g. Bayes theorem), descriptive statistics and hypothesis testing.
- Machine learning and deep learning (e.g., classifiers, neural networks), basic notions of natural language processing and information retrieval (e.g., preprocessing and manipulating text data, tokenization, tagging, TF-IDF, query-based text retrieval).
- Programming for data science: good command of Python, ability to handle the entire data science pipeline (data acquisition and analysis, design and training of ML models, evaluation and interpretation of results).

Brief course description of module objectives and content

This module enables students to understand the main theoretical concepts that are relevant to text and speech processing, and to design applications which, one the one hand, find, classify or extract information from text or speech, and on the other hand, generate text or speech to summarize or translate language data, or in response to user instructions. The module briefly reviews fundamentals of natural language processing from a data science perspective, with emphasis on methods that support recent approaches based on deep learning models. The module emphasizes the origins and rationale of foundation models, which can be fine-tuned, instructed, or given adequate prompts to achieve a wide range of tasks, thus paving the way towards generative artificial intelligence. The module also provides practical knowledge regarding multi-task models for spoken or written input, multilingual models, and interactive systems, as well as practical skills through hands-on exercises using open-source libraries and models, focusing on the rapid prototyping of solutions for a range of typical problems.

The module is divided into four parts. The first part reviews the main concepts of language analysis and then focuses on the representation of words and the uses of bags-of-words, from the vector space model to non-contextual word embeddings with neural networks; applications include document retrieval and text similarity. In the second part, deep learning models for sequences of words are discussed in depth, preceded by a review of statistical sequence models, with application, e.g., to part-of-speech tagging and named entity recognition. The module presents a paradigm based on foundation models with Transformers – encoders, decoders, or both – which can be fine-tuned to various tasks or used for zero-shot learning. The third part surveys neural models for speech processing and synthesis, along with typical tasks, data and evaluation methods. Finally, the module presents methods that enable natural interaction with generative AI systems, including instruction tuning and reinforcement learning from human feedback, along with spoken and written chatbots, concluding with a discussions of the limitations and risks of such systems.

Aims, content, methods

Learning objectives and competencies to be acquired

- The students are able to frame a problem in the domain of text and speech processing and generation. They can relate a new problem to a range of known problems and adapt solutions to their needs.
- The students are able to specify the characteristics of the data and features needed to train and test models, along with the suitable evaluation metrics. Given a language processing problem, they are able to design comparative experiments to identify the most promising solution.
- The students are able to select, among statistical and neural models, the most effective ones for a given task in language or speech processing and generation. Moreover, they know how to select, between existing libraries and pretrained models, the most suitable ones for a given task. The students are aware of the capabilities of foundation models, and know how to adapt them to specific task, through additional layers, fine-tuning, or prompt engineering.

Module content with weighting of different components

Part I: Words [ca. 20%]

1. Brief review of basic notions of natural language processing: properties of language, speech, and text; subword tokenization, including BPE and SentencePiece; main processing stages, tasks, evaluation metrics, and applications.

2. Text classification and sentiment analysis based on statistical learning with a bag-of-words representation; evaluation metrics for these tasks.

3. Word vectors and their uses: (a) high-dimensional vectors, the VSM model, and application to document retrieval; (b) low-dimensional vectors, non-contextual word embeddings, LSA, word2vec, FastText, and applications to text similarity.

Part II: Word Sequences [ca. 35%]

4. Statistical modeling of word sequences for word-level, span-level and sentence-level tasks; application to part-of-speech (POS) tagging, named entity recognition (NER), and parsing; evaluation methods for these tasks.

5. Language modeling, from n-grams to neural networks; sequence-to-sequence models using deep neural networks, RNNs, Transformers; application to machine translation and text summarization; evaluation methods for these tasks.

6. Foundation models: encoders, decoders, and encoder-decoder models; pre-training tasks; adaptation of models to other tasks using additional layers; fine-tuning pre-trained models; few-shot learning in large language models.

Part III : Speech [ca. 20%]

7. Representation and processing of speech with neural networks; statistical models vs. neural architectures based on RNNs and Transformers; CTC architecture; survey of existing frameworks and pretrained models; notions of speech synthesis.

8. Speech processing tasks, benchmark data and evaluation methods; topic detection, information extraction, and speech translation; multilingual systems.

Part IV: Interaction [ca. 25%]

9. Large language models: survey and emerging capabilities; instruction tuning and reinforcement learning from human feedback (RLHF); prompt engineering.

10. Applications of generative AI; benchmarks with multiple tasks for evaluating foundation models and LLMs; limitations and risks, alignment with human preferences.

11. Spoken and written human-computer interaction: chatbots and dialogue systems.

Teaching and learning methods

Classroom teaching; programming exercises.

Literature

Speech and Language Processing, Daniel Jurafsky and James H. Martin, 2nd edition, Prentice-Hall, 2008 / 3rd edition draft, online, 2023.

Introduction to Information Retrieval, Christopher Manning, Prabhakar Raghavan and Hinrich Schütze, 2008.

Neural Network Methods for Natural Language Processing, Yoav Goldberg, Morgan & Claypool, 2017.

Supplemental material (articles) will be indicated for each lesson.

Assessment

Additional performance assessment during the semester

The module contains additional performance assessment(s) during the semester. The achieved mark of the additional performance assessment(s) applies to both the regular and the resit exam.

Description of additional performance assessment during the semester

The grades of homeworks will contribute towards 20% of the final grade.

Basic principle for exams

As a rule, all standard final exams are conducted in written form. For resit exams, lecturers will communicate the exam format (written/oral) together with the exam schedule.

Standard final exam for a module and written resit exam

Kind of exam

Written exam

Duration of exam

120 minutes

Permissible aids

Aids permitted as specified below:

Permissible electronic aids

Non-programmable pocket calculator.

Other permissible aids

Two A4 sheets (front and back) of personal notes (4 pages).

Exception: In case of an electronic Moodle exam, adjustments to the permissible aids may occur. Lecturers will announce the final permissible aids prior to the exam session.

Special case: Resit exam as oral exam

Kind of exam

Oral exam

Duration of exam

30 minutes

Permissible aids

No aids permitted

Description du module, disponible en: EN, FR

Traitement automatique des langues avancé

Informations générales

Nombre de crédits ECTS

3

Code du module

TSM_AdvNLP

Valable pour l'année académique

2026-27

Dernière modification

2024-09-24

Coordinateur/coordinatrice du module

Andrei Popescu-Belis (HES-SO, andrei.popescu-belis@heig-vd.ch)

Explications concernant les langues d'enseignement par site :

- L'enseignement est dispensé dans la langue indiquée ci-dessous pour chaque site et chaque exécution du module.
- Les supports de cours sont disponibles dans les langues indiquées ci-dessous pour chaque site et chaque exécution du module. Lorsque plusieurs langues sont utilisées, la proportion de contenu disponible dans chaque langue est précisée (100 % = ensemble des supports de cours).
- Les examens (questions et réponses) sont entièrement rédigés dans la langue indiquée ci-dessous pour le site et l'exécution du module concernés. Ils se déroulent en présentiel.

	Lausanne			Lugano	Zurich		
Leçons		**X** F 100%			**X** E 100%		
Documentation			**X** E 100%		**X** E 100%		
Examen			**X** E 100%		**X** E 100%		

Catégorie de module

TSM approfondissement technico-scientifique

Recommandations de profil

Ce module est recommandé pour les profils suivants :

	Lausanne	Zurich
Profil	DS	DS

Leçons

2 leçons et 1 leçon de pratique par semaine

Compétences préalables

Connaissances préalables, compétences initiales

- Mathématiques : algèbre linéaire de base, théorie des probabilités (par exemple, théorème de Bayes), statistiques descriptives et tests d'hypothèses.
- Apprentissage automatique et *deep learning* (p. ex., classifieurs, réseaux de neurones), notions de base de traitement du langage naturel et de

recherche d'information (p. ex., prétraitement et manipulation de données textuelles, tokenisation, balisage, TF-IDF, recherche documentaire).

- Programmation pour la science des données : bonne maîtrise de Python, capacité à gérer l'ensemble du pipeline de traitement des données (acquisition et analyse des données, conception et entraînement de modèles ML, évaluation et interprétation des résultats).

Brève description du contenu et des objectifs

Ce module présente les principaux concepts théoriques relatifs au traitement automatique du langage (TAL) écrit et parlé. Ceux-ci permettent par la suite de concevoir des applications qui, d'une part, trouvent, classent ou extraient des informations à partir de textes écrits ou oraux, et d'autre part, génèrent du texte ou de la parole, par exemple pour résumer des textes ou répondre à des instructions des utilisatrices. Le module récapitule les principes fondamentaux du TAL dans la perspective de la science des données, en mettant l'accent sur les méthodes provenant du *deep learning*. Le module s'intéresse aux modèles de langage fondamentaux, qui peuvent être affinés ou instruits pour réaliser de nombreuses tâches, relevant ainsi de l'intelligence artificielle générative. Le module présente également des modèles multitâches pour les textes écrits ou parlés, des modèles multilingues et des systèmes interactifs. Le module offre des compétences pratiques par le biais d'exercices utilisant des bibliothèques et des modèles *open source*, en se concentrant sur le prototypage rapide de solutions à des problèmes typiques.

Le module est divisé en quatre parties. La première partie passe en revue les principaux concepts du TAL puis s'intéresse à la représentation des mots, des modèles vectoriels aux plongements (*embeddings*) non contextuels utilisant les réseaux de neurones, avec application à la recherche de documents et à la similarité de textes. Dans la deuxième partie, les modèles de *deep learning* pour les séquences de mots sont discutés en détail, précédés d'un examen des modèles statistiques de séquences ; les applications concernent par exemple l'étiquetage morpho-syntaxique et la reconnaissance d'entités nommées. L'approche basée sur les Transformers – encodeurs, décodeurs, ou les deux – est également présentée, y compris leur adaptation et le cas non supervisé. La troisième partie aborde les modèles neuronaux pour l'analyse et la synthèse de la parole, avec des tâches, données et métriques typiques. Enfin, le module montre comment atteindre une interaction naturelle avec les systèmes d'IA générative, via des *chatbots* oraux ou écrits, y compris par apprentissage par renforcement à partir de *feed-back* humain, et se termine par une discussion sur les limites et les risques de tels systèmes.

Objectifs, contenus, méthodes

Objectifs d'apprentissage, compétences à acquérir

- Les étudiant·es sont capables de formuler un problème dans le domaine de l'analyse et de la génération du langage écrit ou oral, et peuvent relier un nouveau problème à des cas connus et adapter des solutions à leurs besoins.
- Les étudiant·es sont en mesure de spécifier les caractéristiques des données nécessaires à l'entraînement et au test des modèles, ainsi que les mesures d'évaluation appropriées. À partir d'un problème de TAL, les étudiant·es peuvent concevoir des évaluations comparatives afin d'identifier la meilleure solution.
- Les étudiant·es savent comment sélectionner, parmi des modèles statistiques et neuronaux, les plus efficaces pour une tâche de TAL donnée. De même, entre les bibliothèques et les modèles pré-entraînés, les étudiant·es savent comment sélectionner ceux qui conviennent le mieux à une tâche donnée.
- Les étudiant·es sont conscient·es des capacités des modèles fondamentaux et peuvent les adapter à une tâche spécifique, par le biais de couches supplémentaires, du *fine-tuning*, ou de la conception de nouveaux *prompts*.

Contenu des modules avec pondération du contenu des cours

Partie I : Mots [ca. 20%]

1. Rappels des notions de base du TAL : propriétés du langage écrit ou parlé ; tokenisation en sous-mots avec BPE et SentencePiece ; principales étapes de traitement ; tâches, mesures d'évaluation et applications typiques.

2. Classification de textes et analyse des sentiments basées sur l'apprentissage statistique avec une représentation de type sac-de-mots ; mesures d'évaluation pour ces tâches.

3. Les vecteurs de mots et leur utilisation : (a) vecteurs en grande dimension, le modèle VSM et l'application à la recherche de documents ; (b) vecteurs en faible dimension, plongements de mots non contextuels, LSA, word2vec, FastText et applications à la similarité de textes.

Partie II : Séquences de mots [ca. 35 %]

4. Modélisation statistique de séquences de mots pour des traitements au niveau des mots ou des phrases ; application à l'étiquetage morpho-syntaxique, à la reconnaissance d'entités nommées et à l'analyse syntaxique ; méthodes d'évaluation pour ces tâches.

5. Modèles de langage, des n-grammes aux réseaux de neurones ; modèles de séquence utilisant des réseaux de neurones profonds (RNN et Transformers) ; application à la traduction automatique et au résumé de textes ; méthodes d'évaluation pour ces tâches.

6. Modèles fondamentaux : encodeurs, décodeurs et leur combinaison ; tâches d'entraînement ; adaptation à d'autres tâches à l'aide de couches supplémentaires ; *fine-tuning* de modèles pré-entraînés ; apprentissage basé sur des exemples.

Partie III : Langage parlé [ca. 20%]

7. Représentation et traitement de la parole avec des réseaux de neurones ; modèles statistiques vs. architectures neuronales basées sur les RNN et les Transformers ; l'architecture CTC ; aperçu des boîtes à outils et des modèles pré-entraînés ; notions sur la synthèse vocale.

8. Tâches de traitement automatique de la parole, données et méthodes pour l'évaluation ; détection de thèmes, extraction d'information et traduction vocale ; systèmes multilingues.

Partie IV : Interaction [ca. 25 %]

9. Grands modèles de langage : présentation de leurs capacités émergentes ; *instruction tuning* et apprentissage par renforcement (RLHF) ; conception de *prompts* ; limites et risques pour la société.

Méthodes d'enseignement et d'apprentissage

Enseignement magistral, exercices utilisant la programmation.

Bibliographie

Speech and Language Processing, Daniel Jurafsky and James H. Martin, 2e édition, Prentice-Hall, 2008 / 3e édition en ligne, 2023.

Introduction to Information Retrieval, Christopher Manning, Prabhakar Raghavan and Hinrich Schütze, 2008.

Neural Network Methods for Natural Language Processing, Yoav Goldberg, Morgan & Claypool, 2017.

Le matériel supplémentaire (articles) sera indiqué pour chaque cours.

Evaluation

Évaluation supplémentaire pendant le semestre

Le module comprend une ou des évaluation(s) supplémentaire(s) pendant le semestre. La note obtenue pour la ou les évaluation(s) supplémentaire(s) est valable à la fois pour l'examen final et pour l'examen de répétition.

Description de l'évaluation supplémentaire pendant le semestre

Les notes des devoirs à la maison contribueront pour 20% à la note finale.

Principe pour les examens

En règle générale, tous les examens réguliers de fin de module se déroulent sous forme écrite. Concernant les examens de répétition, leur format (écrit ou oral) sera communiqué par l'enseignant-e en même temps que le calendrier des examens.

Examen de fin de module régulier et examen écrit de répétition

Type de l'examen

Examen écrit

Durée de l'examen

120 minutes

Aides autorisées

Les aides suivantes sont autorisées:

Aides électroniques autorisées

Calculatrice de poche non-programmable.

Autres aides autorisées

Notes personnelles sur deux feuilles A4 recto-verso (4 pages).

Exception : En cas d'examen électronique sur Moodle, des modifications des aides autorisées peuvent survenir. Dans ce cas, les aides autorisées seront annoncées par les enseignant-e-s avant l'examen.

Cas spécial: examen de répétition oral

Type de l'examen

Examen oral

Durée de l'examen

30 minutes

Aides autorisées

Sans aides

Module Description, available in: EN

Advanced Network Security

General Information

Number of ECTS Credits

3

Module code

TSM_AdvNetSec

Valid for academic year

2026-27

Last modification

2023-07-03

Coordinator of the module

Gürkan Gür (ZHAW, gueu@zhaw.ch)

Explanations regarding the language definitions for each location:

- Instruction is given in the language specified for each location and module execution.
- Documentation is available in the language(s) listed for each location and module execution. If the documentation is in multiple languages, the percentage distributed is indicated (100% = all documentation provided).
- The examination, including both questions and answers, is provided entirely (100%) in the language(s) specified for each location and module execution. The exams are on-site.

	Lausanne			Lugano	Zurich		
Instruction					**X** E 100%		
Documentation					**X** E 100%		
Examination					**X** E 100%		

Module Category

TSM Technical scientific module

Profile Recommendations

This module is recommended for the following profiles:

	Zurich
Profile	ICS

Lessons

2 lecture periods and 1 tutorial period per week

Entry level competences

Prerequisites, previous knowledge

- Understanding of the TCP/IP protocol stack including routing protocols and DNS.
- Basic understanding of secure protocols such as WPA, IPSec and TLS.
- Basic understanding of network security appliances such as firewalls and proxies.

Brief course description of module objectives and content

This course aims to provide students with an in-depth understanding of current network security technologies and their application in solving technical security challenges. Upon completion of the course, students will be able to analyze, design and implement secure network infrastructures, using state-of-the-art security technologies and best practices. They will also develop an understanding of emerging network security techniques and solutions.

Aims, content, methods

Learning objectives and competencies to be acquired

The students

- are able to identify threats for a given network and are able to reason about the security properties of their networks.
- know important concepts of network security in the areas of DDoS protection, BGP security, DNS security, IPv6 security and HTTP/3.
- know the relevant key concepts to build secure network architectures and can develop a secure network architecture for different scenarios.
- are able to undertake an investigation into the course topics and report on their findings.

Module content with weighting of different components

This course is split into three parts:

Part 1: Network Threats and Monitoring
In Part 1 we talk about network threats and mitigation techniques as well as network monitoring. We cover topics such as common network attacks (e.g., Distributed Denial of Service(DDoS) attacks) as well as the challenges and solutions for monitoring network traffic (e.g., analysis of encrypted traffic flows).

Part 2: Network Protocols and Security
In Part 2 we focus on network protocols and security. This includes but is not limited to Border Gateway Protocol (BGP) security, Domain Name System (DNS) security, IPv6 security and HTTP/3.

Part 3: Securing Advanced Network Architectures
Part 3 covers several advanced approaches to securing network architectures from a forward-looking perspective. This includes but is not limited to topics such as Software Defined Networking (SDN), Network Function Virtualization (NFV), Zero Trust Architecture (ZTA), Machine Learning (ML) for network security, network security in containerized environments, and cloud network security.

As network security is a very dynamic and constantly evolving field, the course content will be adapted to current trends and emerging topics in network security.

Teaching and learning methods

Lectures with a mix of practical and theoretical exercises.

Literature

The following material is provided:

- Slides (with notes, where appropriate)
- Selected technical publications
- Exercise material

Assessment

Additional performance assessment during the semester

The module does not contain an additional performance assessment during the semester

Basic principle for exams

As a rule, all standard final exams are conducted in written form. For resit exams, lecturers will communicate the exam format (written/oral) together with the exam schedule.

Standard final exam for a module and written resit exam

Kind of exam

Written exam

Duration of exam

120 minutes

Permissible aids

Aids permitted as specified below:

Permissible electronic aids

-

Other permissible aids

Cheat sheet

Exception: In case of an electronic Moodle exam, adjustments to the permissible aids may occur. Lecturers will announce the final permissible aids prior to the exam session.

Special case: Resit exam as oral exam

Kind of exam

Oral exam

Duration of exam

30 minutes

Permissible aids

Aids permitted as specified below:

Permissible electronic aids

-

Other permissible aids

Cheat sheet

Module Description, available in: EN

Advanced Programming Paradigms

General Information

Number of ECTS Credits

3

Module code

TSM_AdvPrPa

Valid for academic year

2026-27

Last modification

2024-10-08

Coordinator of the module

Daniel Kröni (FHNW, daniel.kroeni@fhnw.ch)

Explanations regarding the language definitions for each location:

- Instruction is given in the language specified for each location and module execution.
- Documentation is available in the language(s) listed for each location and module execution. If the documentation is in multiple languages, the percentage distributed is indicated (100% = all documentation provided).
- The examination, including both questions and answers, is provided entirely (100%) in the language(s) specified for each location and module execution. The exams are on-site.

	Lausanne			Lugano	Zurich		
Instruction					**X** E 100%		
Documentation					**X** E 100%		
Examination					**X** E 100%		

Module Category

TSM Technical scientific module

Profile Recommendations

This module is recommended for the following profiles:

	Zurich
Profile	CS

Lessons

2 lecture periods and 1 tutorial period per week

Entry level competences

Prerequisites, previous knowledge

All participants should be able to program in the functional and object-oriented styles to the degree that can be expected after attending an introductory-level undergraduate course on these topics.

Participants without prior experience in functional programming are required to work through the chapters 1 through 8 in the book "Programming in Haskell" (second edition) by Graham Hutton before starting the course.

Brief course description of module objectives and content

Although widespread, the currently mainstream imperative, object-oriented programming paradigm, with testing as its main method of quality assurance, has its limitations. Even though it allows novices to write programs relatively quickly and without much formal training, such programs tend to become complicated as soon as they need to do something non-trivial. This makes them increasingly hard to write and reason about, making assurance methods that give better guarantees than software testing intractable. Similarly, even though it is possible to write software tests relatively quickly and without much formal training, such tests are only able to show the presence of faults, but never their absence.

Few are aware that there exist a number of alternatives to imperative, object-oriented programming and testing. This course will start with a broad overview of these alternatives, and then focus on one of them, functional programming, and the use of formal methods to specify and prove the correctness of functional programs.

Functional programming is an approach to programming where simplicity, clarity, and elegance are the key goals. It is the application of formal mathematical and programming-language-based techniques for the construction and verification of computer programs. Although it has a long history, it has recently received attention due to its potential for writing elegant, correct and efficient programs that are easier to write, compose, and maintain, once one is familiar with its underlying concepts. Its simplicity also allows reasoning about the correctness of functional programs using techniques taught in high-school mathematics. These techniques can not only be used to state and prove functional correctness of smaller programs on paper, but also large systems using automated proof assistants. Such automated proof assistants (e.g. Agda, Isabelle/HOL, Idris, Lean and Coq) are themselves applications and further developments of functional programming.

In the final segment of the course, we broaden our focus to explore sophisticated type systems in imperative, object-oriented and functional programming languages. These advanced type systems serve as effective tools for program verification, and have proven effective for identifying and eliminating critical bugs.

Aims, content, methods

Learning objectives and competencies to be acquired

All participants are able to explain and apply formal programming-language-based techniques for the construction and verification of computer programs. Special emphasis will be made on techniques that surpass some of the limitations of mainstream programming in the imperative object-oriented programming style, and on alternatives to mainstream testing-based software assurance methods.

All participants should be able to:

- enumerate and explain a number of different programming paradigms.
- construct programs in the functional style.
- verify the correctness of functional programs using formal proof.
- apply advanced type systems to make imperative, object-oriented and functional programs more secure.

Module content with weighting of different components

The following is a rough overview of the content of the course and is subject to change:

- Overview (1 week)
  - A broad overview of different programming paradigms.
- Functional Programming (4 weeks)
  - Fast paced revision of functional programming prerequisites and Haskell.
  - Types for correctness, Input/Output in a pure language.
  - Functional design patterns: Functor, Applicative and Monad with parsing as an example application.
  - Application: Interpreters for a small imperative and functional programming language.
- Proving Programs Correct (5 weeks)
  - Equational reasoning
  - Structural induction
  - Automated theorem proving
  - Dependent types
- Advanced Type Systems (4 weeks)
  - Subtyping with generic types (co- and contravariance)
  - Subtyping lattices
  - Ownership typing
  - Effect systems

Teaching and learning methods

Interactive lectures explaining main concepts, interspersed with programming exercises and reading assignments.

Literature

You are required to have a copy of the following book during the course:

- Graham Hutton, Programming in Haskell, Second Edition, Cambridge, 2016.

Further material will be provided during the course as required.

Assessment

Additional performance assessment during the semester

The module does not contain an additional performance assessment during the semester

Basic principle for exams

As a rule, all standard final exams are conducted in written form. For resit exams, lecturers will communicate the exam format (written/oral) together with the exam schedule.

Standard final exam for a module and written resit exam

Kind of exam

Written exam

Duration of exam

120 minutes

Permissible aids

Aids permitted as specified below:

Permissible electronic aids

None

Other permissible aids

A summary on at most 2 pages DIN A4 (= 1 sheet DIN A4, written by hand or electronically and printed out). This summary will be collected together with the exam.

Exception: In case of an electronic Moodle exam, adjustments to the permissible aids may occur. Lecturers will announce the final permissible aids prior to the exam session.

Special case: Resit exam as oral exam

Kind of exam

Oral exam

Duration of exam

30 minutes

Permissible aids

No aids permitted

Module Description, available in: EN

Advanced robotics

General Information

Number of ECTS Credits

3

Module code

TSM_AdvRobot

Valid for academic year

2026-27

Last modification

2024-10-17

Coordinator of the module

Gabriel Gruener (BFH, gabriel.gruener@bfh.ch)

Explanations regarding the language definitions for each location:

- Instruction is given in the language specified for each location and module execution.
- Documentation is available in the language(s) listed for each location and module execution. If the documentation is in multiple languages, the percentage distributed is indicated (100% = all documentation provided).
- The examination, including both questions and answers, is provided entirely (100%) in the language(s) specified for each location and module execution. The exams are on-site.

	Lausanne			Lugano	Zurich		
Instruction					**X** E 100%		
Documentation					**X** E 100%		
Examination					**X** E 100%		

Module Category

TSM Technical scientific module

Profile Recommendations

This module is recommended for the following profiles:

	Zurich
Profile	MA

Lessons

2 lecture periods and 1 tutorial period per week

Entry level competences

Prerequisites, previous knowledge

- Linear algebra and differential equations
- Feedback control systems
- Actuation and sensory systems
- Basic programming skills
- Basic robotics knowhow (recommended)

Brief course description of module objectives and content

In this module, basic and advanced robotics knowhow is developed necessary for leading-edge, innovative industrial and service applications with robot manipulators.

Aims, content, methods

Learning objectives and competencies to be acquired

At the end of this course, the student will have earned the knowledge necessary to build a complete robot system as well as acquired the skills to develop industrial and service applications based on commercial robots beyond their standard interfaces.

Module content with weighting of different components

- **Robot Kinematics**
  - Homogeneous transformation matrices and quaternions
  - Forward, inverse and instantaneous kinematics of serial and parallel robots
  - Kinematic redundancies and subspaces
  - Trajectory generation
- **Robot Dynamics**
  - Motion state: speed, acceleration and jerk
  - Dynamic models of multibody systems
  - Robot dynamic equations for simulation and control
- **Robot Control**
  - Linear and nonlinear control
  - Trajectory, force and hybrid control
  - Adaptive, model-based, vision-based control
  - Haptic control
- **Robot Design**
  - Task requirements and kinematic configuration
  - Joint types, actuators, sensors, communication busses and architectures
  - Control systems and real-time restrictions
- **Applications**
  - Industrial and service use cases
  - Collaborative and interactive robots
  - Research topics
  - Safety and ethics in robotics

Teaching and learning methods

- Ex-cathedra teaching
- Case studies
- Exercises
- The theory learned in class is applied in real robotic applications

Literature

- B. Siciliano, O. Khatib eds., “Springer Handbook of Robotics”, Springer-Verlag, Berlin, 2016.
- J. J. Craig, “Introduction to Robotics: Mechanics and Control”, 3rd edition, Pearson Prentice Hall, USA, 2005.
- P. Corke, “Robotics, Vision and Control - Fundamental Algorithms in Python”, Springer-Verlag, Berlin, 2023.

Assessment

Additional performance assessment during the semester

The module does not contain an additional performance assessment during the semester

Basic principle for exams

As a rule, all standard final exams are conducted in written form. For resit exams, lecturers will communicate the exam format (written/oral) together with the exam schedule.

Standard final exam for a module and written resit exam

Kind of exam

Written exam

Duration of exam

120 minutes

Permissible aids

Aids permitted as specified below:

Permissible electronic aids

All electronic aids permitted except AI and communication tools.

Other permissible aids

Open book

Exception: In case of an electronic Moodle exam, adjustments to the permissible aids may occur. Lecturers will announce the final permissible aids prior to the exam session.

Special case: Resit exam as oral exam

Kind of exam

Oral exam

Duration of exam

30 minutes

Permissible aids

Aids permitted as specified below:

Permissible electronic aids

All electronic aids permitted except AI and communication tools.

Other permissible aids

Open book

Module Description, available in: EN

Advanced Statistical Data Analysis

General Information

Number of ECTS Credits

3

Module code

TSM_AdvStDaAn

Valid for academic year

2026-27

Last modification

2023-09-22

Coordinator of the module

Anna Drewek (ZHAW, drew@zhaw.ch)

Explanations regarding the language definitions for each location:

- Instruction is given in the language specified for each location and module execution.
- Documentation is available in the language(s) listed for each location and module execution. If the documentation is in multiple languages, the percentage distributed is indicated (100% = all documentation provided).
- The examination, including both questions and answers, is provided entirely (100%) in the language(s) specified for each location and module execution. The exams are on-site.

	Lausanne			Lugano	Zurich		
Instruction					**X** E 100%		
Documentation					**X** E 100%		
Examination					**X** E 100%		

Module Category

TSM Technical scientific module

Profile Recommendations

This module is recommended for the following profiles:

	Zurich
Profile	DS

Lessons

2 lecture periods and 1 tutorial period per week

Entry level competences

Prerequisites, previous knowledge

- Basic calculus and linear algebra
- Basic knowledge in probability, statistical inference and regression analysis on the level of Devore, Farnum and Doi, “Applied Statistics for Engineers and Scientists”, 2014 Cengage Learning.
- User knowledge of R, MATLAB, Python or any other statistical software.

Brief course description of module objectives and content

One of the most used (statistical) models for inferential data analysis is the linear regression model. But it is restricted to a Gaussian distributed response and a linear function for linking the linear combination of predictors with the expected response. Generalized Linear and Additive Models (GLM, GAM) allow us to relax some of these restrictions by specifying a more general set of response distributions and non-linear link functions. Hence we can analyse a wider variety of real world phenomenon such as counts, binary outcomes proportions and amounts (i.e. non-negative real-valued data). The aim of this modelling approach is to better understand the response outcome induced by the predictors based on the available data, allowing for better and more informed interpretation of the phenomenon. The first part of this course will provide an overview over the GLM/GAM approach and will detail many benefits and a few pitfalls.

The second part of this course introduces to the basic concepts of causality. Many statistical and machine learning methods (including the statistical models learned in the first part of this module) are about association rather than causation. We will have a closer look at how causal effects are mathematically defined and what assumptions about data and model are necessary for drawing causal conclusions (e.g. interventions, instrumental variables, counterfactuals). In a first step, we start with the definition of causality and introducing graphical models. This enables us in a second step to estimate causal effects and interfere on causal relationships. In particular, the course introduces to structural equation models.

Aims, content, methods

Learning objectives and competencies to be acquired

- The students are able to analyse data by Generalized Linear and Additive Models (GLM and GAM) and understand the benefits that these model approaches offer for the analysis of normally and non-normally distributed response variables.
- The students understand when causal reasoning is important and what regression and machine learning are actually doing. They understand the importance of the data generating process. They can determine causal effects from observational data using graphical models.
- The students acquire a comprehensive overview how the open source statistical environment R is used and are able to perform a data analysis applying the techniques introduced in the course on real data sets.

Module content with weighting of different components

First Part (8 weeks):

- Review of the concepts of multiple linear regression analysis with respect to inference, prediction, model evaluation and model building. Introducing some advanced topics in linear regression modelling. (3 weeks)

- Extending the linear regression model to generalized linear and additive models including logistic, Poisson, and Gamma regression. Revise inference, evaluation and variable selection for such models. (5 weeks)

Second Part (6 weeks):

- Pitfalls of drawing conclusions from observational data; Simpson's paradox and its implications. Causation versus association, When is causal reasoning important? What is regression and machine learning actually doing?
- Introducing the concept of instrumental variables and interventions, determining causal effects from observational data using the most recent approaches such as causal graphical models or structural equation models, Estimating total and direct causal effects.

Both parts:

- The contents listed are illustrated with used cases from the industrial and scientific fields. The practical work is done with the open source statistical analysis environment R.

Teaching and learning methods

Classroom teaching and practical work on computer with the statistical analysis environment R/RStudio.

Literature

Slides and lecture notes will be available in addition to recommended book chapters.

Assessment

Additional performance assessment during the semester

The module does not contain an additional performance assessment during the semester

Basic principle for exams

As a rule, all standard final exams are conducted in written form. For resit exams, lecturers will communicate the exam format (written/oral) together with the exam schedule.

Standard final exam for a module and written resit exam

Kind of exam

Written exam

Duration of exam

120 minutes

Permissible aids

Aids permitted as specified below:

Permissible electronic aids

- Scientific pocket calculator
- R-Studio and Statistical software R on examination laptop

Other permissible aids

- open book

Exception: In case of an electronic Moodle exam, adjustments to the permissible aids may occur. Lecturers will announce the final permissible aids prior to the exam session.

Special case: Resit exam as oral exam

Kind of exam

Oral exam

Duration of exam

30 minutes

Permissible aids

No aids permitted

Module Description, available in: EN, FR

Advanced Thermodynamics

General Information

Number of ECTS Credits

3

Module code

TSM_AdvTherm

Valid for academic year

2026-27

Last modification

2025-10-17

Coordinator of the module

Timothy Griffin (FHNW, timothy.griffin@fhnw.ch)

Explanations regarding the language definitions for each location:

- Instruction is given in the language specified for each location and module execution.
- Documentation is available in the language(s) listed for each location and module execution. If the documentation is in multiple languages, the percentage distributed is indicated (100% = all documentation provided).
- The examination, including both questions and answers, is provided entirely (100%) in the language(s) specified for each location and module execution. The exams are on-site.

	Lausanne			Lugano	Zurich		
Instruction		**X** F 100%			**X** E 100%		
Documentation		**X** F 100%	**X** E 100%		**X** E 100%		
Examination		**X** F 100%	**X** E 100%		**X** E 100%		

Module Category

TSM Technical scientific module

Profile Recommendations

This module is recommended for the following profiles:

	Lausanne	Zurich
Profile	EnEn	EnEn

Lessons

2 lecture periods and 1 tutorial period per week

Entry level competences

Prerequisites, previous knowledge

Successful completion of a bachelor degree course on basic engineering thermodynamics

Brief course description of module objectives and content

In Part A, the module reviews the basics of engineering thermodynamics (the properties of pure and real fluids, the fundamental equations of energy, entropy, and mass balances, and important thermodynamic cycles) and expands on this knowledge to address real fluids in mixtures, phase and chemical equilibria, system stability, and processes with chemical transformation.

Then, in Part B, students learn to establish connections between detailed thermodynamic formulas and complete thermodynamic systems. The fundamental tools of thermodynamics will be used to model complex thermodynamic systems. Selected examples will illustrate the utility of applying thermodynamics in various practical fields.

Aims, content, methods

Learning objectives and competencies to be acquired

Part A:
The achievement of the main goals in Part A is associated with the following competencies:

- Ability to set up and solve energy and entropy balances for open and closed thermodynamic systems.
- Ability to determine the properties of non-ideal gases and gas mixtures using corresponding states and/or a cubic equation of state.
- Understanding the Gibbs free energy and chemical potential and to be able to calculate conditions for thermal, phase and chemical equilibrium.

Part B:

- Deepen understanding of certain areas of Part A, by applying the knowledge acquired in terms of system analysis.
- Understand examples showing how advanced thermodynamics is applied in practice to the modeling of complex thermomechanical processes (e.g., the organic Rankine cycle) and reactive processes (e.g., chemical stability of metal oxides, or electrochemical applications, such as in fuel cells).
- Students can analyze and interpret the differences of basic cycles with mixtures as compared to performance with pure fluids

Module content with weighting of different components

Part A:

Part A begins with a review of basic principles, conservation equations for mass, energy and entropy and their application. Important thermodynamic cycles are analyzed and the Gibbs Free Energy is introduced. The interrelations between thermodynamic variables are shown and used as the basis for calculating deviations from ideal gas behavior using a cubic equation of state or the corresponding states theory. The concept of fugacity is defined and employed to solve phase equilibrium. The necessity for partial molar properties to describe real mixtures is shown and the chemical potential of components in fluid mixtures is introduced. Conditions for phase and chemical equilibrium are derived and employed in mixtures under ideal and real conditions. Finally, the thermodynamic fundamentals of processes with chemical reactîons are also covered: energy and material balances in chemical reactors, adiabatic flame temperatures, chemical equilibrium states.

Weekly problem sets dealing with the topics are distributed and solutions discussed with the class.

Part B:

Part B begins with a review and consolidation of selected topics from Part A, putting the knowledge acquired into practice with, on the one hand, applications of non-reactive binary fluid mixtures (e.g. in refrigeration/heat pumps or power generation processes) and, on the other hand, applications of reactive fluid mixtures in thermochemical systems (e.g. the Ellington diagram for metallurgical systems, processes in power to gas applications).

The fundamentals of processes with chemical reactions are summarized and extended to electrochemical applications and the energetic efficiency of fuel cells. A potentially additional and last topic will be absorption heat pumps.

Teaching and learning methods

Lectures with discussion, interactive derivations, supported by PPT slides, weekly problem sets with solutions. In Part A some exercises will be solved using Excel spreadsheets. (Other tools are demonstrated and provided (e.g. Matlab-based), but not necessary for course completion.)

Literature

Sandler, S.I..(1940). Chemical and Engineering Thermodynamics, 2017, ISBN 978-1-119-32128-6, Wiley.

Assessment

Additional performance assessment during the semester

The module does not contain an additional performance assessment during the semester

Basic principle for exams

As a rule, all standard final exams are conducted in written form. For resit exams, lecturers will communicate the exam format (written/oral) together with the exam schedule.

Standard final exam for a module and written resit exam

Kind of exam

Written exam

Duration of exam

120 minutes

Permissible aids

Aids permitted as specified below:

Permissible electronic aids

No electronic aids permitted

Other permissible aids

Notes and printed course presentations, course textbooks

Exception: In case of an electronic Moodle exam, adjustments to the permissible aids may occur. Lecturers will announce the final permissible aids prior to the exam session.

Special case: Resit exam as oral exam

Kind of exam

Oral exam

Duration of exam

30 minutes

Permissible aids

No aids permitted

Description du module, disponible en: EN, FR

Thermodynamique avancée

Informations générales

Nombre de crédits ECTS

3

Code du module

TSM_AdvTherm

Valable pour l'année académique

2026-27

Dernière modification

2025-10-17

Coordinateur/coordinatrice du module

Timothy Griffin (FHNW, timothy.griffin@fhnw.ch)

Explications concernant les langues d'enseignement par site :

- L'enseignement est dispensé dans la langue indiquée ci-dessous pour chaque site et chaque exécution du module.
- Les supports de cours sont disponibles dans les langues indiquées ci-dessous pour chaque site et chaque exécution du module. Lorsque plusieurs langues sont utilisées, la proportion de contenu disponible dans chaque langue est précisée (100 % = ensemble des supports de cours).
- Les examens (questions et réponses) sont entièrement rédigés dans la langue indiquée ci-dessous pour le site et l'exécution du module concernés. Ils se déroulent en présentiel.

	Lausanne			Lugano	Zurich		
Leçons		**X** F 100%			**X** E 100%		
Documentation		**X** F 100%	**X** E 100%		**X** E 100%		
Examen		**X** F 100%	**X** E 100%		**X** E 100%		

Catégorie de module

TSM approfondissement technico-scientifique

Recommandations de profil

Ce module est recommandé pour les profils suivants :

	Lausanne	Zurich
Profil	EnEn	EnEn

Leçons

2 leçons et 1 leçon de pratique par semaine

Compétences préalables

Connaissances préalables, compétences initiales

Avoir suivi avec succès le cours de niveau Bachelor en Thermodynamique de base

Brève description du contenu et des objectifs

Dans la partie A, le module revient sur les bases de l'ingénierie thermodynamique (les bilans d'énergie, d'entropie et de masse, les propriétés des fluides et les principaux cycles thermodynamiques) et élargit les connaissances pour aborder les fluides réels, l'équilibres entre phases et l'équilibres chimiques, la stabilité des systèmes, et les processus de transformation chimique.

Ensuite, au cours de la partie B, les étudiants apprennent à établir des connexions entre des formules thermodynamiques détaillées et des systèmes thermodynamiques complets. Les outils fondamentaux de thermodynamique seront utilisés pour modéliser tout système thermodynamique complexe. Des exemples choisis viendront illustrer l'utilité de la thermodynamique dans différents domaines d'application pratiques.

Objectifs, contenus, méthodes

Objectifs d'apprentissage, compétences à acquérir

Partie A:
La réalisation des principaux objectifs de la partie A est liée à l'acquisition des compétences suivantes :

- Être capable d'établir et de résoudre des bilans énergétiques et entropiques pour des systèmes thermodynamiques ouverts et fermés.
- Être en mesure de déterminer les propriétés des gaz et des mélanges gazeux non idéaux en utilisant la théorie des états correspondants et/ou une équation d'état cubique.
- Comprendre l'énergie libre de Gibbs et être capable de calculer les conditions d'équilibre thermique, entre phases et chimique.

Partie B:

- Approfondir la compréhension de certains domaines de la partie A en appliquant les connaissances acquises en termes de modélisation de systèmes.
- Comprendre les exemples montrant comment la thermodynamique avancée s'applique dans la pratique à la modélisation de processus thermomécaniques complexes (p. ex. machines trithermes à cycles avancés) et des processus réactifs (p. ex. installations de piles à combustible).

Contenu des modules avec pondération du contenu des cours

Partie A:
La partie A commence par une révision des principes fondamentaux, les équations de conservation de masse, d'énergie et d'entropie ainsi que leur application. Les principaux cycles thermodynamiques sont analysés et on introduit l'énergie libre de Gibbs. Les corrélations entre les variables thermodynamiques sont présentées et utilisées comme bases pour calculer les déviations d'un gaz par rapport au comportement idéal, à l'aide d'une équation cubique d'état. La nécessité d'utiliser des grandeurs molaires partielles pour décrire des mélanges réels est présentée et le potentiel chimique est introduit. Les conditions d'équilibre entre phases et d'équilibre chimique sont dérivées et ensuite utilisées dans des systèmes simples.

Des problèmes en lien avec les sujets abordés sont distribués chaque semaine aux étudiants et les solutions sont discutées en cours.

Partie B:
La partie B commence par une révision et une consolidation de thèmes choisis de la partie A passant par une mise en pratique des connaissances acquises avec d'une part les applications de mélange de fluides binaires non-réactifs dans les installations à processus thermomécaniques de chauffage, réfrigération et de production d'électricité et d'autre part les applications de mélange de fluides réactifs dans les systèmes thermochimiques de combustion et de piles à combustible.
L'introduction est une revue des systèmes thermomécaniques avancés à fluides binaires (p. ex : Le cycle de pompe à chaleur de Lorenz, les cycles à mélange de fluides organiques de Rankine), Ainsi:

- Les étudiants peuvent analyser et interpréter les différences par rapport aux cycles de base à fluides purs ;
- Les étudiants peuvent connecter des formules détaillées vues dans la partie A à une vue d'ensemble des systèmes à grande échelle.

Au fur et à mesure de la progression dans la partie B, les étudiants peuvent utiliser les diagrammes avancés pour résoudre des problèmes complexes en thermodynamiques:

- Le diagramme d'Ellingham, son rapport avec le contenu d'apprentissage et son vaste champ d'application au sein de la métallurgie;
- Les diagrammes de Oldham et de Merkel et ses applications dans les installations de machines à absorption, de transformateurs de chaleur et de machines à cycle de Kalina pour les installations géothermiques de production d'électricité.

En fin, les fondements thermodynamiques de l'ingénierie de la réaction chimique sont également abordés:

- Transferts thermiques et de masse dans les réacteurs tubulaires, températures de réaction et d'inflammation
- L'analyse des processus réactifs de base et plus avancés (p. ex.: Les processus de combustion pour les applications de moteurs à Gaz ou Diesel, les processus d'oxydo-réduction pour les applications de piles à combustible

Méthodes d'enseignement et d'apprentissage

Cours avec discussion, dérivations interactives au tableau, à l'appui de diapositives PPT, présentations de problèmes chaque semaine avec solutions. Au cours de la partie A, certains exercices seront résolus en utilisant des feuilles Excel.

Bibliographie

Sandler, S.I..(1940). Chemical and Engineering Thermodynamics, Thermodynamique chimique et ingénierie thermodynamique, 1989, ISBN 978-0-471-66174-0

Lucien Borel & Daniel Favrat,PPUR.(2005). Thermodynamique et Energétique, Tome 1 : De l'énergie à l'exergie, 2005, ISBN 2-88074-545-4

Evaluation

Évaluation supplémentaire pendant le semestre

Le module ne comprend pas d'évaluation supplémentaire pendant le semestre

Principe pour les examens

En règle générale, tous les examens réguliers de fin de module se déroulent sous forme écrite. Concernant les examens de répétition, leur format (écrit ou oral) sera communiqué par l'enseignant-e en même temps que le calendrier des examens.

Examen de fin de module régulier et examen écrit de répétition

Type de l'examen

Examen écrit

Durée de l'examen

120 minutes

Aides autorisées

Les aides suivantes sont autorisées:

Aides électroniques autorisées

Aucune aide électronique autorisée

Autres aides autorisées

Notes et présentations de cours imprimées, manuels de cours

Exception : En cas d'examen électronique sur Moodle, des modifications des aides autorisées peuvent survenir. Dans ce cas, les aides autorisées seront annoncées par les enseignant-e-s avant l'examen.

Cas spécial: examen de répétition oral

Type de l'examen

Examen oral

Durée de l'examen

30 minutes

Aides autorisées

Sans aides

Module Description, available in: EN

Analysis of Sequential Data

General Information

Number of ECTS Credits

3

Module code

TSM_AnSeqDa

Valid for academic year

2026-27

Last modification

2023-11-12

Coordinator of the module

Stéphan Robert (HES-SO, stephan.robert-nicoud@heig-vd.ch)

Explanations regarding the language definitions for each location:

- Instruction is given in the language specified for each location and module execution.
- Documentation is available in the language(s) listed for each location and module execution. If the documentation is in multiple languages, the percentage distributed is indicated (100% = all documentation provided).
- The examination, including both questions and answers, is provided entirely (100%) in the language(s) specified for each location and module execution. The exams are on-site.

	Lausanne			Lugano	Zurich		
Instruction	**X** E 100%						
Documentation	**X** E 100%						
Examination	**X** E 100%						

Module Category

TSM Technical scientific module

Profile Recommendations

This module is recommended for the following profiles:

	Lausanne
Profile	DS

Lessons

2 lecture periods and 1 tutorial period per week

Entry level competences

Prerequisites, previous knowledge

- Basic knowledge in statistics.
- Programming with scripting languages.

Brief course description of module objectives and content

- This course provides a comprehensive introduction to time series analysis, covering both classical statistical methods and modern machine learning approaches. Starting with foundational concepts in probability and stationarity, students learn to model temporal dependencies through autocorrelation structures and classical models (MA, AR, ARMA, ARIMA, SARIMA). The curriculum progresses to practical forecasting techniques including smoothing and regression methods, volatility modeling for financial applications (ARCH/GARCH), and frequency-domain analysis through spectral methods. Advanced topics include Kalman filtering for recursive state estimation and deep learning architectures for time series. The course emphasizes both theoretical understanding and practical applications across domains such as finance, economics, and signal processing.
- The labs are done using Python

Aims, content, methods

Learning objectives and competencies to be acquired

Theoretical Understanding:
- Understand fundamental concepts of time series analysis including stationarity, autocorrelation, and temporal dependence structures
- Master classical time series models (MA, AR, ARMA, ARIMA, SARIMA) and their mathematical foundations
- Comprehend volatility modeling frameworks (ARCH/GARCH) and their applications in financial contexts
- Grasp frequency-domain analysis through spectral methods and Fourier transforms
- Understand state-space models and recursive filtering through Kalman filtering theory

Practical Skills:
- Identify and characterize temporal patterns in real-world data using autocorrelation and partial autocorrelation functions
- Select, estimate, and validate appropriate time series models for different data characteristics
- Apply smoothing techniques and build forecasting models using both classical and regression-based approaches
- Implement volatility models for financial risk assessment and market analysis
- Utilize spectral analysis tools to detect periodic components and frequency patterns
- Apply Kalman filtering for prediction and correction in dynamic systems
- Leverage deep learning architectures for complex time series prediction tasks

Applied Competencies:
- Conduct end-to-end time series analysis projects from data exploration to model deployment
- Critically evaluate model performance and select appropriate methods based on data properties and objectives
- Interpret and communicate analysis results to technical and non-technical audiences
- Apply learned techniques across various domains including finance, economics, engineering, and data science

Module content with weighting of different components

- Getting Started: overview of time series data, objectives of analysis, and course organization.
- Basic Statistics and Probability (review): random variables, expectations, correlations, stationarity.
- Correlations and MA Processes: autocorrelation, partial autocorrelation, and moving average models.
- AR, ARMA, ARIMA, SARIMA Processes: autoregressive structures, seasonal extensions, model selection.
- Smoothing, Prediction, and Regression: moving averages, exponential smoothing, linear and nonlinear regression approaches.
- Volatility Models: ARCH, GARCH, and extensions; applications in financial time series.
- Spectral Analysis: Fourier methods, frequency-domain approaches, and applications.
- Kalman Filtering: Recursive structure: prediction and correction, interpretation.
- Deep Learning for Time Series and selected topics.

Teaching and learning methods

- Lectures (pdfs)
- Problem Sets & Solutions
- Labs (Jupyter Notebooks)
- Project (Python)

Literature

Slides will be available covering the topics of the course.

In addition, recommended books are:
- R.H.Shumway and D.S. Stoffer, Time Series Analysis and Its Applications, Springer 2017
- François Chollet, Deep Learning with Python, 3rd edition, Manning Publications Co., 2025 (https://www.manning.com/books/deep-learning-with-python)
- R. Hyndman and G. Athanasopoulos., Forecasting: Principles and Practice, Springer, 2018 (online free textbook at https://otexts.com/fpppy/, 2025 version)

Assessment

Additional performance assessment during the semester

The module contains additional performance assessment(s) during the semester. The achieved mark of the additional performance assessment(s) applies to both the regular and the resit exam.

Description of additional performance assessment during the semester

The students will be required to do a small project which will determine 20% of the final grade.

Basic principle for exams

As a rule, all standard final exams are conducted in written form. For resit exams, lecturers will communicate the exam format (written/oral) together with the exam schedule.

Standard final exam for a module and written resit exam

Kind of exam

Written exam

Duration of exam

120 minutes

Permissible aids

Aids permitted as specified below:

Permissible electronic aids

Scientific calculator

Other permissible aids

2 Handwritten summary sheets

Exception: In case of an electronic Moodle exam, adjustments to the permissible aids may occur. Lecturers will announce the final permissible aids prior to the exam session.

Special case: Resit exam as oral exam

Kind of exam

Oral exam

Duration of exam

30 minutes

Permissible aids

No aids permitted

Description du module, disponible en: FR

Applied Electromagnetics

Informations générales

Nombre de crédits ECTS

3

Code du module

TSM_AppElm

Valable pour l'année académique

2026-27

Dernière modification

2021-12-24

Coordinateur/coordinatrice du module

Christophe Besson (HES-SO, Christophe.Besson@heig-vd.ch)

Explications concernant les langues d'enseignement par site :

- L'enseignement est dispensé dans la langue indiquée ci-dessous pour chaque site et chaque exécution du module.
- Les supports de cours sont disponibles dans les langues indiquées ci-dessous pour chaque site et chaque exécution du module. Lorsque plusieurs langues sont utilisées, la proportion de contenu disponible dans chaque langue est précisée (100 % = ensemble des supports de cours).
- Les examens (questions et réponses) sont entièrement rédigés dans la langue indiquée ci-dessous pour le site et l'exécution du module concernés. Ils se déroulent en présentiel.

	Lausanne			Lugano	Zurich		
Leçons		**X** F 100%					
Documentation		**X** F 70%	**X** E 30%				
Examen		**X** F 100%					

Catégorie de module

TSM approfondissement technico-scientifique

Recommandations de profil

Ce module est recommandé pour les profils suivants :

	Lausanne
Profil	EIE

Leçons

2 leçons et 1 leçon de pratique par semaine

Compétences préalables

Connaissances préalables, compétences initiales

Knowledge on vectorial algebra, multivariable functions, ordinary and partial differential equations

Brève description du contenu et des objectifs

This module offers a comprehensive introduction and provides fundamental tools for electromagnetic field theory, up to modern numerical methods for solving the field equations and state-of-the-art simulation techniques. The global objective is to provide a deep theoretical knowledge in electromagnetic field from low frequency domain (required for electrical machines as example) up to radio- frequency domain (required in domains of RF-antennas).

Objectifs, contenus, méthodes

Objectifs d'apprentissage, compétences à acquérir

This module offers a comprehensive introduction into electromagnetic field theory and its relevant applications, modern numerical methods for solving the field equations, and state-of-the-art simulation techniques. This aim is to present tools and formalism leading to the understanding of following items:

- Fundamental equations of the electromagnetic field theory.
- Finite difference time domain. Finite element method. Finite integral method.
- From low to super high frequency domain.

Contenu des modules avec pondération du contenu des cours

1. Fundamental equations of the electromagnetic field theory (20%)

- Maxwell equations
- Static and quasi-static analysis (electric and magnetic field simulation, computation of the electric capacitance and magnetic inductance, eddy currents, skin effect, proximity effect, energy, and magnetic force)
- Emission, propagation and reception of electromagnetic waves
- Eigenvalue problems (waveguide, antenna, resonator)

2. Finite difference time domain (FDTD) (20%)

- 2-D and 3-D FDTD theory (Cartesian grid, discretization of Maxwell equations, stability criterion, etc.) and practical experience
- FDTD simulations (wave propagation, antenna, etc.)

3. Finite element method (FEM) for electromagnetic simulations (20%)

- Scalar FEM (electrostatic, magnetostatic, eddy currents, etc.)
- Vector FEM (3-D eddy currents, wave propagation, eigenvalue problems, etc.)

4. Examples of practical application (40%)

- Dielectric simulations of high voltage devices
- Electromagnetic simulations of electrical machines
- Eddy-current analysis
- Electromagnetic simulations of actuators and sensors
- Eigenvalue analysis of filters and waveguides
- Electromagnetic simulations of RF-antennas
- Electromagnetic analysis of microstrip structures
- Electromagnetic meta-materials

Méthodes d'enseignement et d'apprentissage

This course involves theoretical presentations and practical exercises

Own laptop computer is necessary

Bibliographie

Lecture slides, references to internet resources and books

Evaluation

Évaluation supplémentaire pendant le semestre

Le module ne comprend pas d'évaluation supplémentaire pendant le semestre

Principe pour les examens

En règle générale, tous les examens réguliers de fin de module se déroulent sous forme écrite. Concernant les examens de répétition, leur format (écrit ou oral) sera communiqué par l'enseignant-e en même temps que le calendrier des examens.

Examen de fin de module régulier et examen écrit de répétition

Type de l'examen

Examen écrit

Durée de l'examen

120 minutes

Aides autorisées

Les aides suivantes sont autorisées:

Aides électroniques autorisées

Calculator, no social network

Autres aides autorisées

Personal summary of two pages A4

Exception : En cas d'examen électronique sur Moodle, des modifications des aides autorisées peuvent survenir. Dans ce cas, les aides autorisées seront annoncées par les enseignant-e-s avant l'examen.

Cas spécial: examen de répétition oral

Type de l'examen

Examen oral

Durée de l'examen

30 minutes

Aides autorisées

Les aides suivantes sont autorisées:

Aides électroniques autorisées

Same as written exam

Autres aides

Aucune autre aide autorisée

Module Description, available in: EN

Applied Micro & Nano Technologies

General Information

Number of ECTS Credits

3

Module code

TSM_AppMNT

Valid for academic year

2026-27

Last modification

2023-09-25

Coordinator of the module

Martin Gutsche (OST, martin.gutsche@ost.ch)

Explanations regarding the language definitions for each location:

- Instruction is given in the language specified for each location and module execution.
- Documentation is available in the language(s) listed for each location and module execution. If the documentation is in multiple languages, the percentage distributed is indicated (100% = all documentation provided).
- The examination, including both questions and answers, is provided entirely (100%) in the language(s) specified for each location and module execution. The exams are on-site.

	Lausanne			Lugano	Zurich		
Instruction					**X** E 100%		
Documentation					**X** E 100%		
Examination					**X** E 100%		

Module Category

TSM Technical scientific module

Profile Recommendations

This module is recommended for the following profiles:

	Zurich
Profile	ME

Lessons

2 lecture periods and 1 tutorial period per week

Entry level competences

Prerequisites, previous knowledge

Basic knowledge in chemistry and physics

Brief course description of module objectives and content

Based on selected examples, this module imparts the scientific and technological basics as well as the possibilities and the perspectives of the micro- and nanotechnologies to the participants. The students will become aware of the enormous potential of applications of this field and acquire a certain ability in handling it.

Aims, content, methods

Learning objectives and competencies to be acquired

- the students know the scientific and technological basics of this technology
- the students have a general unterstanding of the numerous fields of the micro- and nanotechnologies and their applications
- the students are able to combine the advantages of scaling and materials with the desired functions of the device
- based on selected nanodevices the students develop the ability to apply specific nano properties

Module content with weighting of different components

Introduction to modern device fabrication

- scaling laws
- from photo- to nanolithography and self-assembly
- technologies for the deposition of materials and the structuring of surfaces with the intention to realize certain electrical and other properties
- nanotools for the analysis and the modification of surfaces
- surface topography on micro- and nanolevel: AFM, SEM/TEM, IOM, FIB

Future technologies

- from MEMS to NEMS
- fullerene-based nanosystems and functional nanocomposites
- biomedical applications of nanotechnology
- micro- and nanofluidics
- nanosafety and risks

Teaching and learning methods

Lectures and exercises

Literature

Assessment

Additional performance assessment during the semester

The module does not contain an additional performance assessment during the semester

Basic principle for exams

As a rule, all standard final exams are conducted in written form. For resit exams, lecturers will communicate the exam format (written/oral) together with the exam schedule.

Standard final exam for a module and written resit exam

Kind of exam

Written exam

Duration of exam

120 minutes

Permissible aids

No aids permitted

Exception: In case of an electronic Moodle exam, adjustments to the permissible aids may occur. Lecturers will announce the final

permissible aids prior to the exam session.

Special case: Resit exam as oral exam

Kind of exam

Oral exam

Duration of exam

30 minutes

Permissible aids

No aids permitted

Module Description, available in: EN

Applied Photonics

General Information

Number of ECTS Credits

3

Module code

TSM_AppPhot

Valid for academic year

2026-27

Last modification

2024-10-24

Coordinator of the module

Markus Michler (OST, markus.michler@ost.ch)

Explanations regarding the language definitions for each location:

- Instruction is given in the language specified for each location and module execution.
- Documentation is available in the language(s) listed for each location and module execution. If the documentation is in multiple languages, the percentage distributed is indicated (100% = all documentation provided).
- The examination, including both questions and answers, is provided entirely (100%) in the language(s) specified for each location and module execution. The exams are on-site.

	Lausanne			Lugano	Zurich		
Instruction					**X** E 100%		
Documentation					**X** E 100%		
Examination					**X** E 100%		

Module Category

TSM Technical scientific module

Profile Recommendations

This module is recommended for the following profiles:

	Zurich
Profile	Pho

Lessons

2 lecture periods and 1 tutorial period per week

Entry level competences

Prerequisites, previous knowledge

- Optics: Basics of wave and geometrical optics;
  without optics basics during bachelor studies, the EVA "Fundamentals of light" should be visited before visiting further TSM modules.
- Physics: Basics for engineers (bachelor niveau)
- Electronics: Basic analog electronics (bachelor niveau)

Brief course description of module objectives and content

Applied photonics offers an insight into various application areas of photonics, such as optoelectronics, waveguide optics, micro-optics and several application examples. Starting from the basic physics of light matter interaction, the module covers various topics of modern optoelectronics in the field of light detection systems and light sources. After an introduction to the basics of light guiding and the occurrence of fiber modes, loss and dispersion mechanisms in fibers are discussed. The module gives an overview of different types of fibers and shows the importance of single mode fibers, specialty fibers and integrated waveguides for modern photonic applications. Furthermore, microoptical components are introduced to emphasize their advantages for light shaping, beam guidance and fiber coupling. The module is rounded off by a selection of special applications such as optical telecom, fiber measurement and sensor technology, organic electronics, optical biosensors, smart lighting concepts or similar topics.

Aims, content, methods

Learning objectives and competencies to be acquired

After successfully completing this course the student

- understands the main principles of light matter interaction
- has a clear picture of the different types of semiconductor light sources and detectors used today
- knows how micro optics can be used to shape light in modern photonic systems
- knows the principles of light guiding in optical waveguides including losses and dispersion
- is familiar with different types of fibers and waveguides and their fields of applications
- knows how to select and apply sources, detectors, micro optics and fibers for designing photonic systems

Module content with weighting of different components

1. Fundamentals of light-matter interaction (absorption, emission, scattering) (1 week)
2. Optoelectronics (4 weeks):
    1. detectors: photodiodes, photomultipliers, CCDs, CMOS sensors and dedicated electronic circuits
    2. sources: LEDs, SLEDs, OLEDs, laser diodes
3. Micro-optics: ROEs and DOEs (1 week)
4. Fibers & Waveguides (4 weeks):
    1. modes in planar waveguides and fibers, loss mechanisms and dispersion
    2. single mode fibers, specialty fibers and integrated waveguides
5. Photonic systems (4 weeks):
   modern applications that illustrate the importance of optoelectronics, micro-optics and fiber optics like e.g. optical telecom, fiber metrology and sensing, organic electronics, optical biosensors, smart lighting concepts and many others more

Teaching and learning methods

- Lectures and self-study
- Practical exercises

Literature

Lecturers' scripts with references to current literature

Textbook: Optoelectronics & Photonics: Principles & Practices (2nd Edition), S.O. Kasap, Pearson Education Limited

Assessment

Additional performance assessment during the semester

The module does not contain an additional performance assessment during the semester

Basic principle for exams

As a rule, all standard final exams are conducted in written form. For resit exams, lecturers will communicate the exam format (written/oral) together with the exam schedule.

Standard final exam for a module and written resit exam

Kind of exam

Written exam

Duration of exam

120 minutes

Permissible aids

Aids permitted as specified below:

Permissible electronic aids

none

Other permissible aids

Personal formulary: 4 A4 pages

Exception: In case of an electronic Moodle exam, adjustments to the permissible aids may occur. Lecturers will announce the final permissible aids prior to the exam session.

Special case: Resit exam as oral exam

Kind of exam

Oral exam

Duration of exam

30 minutes

Permissible aids

Aids permitted as specified below:

Permissible electronic aids

No electronic aids permitted

Other permissible aids

Personal formulary: 4 A4 pages

Module Description, available in: EN

Autonomous mobile robot systems

General Information

Number of ECTS Credits

3

Module code

TSM_AutMobRoS

Valid for academic year

2026-27

Last modification

2021-12-01

Coordinator of the module

Björn Jensen (HSLU, bjoern.jensen@hslu.ch)

Explanations regarding the language definitions for each location:

- Instruction is given in the language specified for each location and module execution.
- Documentation is available in the language(s) listed for each location and module execution. If the documentation is in multiple languages, the percentage distributed is indicated (100% = all documentation provided).
- The examination, including both questions and answers, is provided entirely (100%) in the language(s) specified for each location and module execution. The exams are on-site.

	Lausanne			Lugano	Zurich		
Instruction					**X** E 100%		
Documentation					**X** E 100%		
Examination					**X** E 100%		

Module Category

TSM Technical scientific module

Profile Recommendations

This module is recommended for the following profiles:

	Zurich
Profile	MA

Lessons

2 lecture periods and 1 tutorial period per week

Entry level competences

Prerequisites, previous knowledge

- Linear algebra
- General affinity to mathematics
- Basic feedback control systems
- Basic programming skills

Brief course description of module objectives and content

Mobile robots are complex mechatronic systems often interacting autonomously with their environment.

In the first part, the course provides theoretical fundamentals of mobile robot sensor fusion, planning, localization and mapping with examples in ROS. Tests of these complex systems can be conducted in simulated environments to speed up development and minimize risk of damage. Data from live tests can be recorded for later reuse and analysis as a foundation for further development.

In the second part of the course, students learn how to develop robot software and put it into practice using a practical example on a training robot. This includes real-time control, path planning, odometry, observers, position estimation, path control, etc. In the development process, we use the same development environments and libraries as in our industrial research projects.

Aims, content, methods

Learning objectives and competencies to be acquired

This course aims at giving students a deep insight into and theoretical understanding of the inner workings of autonomous mobile systems reinforced by hands-on experience of mobile robots or simulations thereof. At the end of this course students will be able to build mobile robots with autonomous behaviour.

Module content with weighting of different components

* Mathematical foundations (short primer)

  + Coordinate transformations, quaternions

* Mobile robot platforms in different environments: air, land, sea

  + Wheeled robots, drones, submarines,

  + Kinematics

  + Typical sensors

  + Control

  + Real-time systems

* Localization

  + Odometry

  + GPS

  + Sensor fusion

* Mapping

  + SLAM & Loop-Closing

* Navigation

  + Planning

  + Obstacle avoidance

  + Trajectory follower

* Advanced Topics

  + Real-time systems & Robot operating system frameworks

  + Modelling & simplification (Simulation & Design)

  + Dynamics of mobile robot platforms.

Teaching and learning methods

Ex-cathedra teaching

Case studies
The theory learned in class is applied in exercises

Literature

Siegwart, R. et al. "Introduction to Autonomous Mobile Robots", 2011, 2nd edition, MIT Press.

ISBN 978-0262015356

Assessment

Additional performance assessment during the semester

The module does not contain an additional performance assessment during the semester

Basic principle for exams

As a rule, all standard final exams are conducted in written form. For resit exams, lecturers will communicate the exam format (written/oral) together with the exam schedule.

Standard final exam for a module and written resit exam

Kind of exam

Written exam

Duration of exam

120 minutes

Permissible aids

No aids permitted

Exception: In case of an electronic Moodle exam, adjustments to the permissible aids may occur. Lecturers will announce the final permissible aids prior to the exam session.

Special case: Resit exam as oral exam

Kind of exam

Oral exam

Duration of exam

30 minutes

Permissible aids

No aids permitted

Module Description, available in: EN

Automatic Drive Systems

General Information

Number of ECTS Credits

3

Module code

TSM_AutoSys

Valid for academic year

2026-27

Last modification

2021-02-12

Coordinator of the module

Norman Baier (BFH, norman.baier@bfh.ch)

Explanations regarding the language definitions for each location:

- Instruction is given in the language specified for each location and module execution.
- Documentation is available in the language(s) listed for each location and module execution. If the documentation is in multiple languages, the percentage distributed is indicated (100% = all documentation provided).
- The examination, including both questions and answers, is provided entirely (100%) in the language(s) specified for each location and module execution. The exams are on-site.

	Lausanne			Lugano	Zurich		
Instruction					**X** E 100%		
Documentation					**X** E 100%		
Examination					**X** E 100%		

Module Category

TSM Technical scientific module

Profile Recommendations

This module is recommended for the following profiles:

	Zurich
Profile	MA

Lessons

2 lecture periods and 1 tutorial period per week

Entry level competences

Prerequisites, previous knowledge

- Basic knowledge of control engineering and machines (Bachelor degree level)
- Mastery of *Matlab* and *Simulink*
- Possession of a laptop with *Matlab* /*Simulink* installed

Brief course description of module objectives and content

This module treats methods of concept, dimensioning and development in the servo drive technology sector which are particularly compatible with the various industries.

Aims, content, methods

Learning objectives and competencies to be acquired

After the completion of this module, students will be able to:

- analyze the dynamics of a drive,
- quantify or even improve its dynamic behavior, and
- integrate a drive into a mechatronic system.

Module content with weighting of different components

Electric motor drives (DC, synchronous, asynchronous, stepper, reluctance, and piezoelectric motors), pneumatic drives, hydraulic drives
Actuator selection from the energy source to the mechanical process: modeling, dimensioning, alignment
Selection of case studies from the industrial sector

Preface for documentation: https://moodle.msengineering.ch/course/view.php?id=35

Content

1. Presentations, description of module, organization
2. Introduction on drives
3. Evaluation: development of model on Matlab/Simulink for a drive, and simulation.
4. Variants on drive solutions.
5. Drive solutions with DC or BLDC motors
    - dynamic description of movement
    - modeling (*Matlab+Simulink*)
    - transmitters and power electronics
    - transmissions
    - cascade regulation of drives.
    - synchronous motor
    - asynchronous motor
    - stepper motor
    - reluctance motor
6. Several case studies from the industrial sector: multiaxial drives, robotics, medical, railway, automotive, ...

Teaching and learning methods

- Ex-cathedra teaching
- Case studies
- Exercises (*Matlab*)

Literature

H. Bühler: Réglage d'électronique de puissance, PPUR, vol 1 & 2.

E. Riefenstahl: Elektrische Antriebssysteme, Teubner Verlag, 2006.

A. Shumway-Cook, M. H. Woollacott: Motor Control: Theory and Practical Applications.

W. N. Alerich, S. L. Hermann: Electric Motor Control.

M. Nakamura, S. Goto, N. Kyura: Mechatronic Servo System Control: Problems in Industries and their Solutions.

Scripts on Moodle

Assessment

Additional performance assessment during the semester

The module does not contain an additional performance assessment during the semester

Basic principle for exams

As a rule, all standard final exams are conducted in written form. For resit exams, lecturers will communicate the exam format (written/oral) together with the exam schedule.

Standard final exam for a module and written resit exam

Kind of exam

Written exam

Duration of exam

120 minutes

Permissible aids

Aids permitted as specified below:

Permissible electronic aids

Pocket calculator, laptop with *Matlab* / *Simulink*

Other permissible aids

Module documents, forms, (all means of communication are forbidden).

Exception: In case of an electronic Moodle exam, adjustments to the permissible aids may occur. Lecturers will announce the final permissible aids prior to the exam session.

Special case: Resit exam as oral exam

Kind of exam

Oral exam

Duration of exam

30 minutes

Permissible aids

No aids permitted

Module Description, available in: EN, FR

Building Information Modelling (BIM)

General Information

Number of ECTS Credits

3

Module code

TSM_BIM

Valid for academic year

2026-27

Last modification

2024-10-17

Coordinator of the module

Wissam Wahbeh (FHNW, wissam.wahbeh@fhnw.ch)

Explanations regarding the language definitions for each location:

- Instruction is given in the language specified for each location and module execution.
- Documentation is available in the language(s) listed for each location and module execution. If the documentation is in multiple languages, the percentage distributed is indicated (100% = all documentation provided).
- The examination, including both questions and answers, is provided entirely (100%) in the language(s) specified for each location and module execution. The exams are on-site.

	Lausanne			Lugano	Zurich		
Instruction		**X** F 100%			**X** E 100%		
Documentation		**X** F 100%			**X** E 100%		
Examination		**X** F 100%			**X** E 100%		

Module Category

TSM Technical scientific module

Profile Recommendations

This module is recommended for the following profiles:

	Lausanne	Zurich
Profile	CE	Geo

Lessons

2 lecture periods and 1 tutorial period per week

Entry level competences

Prerequisites, previous knowledge

Bachelor degree in a technical or engineering discipline, Business Engineering, Computer Science or similar. Some basic knowledge of the BIM method would be an advantage. No knowledge of CAD required.

Brief course description of module objectives and content

The BIM method (VDC) comprises the digital planning, construction and operation of built assets using digital modelling in combination with suitable organizational forms and processes.

The digital building model is created in interdisciplinary collaboration with a specific goal. It includes both the geometric (3D) and the non-geometric information needed for the agreed uses.

The BIM method is used in the construction industry for project planning and execution (e.g. fundamentals [legal, geological/geotechnical], architecture, engineering, building services), in geomatics for capturing, modelling, tracking and managing building geometry, and in facilities management.

Aims, content, methods

Learning objectives and competencies to be acquired

In TSM_BIM, students will learn the basic principles of the BIM method. Aspects relevant to both construction (BIM) and geomatics (GeoBIM) will be examined.

The focus of the module is on the interdisciplinary use of digital building models.

After taking the TSM_BIM module, students will be able to formulate and record information requirements for simple digital building models, exchange the resulting data in the IFC open data exchange format and assess them in a targeted manner to obtain the desired information.

Instruction is also includes hands-on session, using digital building models and the appropriate BIM tools.

Module content with weighting of different components

PART 1: BIM Method – Foundations and a look at into practice Introduction (25%)

Definition and basic idea. Planning and construction process yesterday, today and tomorrow. Status of BIM in Switzerland and internationally. Terminology. Challenges.

Stakeholders, models and roles: From client to planners to operators and users. Principle of information requirements and delivery. Information requester / information sender.

Data and digital building models: Reading and evaluating data from digital building models.

A look at practice: Requirements, structuring, construction and evaluation of digital building models.

PART 2: Data, Tools and Geospatial Competence (BIM and Geodata) (25%)

BIM modelling: The use of authoring software and parametric modelling

BIM and geodata: The differences between BIM and GIS and their possible data integration

IFC data exchange model: IFC outline, IFC vs. CityGML.

PART 3: Process Competence (BIM Standards and Applications) (25%)

Formulating BIM objectives, specifications (EIR). Description and verification of information requirements.

Data evaluation I: Obtaining information through the predefined evaluation of digital building models. Checking the data quality.

BIM project execution plan: The BIM project execution plan as a specification that regulates the framework, structure, quality assurance and data exchange.

PART 4: Practice & Applications (25%)

Overview of the “BIM to Field”, “Field to BIM” & “Extended Reality” applications and solutions for BIM projects: Software, Services and web platforms.

Data exchange model: Use of an authoring tool. Expanding the native data model. Mapping the native data model to the IFC data exchange model.

Teaching and learning methods

Lectures, case studies, exercises. May include field trips. Instructional concept: Blended Learning - Inverted Classroom. In-person teaching alternating with self-study.

Literature

Eastman, C.M., Eastman, C., Teicholz, P., Sacks, R. and Liston, K., 2011. BIM handbook: A guide to building information modeling for owners, managers, designers, engineers and contractors. John Wiley & Sons.

ISO (2018): ISO 19650-1 Organization and digitization of information about buildings and civil engineering works, including building information modelling (BIM) — Information management using building information modelling — Part 1: Concepts and principles.

Additional readings will be announced in class.

Assessment

Additional performance assessment during the semester

The module contains additional performance assessment(s) during the semester. The achieved mark of the additional performance assessment(s) applies to both the regular and the resit exam.

Description of additional performance assessment during the semester

Assignments during the semester (exercises/project) counts as 30% of the final grade.

Basic principle for exams

As a rule, all standard final exams are conducted in written form. For resit exams, lecturers will communicate the exam format (written/oral) together with the exam schedule.

Standard final exam for a module and written resit exam

Kind of exam

Written exam

Duration of exam

120 minutes

Permissible aids

No aids permitted

Exception: In case of an electronic Moodle exam, adjustments to the permissible aids may occur. Lecturers will announce the final permissible aids prior to the exam session.

Special case: Resit exam as oral exam

Kind of exam

Oral exam

Duration of exam

30 minutes

Permissible aids

No aids permitted

Description du module, disponible en: EN, FR

Building Information Modelling (BIM)

Informations générales

Nombre de crédits ECTS

3

Code du module

TSM_BIM

Valable pour l'année académique

2026-27

Dernière modification

2024-10-17

Coordinateur/coordinatrice du module

Wissam Wahbeh (FHNW, wissam.wahbeh@fhnw.ch)

Explications concernant les langues d'enseignement par site :

- L'enseignement est dispensé dans la langue indiquée ci-dessous pour chaque site et chaque exécution du module.
- Les supports de cours sont disponibles dans les langues indiquées ci-dessous pour chaque site et chaque exécution du module. Lorsque plusieurs langues sont utilisées, la proportion de contenu disponible dans chaque langue est précisée (100 % = ensemble des supports de cours).
- Les examens (questions et réponses) sont entièrement rédigés dans la langue indiquée ci-dessous pour le site et l'exécution du module concernés. Ils se déroulent en présentiel.

	Lausanne			Lugano	Zurich		
Leçons		**X** F 100%			**X** E 100%		
Documentation		**X** F 100%			**X** E 100%		
Examen		**X** F 100%			**X** E 100%		

Catégorie de module

TSM approfondissement technico-scientifique

Recommandations de profil

Ce module est recommandé pour les profils suivants :

	Lausanne	Zurich
Profil	CE	Geo

Leçons

2 leçons et 1 leçon de pratique par semaine

Compétences préalables

Connaissances préalables, compétences initiales

Diplôme Bachelor dans une discipline technique spécialisée, Business Engineering, Informatique, ou similaire; des premiers contacts avec la méthode BIM constitueraient un atout. Les connaissances en CAD ne sont pas nécessaires.

Brève description du contenu et des objectifs

La méthode BIM (VDC) comprend la planification, la construction et l'exploitation informatisée d'ouvrages à l'aide de maquettes numériques combinée à des formes d'organisation et des processus adaptés.

La maquette numérique est ainsi réalisée conformément à la finalité et en collaboration multidisciplinaire. Elle regroupe les informations géométriques (3D) et non géométriques nécessaires aux applications définies pour l'usage de l'ouvrage.

La méthode BIM est appliquée tant

- dans le domaine de la construction lors de la mise en projet et de la réalisation (p.ex.: fondements [juridiques, géologiques/géotechniques], architecture, ingénierie, technique du bâtiment) ;
- en géomatique pour le relevé, la modélisation, la réalisation et la gestion de la géométrie d'ouvrage ;
- pour le Facility Management.

Objectifs, contenus, méthodes

Objectifs d'apprentissage, compétences à acquérir

Au cours du module TSM_BIM, les étudiant-e-s se familiarisent avec les grands principes de la méthode BIM. Tant les aspects de construction (BIM) que de géomatique (GeoBIM) seront abordés.

L'objectif du module se concentre sur l'utilisation interdisciplinaire des maquettes d'ouvrages digitalisés.

Les étudiant-e-s ayant suivi le module TSM_BIM sont en mesure de formuler et de saisir des exigences en termes d'information sur des maquettes d'ouvrages simples puis de les évaluer de manière ciblée en vue d'obtenir des informations.

Le cours est orienté pratique par le biais de l'utilisation de maquettes d'ouvrages numériques et d'outils BIM adaptés

Contenu des modules avec pondération du contenu des cours

PARTIE 1: Méthode BIM– Bases et aperçu de la pratique (30%)

Introduction Définition et idée fondamentale. Processus de planification et de construction d'hier, d'aujourd'hui et de demain. Statut BIM CH-International. Terminologies. Défis.

Groupes d'exigences, modèles et rôles: Du donneur d'ordre aux exploitants et utilisateurs en passant par les bureaux d'étude. Principe des exigences et de la transmission d'informations. Demandeur / émetteur d'informations.

Aperçu de la pratique: Exigences, structure, cadre et évaluation des maquettes d'ouvrages numériques.

Donnes et maquettes d'ouvrages numériques: Lecture et évaluation de données à partir de maquettes d'ouvrages numériques.

PARTIE 2: Modèles d'échange de données (40%)

Bases de la modélisation BIM : Positionnement et structuration de la maquette, composants d'un ouvrage, associer des informations (propriétés) à un composant

Modélisation 3D et objets paramétriques : Représentation des données géométriques en 3D (CSG, B-rep), dévéloppement d'un élément paramétrique simple

Modèle d'échange de données IFC: Schéma IFC, interopérabilité selon buildingSMART.

Logiciels de la méthode BIM et saisie de géodonnées pour BIM: Logiciels et plateforme internet BIM, services web BIM, intégration de la géoinformation avec une maquette BIM.

PARTIE 3: Maquettes d'ouvrages numérique et gestion des données (30%)

Exigences d'information: Formulation d'objectifs BIM et cahier des charges (EIR). Description et vérification des exigences relatives à l'information.

Structuration, extraction et gestion de la donnée : Divers concepts des bases de données (orienté objet, relationnel), méthodologie de la structuration de la donnée, transfert de données d'une maquette dans une base de données structurée

Élargissement du modèle d'échange de données : Utilisation d'un outil auteur. Mapping du modèle de données natif sur le modèle d'échange de données.

Évaluation des données : Édition ciblée d'informations à partir de maquettes d'ouvrages numériques dans des modèles en vue de leur traitement ultérieur.

Coordination et collaboration: Structuration de la coordination BIM autour d'une plateforme de collaboration et les outils de buildingSMART

Méthodes d'enseignement et d'apprentissage

Enseignement frontal- cours; études de cas, exercices; éventuellement excursions

Concept didactique : Blended Learning -Inverted Classroom

Bibliographie

Borrmann, A., König, M., Koch, C., Beetz, J. (Hrsg.), 2015. Building Information Modeling - Technologische Grundlagen und industrielle Praxis. VDI-Buch. 1. Auflage 2015. Springer Verlag ISBN 978-3-658-05606-3

Clemen, C. und Ehrich, R., 2014. Geodesy goes BIM, avn 121(6).Clemen, C., Ehrich, R. und van Zyl, C., 2o14. Building information model (BIM) and measuring techniques, Proc' XXV FIG Congress 2014, FIG, Kuala Lumpur, Malaysia. Disponible sous: http://www.fig.net/pub/fig2014/papers/ts08k/TS08K_clemen_ehrich_et_al_6880.pdf

Hausknecht, Kerstin; Liebich, Thomas, 2018. BIM-Kompendium. Fraunhofer Irb ISBN 978-3-8167-9948-1

Schweizerischer Ingenieur und Architektenverein (SIA), 2018. SIA D 0270: Anwendung der BIM-Methode - Leitfaden zur Verbesserung der Zusammenarbeit

Schweizerischer Ingenieur und Architektenverein (SIA), 2017. SIA 2051: Building Information Modelling (BIM) – Grundlagen zur Anwendung der BIM-Methode.

Sacks, R., Eastman, C., Lee G., Teicholz, P. (2018): BIM Handbook. A Guide to Building Information Modeling, Third Edition, Wiley

Renou, J., Chemise, S. (2018): Revit pour le BIM – Initiation générale & perfectionnement structure, 5eme édition, Eyrolles

Guézo, J., Navarra, P. (2018): Revit pour les Architectes – Bonnes pratiques pour le BIM, 2eme édition, Eyrolles

Ascent : Autodesk Revit 2019 Structure Fundamentals - Metric edition, SDC publications

Bleyenheuft, V. (2018): Les familles de Revit pour le BIM, 2eme édition, Eyrolles

Domer, B., Rinquet, L., Joss, F. : Le management du projet de la construction: Un vademecum d'économie, de droit et de planification pour le bâtiment, PPUR

Borrmann, A., König, M., Koch, C., Beetz, J.: "Building Information Modeling - Technology Foundations and Industry Practice", Springer

Evaluation

Évaluation supplémentaire pendant le semestre

Le module comprend une ou des évaluation(s) supplémentaire(s) pendant le semestre. La note obtenue pour la ou les évaluation(s) supplémentaire(s) est valable à la fois pour l'examen final et pour l'examen de répétition.

Description de l'évaluation supplémentaire pendant le semestre

Devoirs pendant le semestre (exercices/projets) compte pour 30 % de la note finale.

Principe pour les examens

En règle générale, tous les examens réguliers de fin de module se déroulent sous forme écrite. Concernant les examens de répétition, leur format (écrit ou oral) sera communiqué par l'enseignant-e en même temps que le calendrier des examens.

Examen de fin de module régulier et examen écrit de répétition

Type de l'examen

Examen écrit

Durée de l'examen

120 minutes

Aides autorisées

Sans aides

Exception : En cas d'examen électronique sur Moodle, des modifications des aides autorisées peuvent survenir. Dans ce cas, les aides autorisées seront annoncées par les enseignant-e-s avant l'examen.

Cas spécial: examen de répétition oral

Type de l'examen

Examen oral

Durée de l'examen

30 minutes

Aides autorisées

Sans aides

Modulbeschreibung, verfügbar in: DE

Baustatik

Allgemeine Angaben

Anzahl ECTS-Credits

3

Modulkürzel

TSM_BauStat

Gültig für akademisches Jahr

2026-27

Letzte Änderung

2019-12-15

Modul-Koordinator/in

Simon Zweidler (FHNW, simon.zweidler@fhnw.ch)

Erläuterungen zu den Sprachdefinitionen je Standort:

- Der Unterricht findet in der pro Standort und Durchführung definierten Sprache statt.
- Die Unterlagen sind in den pro Standort und Durchführung definierten Sprachen verfügbar. Bei Mehrsprachigkeit ist die prozentuale Verteilung angegeben (100% = komplette Unterlagen).
- Die Prüfungsfragen und -antworten sind in jeder pro Standort und Durchführung definierten Sprache. Die Prüfung wird vor Ort durchgeführt.

	Lausanne			Lugano	Zurich		
Unterricht						**X** D 100%	
Dokumentation						**X** D 100%	
Prüfung						**X** D 100%	

Modulkategorie

TSM Technisch-wissenschaftliche Vertiefung

Profilempfehlungen

Dieses Modul wird für die folgenden Profile empfohlen:

	Zurich
Profil	CE

Lektionen

2 Lektionen und 1 Übungslektion pro Woche

Eintrittskompetenzen

Vorkenntnisse, Eingangskompetenzen

Grundlagen der Baustatik, des Stahlbaus und des Stahlbetonbaus

Kurzbeschreibung der Inhalte und Ziele

Ziel des Moduls ist, durch die Erweiterung des im Bachelorstudium angeeigneten Wissens ein vertieftes Verständnis über das Tragverhalten schlanker Stabstrukturen zu erlangen.
Im Modul werden verschiedene Tragwirkungen vor allem schlanker und elastischer Stäbe behandelt. Speziellere Beanspruchungen wie Querkraftschub und Torsion, inkl. Wölbkrafttorsion werden vertieft behandelt. Weiterhin wird das Tragverhalten besonderer schlanker Stabkonstruktionen, wie z.B. Seile und Bögen vertieft. Einen grossen Teil wird ausserdem die Stabilitätstheorie einnehmen, in dem mit analytischen und numerischen Methoden Verzweigungsprobleme gelöst und Berechungen nach Theorie II. Ordnung durchgeführt werden.

Ziele, Inhalte, Methoden

Lernziele und zu erwerbende Kompetenzen

Einfache Tragwirkungen: Stabdehnung, Schubträger, Berechnung von Querkraftschub, Torsion (Umlauf- und Wölbkrafttorsion), Biegeträger, Seile (Berechnung biegeweicher Tragwerke), Bogen und Ringe.
Kombinierte Tragwirkungen: Timoshenko-Balken als Schub-/Biegeträger der im Gegensatz zum Bernoulli-Träger über keine ebenbleibenden Querschnitte verfügt, Schub- und Biegeträger, Biegung und Normalkraft, Seilwirkung und Biegung.
Stabilitätstheorie: Stabilitätsprobleme Biegeknicken und Biegedrillknicken, Allgemeine Lösung von Eigenwertproblemen mit der Gleichgewichts- und der Energiemethode, Analytische und numerische Berechnung von kritischen Lasten, Ermittlung und Beurteilung von Knickbiegelinien und Knicklängen, Berechnungen mit der Spannungstheorie II. Ordnung für Biegung und Normalkraft.

Modulinhalt mit Gewichtung der Lehrinhalte

• Teil 1 -- Einfache und kombinierte Tragwirkungen: 2/3
• Teil 2 -- Stabilitätstheorie: 1/3

Lehr- und Lernmethoden

- Input-Lehrveranstaltungen
- Übungen und Hausübungen
- Kolloquien

Bibliografie

wird in der Lehrveranstaltung bekanntgegeben

Bewertung

Zusätzliche Leistungsbewertung während des Semesters

Das Modul beinhaltet keine zusätzliche Leistungsbewertung während des Semesters.

Grundsatz Prüfungen

Grundsätzlich werden alle regulären Abschlussprüfungen in schriftlicher Form durchgeführt. Bei den Wiederholungsprüfungen teilen die Dozierenden das Prüfungsformat (schriftlich/mündlich) zusammen mit dem Prüfungsplan mit.

Reguläre Modulschlussprüfung und schriftliche Wiederholungsprüfung

Art der Prüfung

Schriftliche Prüfung

Prüfungsdauer

120 Minuten

Erlaubte Hilfsmittel

Erlaubt sind die aufgeführten Hilfsmittel:

Zulässige elektronische Hilfsmittel

- Taschenrechner

Weitere erlaubte Hilfsmittel

- selbstverfasste Zusammenfassung, 10 DIN A4 Seiten

Ausnahme: Im Falle einer elektronischen Moodle-Prüfung können Änderungen der Hilfsmittel vorkommen. Dozierende werden die endgültig zulässigen Hilfsmittel vor der Prüfung bekanntgeben.

Spezialfall: Wiederholungsprüfung als mündliches Examen

Art der Prüfung

Mündliche Prüfung

Prüfungsdauer

30 Minuten

Erlaubte Hilfsmittel

Erlaubt sind die aufgeführten Hilfsmittel:

Zulässige elektronische Hilfsmittel

- Taschenrechner

Andere zulässige Hilfsmittel

- selbstverfasste Zusammenfassung, 10 DIN A4 Seiten

Module Description, available in: EN

Bayesian Machine Learning

General Information

Number of ECTS Credits

3

Module code

TSM_BayMachLe

Valid for academic year

2026-27

Last modification

2023-10-11

Coordinator of the module

Cedric Huwyler (FHNW, cedric.huwyler@fhnw.ch)

Explanations regarding the language definitions for each location:

- Instruction is given in the language specified for each location and module execution.
- Documentation is available in the language(s) listed for each location and module execution. If the documentation is in multiple languages, the percentage distributed is indicated (100% = all documentation provided).
- The examination, including both questions and answers, is provided entirely (100%) in the language(s) specified for each location and module execution. The exams are on-site.

	Lausanne			Lugano	Zurich		
Instruction					**X** E 100%		
Documentation					**X** E 100%		
Examination					**X** E 100%		

Module Category

TSM Technical scientific module

Profile Recommendations

This module is recommended for the following profiles:

	Zurich
Profile	DS

Lessons

2 lecture periods and 1 tutorial period per week

Entry level competences

Prerequisites, previous knowledge

Basic probability and statistics, basic programming skills (R and/or Python), linear algebra and multivariate calculus, basic concepts of machine learning.

Brief course description of module objectives and content

Bayesian statistics provides an alternative viewpoint to the classical ‘frequentist’ statistics by using a different, more subjective interpretation of probability. This brings various advantages in solving typical industry problems, such as the inclusion of prior knowledge, more intuitive hypothesis tests or modeling uncertainty given small amounts of data. With increasing computational power, the popularity of Bayesian statistics and machine learning has grown significantly over the past decade. This course provides students with a solid understanding of the fundamental concepts of Bayesian statistics, introduces various computational methods required in Bayesian statistics and Bayesian machine learning, and discusses numerous examples and applications of Bayesian machine learning. Bayesian as well as Gaussian process regression models are introduced and explored, with a particular focus on graphical models and Bayesian networks to model relationships and to infer causality. In addition, advanced topics and their applications are covered, such as Bayesian optimisation, non-parametric mixture models for clustering, and Bayesian neural networks.

Aims, content, methods

Learning objectives and competencies to be acquired

Students are able to formulate their problem setting on the basis of Bayesian models and to include their prior understanding. They are able to explain how Bayesian models balance between prior understanding and data towards a posterior understanding of a problem. They are aware of the advantages and disadvantages of the Bayesian approach and know in which situation it is better suited than standard frequency statistics. Since Bayesian models can rarely be computed in closed form, they are experienced in approximating posterior distributions by means of sampling-based approaches

Module content with weighting of different components

Fundamental concepts of Bayesian statistics: Reasoning under uncertainty, probability theory, Bayes theorem, prior, likelihood, posterior, conjugate families (beta-binomial, gamma-poisson, normal-normal), sequential learning, inference, prediction

Sampling methods: Markov chains, Metropolis algorithm, Gibbs sampling, Hamiltonian MC, sequential MC

Bayesian and Gaussian Process regression: kernels, model selection, state-space models, variational inference

Bayesian networks: graphical models, causality

Selection of advanced topics: Bayesian optimisation, Bayesian non-parametric mixture modeling, Bayesian neural networks, physics-informed ML models

Teaching and learning methods

Lecture and practical work on computer.

Literature

Lecture notes and notebooks will be available in addition to recommended book chapters.

Assessment

Additional performance assessment during the semester

The module does not contain an additional performance assessment during the semester

Basic principle for exams

As a rule, all standard final exams are conducted in written form. For resit exams, lecturers will communicate the exam format (written/oral) together with the exam schedule.

Standard final exam for a module and written resit exam

Kind of exam

Written exam

Duration of exam

120 minutes

Permissible aids

Aids permitted as specified below:

Permissible electronic aids

personal computer (open book, no communication, no AI-based chatbot assistance)

Other permissible aids
written summary of 8 pages (4 sheets)

Exception: In case of an electronic Moodle exam, adjustments to the permissible aids may occur. Lecturers will announce the final permissible aids prior to the exam session.

Special case: Resit exam as oral exam

Kind of exam
Oral exam

Duration of exam
30 minutes

Permissible aids
Aids permitted as specified below:

Permissible electronic aids
None

Other permissible aids
None

Module Description, available in: EN

Biomedical Engineering

General Information

Number of ECTS Credits

3

Module code

TSM_BioMedEng

Valid for academic year

2026-27

Last modification

2024-10-18

Coordinator of the module

Marcel Egli (HSLU, marcel.egli@hslu.ch)

Explanations regarding the language definitions for each location:

- Instruction is given in the language specified for each location and module execution.
- Documentation is available in the language(s) listed for each location and module execution. If the documentation is in multiple languages, the percentage distributed is indicated (100% = all documentation provided).
- The examination, including both questions and answers, is provided entirely (100%) in the language(s) specified for each location and module execution. The exams are on-site.

	Lausanne			Lugano	Zurich		
Instruction					**X** E 100%		
Documentation					**X** E 100%		
Examination					**X** E 100%		

Module Category

TSM Technical scientific module

Profile Recommendations

This module is recommended for the following profiles:

	Zurich
Profile	Med

Lessons

2 lecture periods and 1 tutorial period per week

Entry level competences

Prerequisites, previous knowledge

Basic knowledge in cell biology, anatomy, functional anatomy, and pathology (fracture, neuro, orthopedics, osteosynthesis) is beneficial. Potentially missing knowledge can be acquired individually as an autodidact effort.

Brief course description of module objectives and content

The lecture encompasses a comprehensive exposition of Biomedical Engineering. It commences with a historical overview, followed by an examination of contemporary methodologies and tools. Physiological principles will be discussed before focusing on subjects like biosignals and sensors. An array of topics will be dissected, including but not limited to bioimaging, biomolecular engineering, tissue engineering, and the intricacies of precision and personalized medicine. Attendees will attain discernment concerning foundational prerequisites such as biology and physiology and the variety of materials used for implants, prostheses, and available biomaterials. Current clinical paradigms will be scrutinized, notably osteoporosis, fracture fixation, and osteoarthritis. Furthermore, orthopedic treatment modalities and osteosynthesis techniques will be meticulously analyzed, encompassing fracture fixation and the primary stability of implants and joint replacements. A deeper comprehension will be given to measurement technologies catering to human physiological performance encompassing kinematics and kinetics. This includes evaluating movement analysis, muscular dynamics, and cerebral activity. (7) The course will also discuss (robot-assistive) rehabilitation technologies in the case of neuropathology, such as stroke, MS, and paraplegia, with a specific focus on innovations in virtual/augmented reality.

Aims, content, methods

Learning objectives and competencies to be acquired

The first half of each afternoon session will focus on biomedical engineering and prosthetics. During the second half, the students will be tasked to work as a group on describing a medical device product of their choice (an existing device or a medical aid they would like to build).

Module content with weighting of different components

Biomedical engineering

- Physiological systems
- Biotechnology and tissue engineering
- Bioelectric and neuro-engineering
- Human sensory systems
- Bioreactors and tissue engineering in regenerative medicine

Prosthetics

- [illegible]
- Human movement analysis, orthopedics, (clinical) biomechanics, biomaterials
- Biomechanical testing of implants/test development & lab accreditation
- Diagnosis & assessment based on AI-based algorithms

Robot assistive rehabilitation

- Clinical assessment of neurodegenerative diseases/human performance analysis
- Rehabilitation devices and procedures
- Therapeutic procedures based on virtual/augmented reality

Teaching and learning methods

Various teaching methods, like classical or group work, will be applied.

Literature

Slides and lecture notes will be made available to the students. Furthermore, a list will be provided with books and articles relevant to the topics taught.

Assessment

Additional performance assessment during the semester

The module contains additional performance assessment(s) during the semester. The achieved mark of the additional performance assessment(s) applies to both the regular and the resit exam.

Description of additional performance assessment during the semester

Throughout the semester, students will give group presentations on selected medical devices. The lecturer will provide feedback on the presentation immediately afterward, and the grade received will account for the final mark but is weighted only for 10%.

Basic principle for exams

As a rule, all standard final exams are conducted in written form. For resit exams, lecturers will communicate the exam format (written/oral) together with the exam schedule.

Standard final exam for a module and written resit exam

Kind of exam

Written exam

Duration of exam

120 minutes

Permissible aids

Aids permitted as specified below:

Permissible electronic aids

No electronic aids permitted

Other permissible aids

Students can use physical cheat sheets of up to two DIN A4 pages. These sheets must be handwritten on paper or a tablet PC / iPad and then printed. The use of electronic devices during the exam is strictly prohibited.

Exception: In case of an electronic Moodle exam, adjustments to the permissible aids may occur. Lecturers will announce the final permissible aids prior to the exam session.

Special case: Resit exam as oral exam

Kind of exam

Oral exam

Duration of exam

30 minutes

Permissible aids

No aids permitted

Module Description, available in: EN

Bridge Design and Assessment

General Information

Number of ECTS Credits

3

Module code

TSM_Bridge

Valid for academic year

2026-27

Last modification

2026-06-19

Coordinator of the module

Deborah Briccola (SUPSI, deborah.briccola@supsi.ch)

Explanations regarding the language definitions for each location:

- Instruction is given in the language specified for each location and module execution.
- Documentation is available in the language(s) listed for each location and module execution. If the documentation is in multiple languages, the percentage distributed is indicated (100% = all documentation provided).
- The examination, including both questions and answers, is provided entirely (100%) in the language(s) specified for each location and module execution. The exams are on-site.

	Lausanne			Lugano	Zurich		
Instruction				**X** E 100%			
Documentation				**X** E 100%			
Examination				**X** E 100%			

Module Category

TSM Technical scientific module

Profile Recommendations

This module is recommended for the following profiles:

	Lugano
Profile	CE

Lessons

2 lecture periods and 1 tutorial period per week

Entry level competences

Prerequisites, previous knowledge

Deep knowledge of structural mechanics and the basis of reinforced and prestressed concrete design. Basic knowledge of coding (MathWorks MATLAB) and FEM modeling would be an advantage.

Brief course description of module objectives and content

The federal road network comprises more than 4500 highway bridges, 66% of which were built in the 1980s or earlier. As a result, practitioners increasingly face the challenge of assessing and, when necessary, strengthening these structures in response to rising traffic demands and the evolving impacts of climate change.

This module introduces students to the multifaceted domain of bridge design and assessment following current standards and design recommendations. The focus is placed on the structural behavior of box girder and multi girder bridges in reinforced and prestressed concrete, which represent the most common typologies in Switzerland. The objective is to familiarize students with the relevant design situations and verifications that support subsequent detailing (beyond the scope of the course) or strengthening interventions, with particular emphasis on UHPFRC technology.

In the first part of the module, we examine established models for analyzing the longitudinal and transverse behavior of bridges, highlighting the suitability of analytical and numerical methods for different typologies. We then explore how the general principles governing the safety assessment of existing structures influence the application of these well-established methods.

The second part of the module introduces the fundamental maintenance strategies adopted by the Federal Road Office (FEDRO). Topics include the bearing capacity and ductility of girders and columns eventually strengthened. Through additional autonomous readings, students will also investigate the emerging challenges that climate change poses to bridge design and assessment. The course adopts an engineering-oriented approach and features numerous examples drawn from the Swiss road network.

Aims, content, methods

Learning objectives and competencies to be acquired

At the end of the course, you will be able to:

- Describe the conceptual design and structural behavior of the main bridge typologies with a specific focus on Swiss practice Critically evaluate the suitability of different bridge typologies in relation to specific design situations
- Apply the key technical provisions and design standards governing bridge design and assessment Identify the primary design constraints influencing the choice of girder-bridge typologies
- Select the most appropriate analytical or numerical methods of analysis for a given bridge typology Recognize the potential impact of climate change on bridge design and assessment
- List the monitoring and maintenance strategies adopted by road authorities Assess the structural behavior of girder bridges under different load cases
- Determine the updated traffic load values required for the assessment of existing bridges
- Communicate effectively with specialists and stakeholders involved in bridge management, design, and construction

Module content with weighting of different components

PART 1: BASIC CONCEPTS – Foundation and insights from practice (10%)

- Bridge typologies, conceptual design, and key challenges in bridge assessment, including the role of digitalization in bridge management Overview of the Swiss road network: asset portfolio and condition state
- Standards for bridge design, assessment, and maintenance currently in force in Switzerland

PART 2: DESIGN OF GIRDER BRIDGES (60%)

- **LONGITUDINAL BEHAVIOR**: Influence line and influence surface theory for analyzing global and local effects on deck slabs
- **TRANSVERSE BEHAVIOR**: Bridge-deck modeling techniques, including orthotropic plate analysis, grillage models and frame models; transversal load distribution theory (Engesser, Courbon and Massonet methods).
- **BRIDGE ACCESSORIES AND SPECIFIC DESIGN ASPECTS**: Bearing layouts, expansion joints, and notes on skew, curved and integral bridges

PART 3: BRIDGE ASSESSMENT (30%)

- **OVERVIEW**: Principles for assessing existing structures and their implications for bridges; updating traffic actions and consequence for structural analysis.
- **STRENGTHENING**: UHPFRC technology in bridge engineering in Switzerland and abroad; bearing capacity and ductility of UHPFRC–RC elements; case studies

Teaching and learning methods

- Lectures, case studies, and exercises
- Field trip and guest lectures (to be confirmed)
- Students will receive reading assignments on bridge construction procedures and management systems to supplement the lecture notes.

Literature

- Course notes and slides
- Menn, C., “Prestressed Concrete Bridges“, Birkhäuser Basel, 1990
- Structural design codes SIA 260-267 & 269 (with emphasis on 260-262 and 269-269/1-269/2-269/3) Eurocodes, EN 1990-1999 (with emphasis on 1990, 1991-2, 1992-2)
- FEDRO technical provisions, standards, methodologies, examples and studies, with emphasis on:
    - ASTRA 12004 Details de construction de ponts: directives
    - ASTRA 82001 Évaluation de ponts routiers existants avec un modèle de charge de trafic actualisé ASTRA 82001 Web-Tool https://astra-82001.epfl.ch/#/
    - ASTRA 82002 CFUP pour la maintenance et la construction d’ouvrages d’art de l’infrastructure routiere
    - ASTRA 84011 Technologien zur überwachung der infrastruktur
- Training and professional updating (with emphasis on FEDRO and IABSE webinars) Scientific papers (additional readings will be announced in class).

Note: Since part of the module content is based on Swiss standards, some literature is provided in German/French only.

Assessment

Additional performance assessment during the semester

The module contains additional performance assessment(s) during the semester. The achieved mark of the additional performance assessment(s) applies to both the regular and the resit exam.

Description of additional performance assessment during the semester

Assignments during the semester (exercise/project) count as 30% of the final grade.

Basic principle for exams

As a rule, all standard final exams are conducted in written form. For resit exams, lecturers will communicate the exam format (written/oral) together with the exam schedule.

Standard final exam for a module and written resit exam

Kind of exam

Written exam

Duration of exam

120 minutes

Permissible aids

No aids permitted

Exception: In case of an electronic Moodle exam, adjustments to the permissible aids may occur. Lecturers will announce the final permissible aids prior to the exam session.

Special case: Resit exam as oral exam

Kind of exam

Oral exam

Duration of exam

30 minutes

Permissible aids

No aids permitted

Modulbeschreibung, verfügbar in: DE

Zustandserfassung von Bauwerken

Allgemeine Angaben

Anzahl ECTS-Credits

3

Modulkürzel

TSM_Build

Gültig für akademisches Jahr

2026-27

Letzte Änderung

2023-08-29

Modul-Koordinator/in

Felix Wenk (OST, felix.wenk@ost.ch)

Erläuterungen zu den Sprachdefinitionen je Standort:

- Der Unterricht findet in der pro Standort und Durchführung definierten Sprache statt.
- Die Unterlagen sind in den pro Standort und Durchführung definierten Sprachen verfügbar. Bei Mehrsprachigkeit ist die prozentuale Verteilung angegeben (100% = komplette Unterlagen).
- Die Prüfungsfragen und -antworten sind in jeder pro Standort und Durchführung definierten Sprache. Die Prüfung wird vor Ort durchgeführt.

	Lausanne			Lugano	Zurich		
Unterricht						**X** D 100%	
Dokumentation						**X** D 100%	
Prüfung						**X** D 100%	

Modulkategorie

TSM Technisch-wissenschaftliche Vertiefung

Profilempfehlungen

Dieses Modul wird für die folgenden Profile empfohlen:

	Zurich
Profil	CE

Lektionen

2 Lektionen und 1 Übungslektion pro Woche

Eintrittskompetenzen

Vorkenntnisse, Eingangskompetenzen

Kenntnisse in Baustatik, Materialtechnologie

Kurzbeschreibung der Inhalte und Ziele

Ein grosser Teil der zukünftigen Bauaufgaben wird an bestehender Bausubstanz durchgeführt werden. Dieses Modul vermittelt dem Masterstudierenden die grundlegenden Methoden und Verfahren zur Erhaltung von Bauwerken.

Die Zustandserfassung mit einer fachlich fundierten Beurteilung ist Grundlage jeder Instandsetzung und ggf. Veränderung von Bauwerken und Infrastrukturanlagen. Die Auseinandersetzung mit bestehenden Tragsystemen, das Erkennen von konstruktiven Zusammenhängen sowie die Beurteilung der aktuellen Tragfähigkeit sind Schwerpunkte der Ausbildung. Anhand von Beispielen aus dem Stahlbeton-, Stahl- und Holzbau lernen die Studierenden die Methodik und die Spezialitäten kennen.

Ziele, Inhalte, Methoden

Lernziele und zu erwerbende Kompetenzen

Die Studierenden erwerben grundlegende Kompetenzen in der Zustandserfassung und Überprüfung von bestehenden Bauwerken. Hierzu werden in den Vorlesungslektionen die Aufgaben und Anforderungen an die Zustandserfassung vermittelt und der notwendige Detaillierungsgrad diskutiert. Der Umfang und Ablauf einer Überprüfung werden in Fallbeispielen eingeübt.

Die Studierenden lernen die gängigsten (zerstörungsfreie und nicht zerstörungsfreie) Untersuchungsmethoden für die Baustoffe Stahlbeton, Stahl und Holz kennen und diese zielgerichtet baupraktisch einzusetzen. Sie erhalten in den Vorlesungslektionen und einem Workshop Informationen über deren Einsatzgebiete und lernen deren Anwendungsgrenzen kennen.

Die Studierenden werden für die wesentlichsten Schädigungsmechanismen und Mängel der gängigsten Stahlbeton-, Stahl- und Holzkonstruktionen sensibilisiert und erwerben Kenntnisse in der statischen Überprüfung und Modellierung von bestehenden Bauwerken. Auf dieses Ziel wird in den Vorlesungslektionen hingearbeitet und in Übungsbeispielen vertieft.

Die Studierenden erhalten Wissen über die gängigsten Instandsetzungsverfahren. Diese werden anhand von baupraktischen Beispielen vermittelt. In den Übungsbeispielen wird das erworbene Wissen vertieft.

Modulinhalt mit Gewichtung der Lehrinhalte

Das Modul gliedert sich in vier Teile:

1. Grundlagen (ca. 10%)

Wesen und Aufgabe der Zustandserfassung / Überprüfung von Bauwerken Anforderungen an eine Zustandsanalyse, Detaillierungsgrad

Ablauf einer Zustandserfassung / Überprüfung (Vorbereitung, Durchführung, Auswertung, Beurteilung)

2. Stahlbetonbau (ca. 60%)

Mängel, Schadenbilder, Schadenursachen, Schadensmechanismen, Schadensausmass zerstörungsfreie und zerstörende Untersuchungsmethoden

Auswertung und Beurteilung Tragsicherheitsanalyse und -beurteilung Instandsetzungs- und Verstärkungsmassnahmen

3. Holzbau (ca. 15%)

Mängel, Schadenbilder, Schadenursachen, Schadensmechanismen, Schadensausmass zerstörungsfreie und zerstörende Untersuchungsmethoden

Auswertung und Beurteilung

Instandsetzungs- und Verstärkungsmassnahmen

4. Stahlbau (ca. 15%)

Mängel, Schadenbilder, Schadenursachen, Schadensmechanismen, Schadensausmass zerstörungsfreie und zerstörende Untersuchungsmethoden

Auswertung und Beurteilung

Instandsetzungs- und Verstärkungsmassnahmen

Lehr- und Lernmethoden

- Frontalunterricht
- Diskussion praktischer Beispiele
- Übungen und Selbststudium ausgewählter Themen

Bibliografie

PowerPoint, Fachartikel, UL F. Wenk / Dr. R. Wagner

Bewertung

Zusätzliche Leistungsbewertung während des Semesters

Das Modul beinhaltet keine zusätzliche Leistungsbewertung während des Semesters.

Grundsatz Prüfungen

Grundsätzlich werden alle regulären Abschlussprüfungen in schriftlicher Form durchgeführt. Bei den Wiederholungsprüfungen teilen die Dozierenden das Prüfungsformat (schriftlich/mündlich) zusammen mit dem Prüfungsplan mit.

Reguläre Modulschlussprüfung und schriftliche Wiederholungsprüfung

Art der Prüfung

Schriftliche Prüfung

Prüfungsdauer

120 Minuten

Erlaubte Hilfsmittel

Erlaubt sind die aufgeführten Hilfsmittel:

Zulässige elektronische Hilfsmittel

Keine elektronischen Hilfsmittel zulässig

Weitere erlaubte Hilfsmittel

Open Book

Ausnahme: Im Falle einer elektronischen Moodle-Prüfung können Änderungen der Hilfsmittel vorkommen. Dozierende werden die endgültig zulässigen Hilfsmittel vor der Prüfung bekanntgeben.

Spezialfall: Wiederholungsprüfung als mündliches Examen

Art der Prüfung

Mündliche Prüfung

Prüfungsdauer

30 Minuten

Erlaubte Hilfsmittel

Ohne Hilfsmittel

Module Description, available in: EN

Business Analytics

General Information

Number of ECTS Credits

3

Module code

TSM_BusAn

Valid for academic year

2026-27

Last modification

2023-08-28

Coordinator of the module

Marcel Dettling (ZHAW, dtli@zhaw.ch)

Explanations regarding the language definitions for each location:

- Instruction is given in the language specified for each location and module execution.
- Documentation is available in the language(s) listed for each location and module execution. If the documentation is in multiple languages, the percentage distributed is indicated (100% = all documentation provided).
- The examination, including both questions and answers, is provided entirely (100%) in the language(s) specified for each location and module execution. The exams are on-site.

	Lausanne			Lugano	Zurich		
Instruction					**X** E 100%		
Documentation					**X** E 100%		
Examination					**X** E 100%		

Module Category

TSM Technical scientific module

Profile Recommendations

This module is recommended for the following profiles:

	Zurich
Profile	BE

Lessons

2 lecture periods and 1 tutorial period per week

Entry level competences

Prerequisites, previous knowledge

Basic knowledge in statistics on the level of an introductory stochastics course.

Brief course description of module objectives and content

Business Analytics (BA) is the science of analyzing enterprise data with statistical methods. The aim is to better understand market, customers, internal processes and the competitive environment, allowing for better and more informed decisions in business. As such, BA goes well beyond simply presenting data, numbers and tables, but focuses on finding new patterns, explaining the occurrence of results and forecasting future development. The essence is to find meaning in the data und successfully deploy it into the daily business life. This course will provide an overview over the principal questions, practices, methods, tools and goals in BA.

Aims, content, methods

Learning objectives and competencies to be acquired

The students understand the benefits that BA offers for an enterprise, i.e. they perceive the potential that quantitative analysis of business data harbors and that it is important to turn data into information. They acquire a comprehensive overview how and in which fields BA can offer added value to a company. The students are able to perform basic tasks in e.g. customer selection, segmentation, demand forecasting and maintenance planning on their own means. They recognize points of contact to other, technical modules such as Predictive Modelling and can strengthen their skills in statistical data analysis.

Module content with weighting of different components

Throughout the course, there will be a strong focus on the process of gaining information from and making use of business data. That involves setting realistic goals, selecting suitable data, drawing unbiased conclusions, reporting facts correctly and deploying the results. This goes along with pointing out some common misconceptions and pitfalls that often repeat themselves in statistical analysis.

The meat of the course will be made up by case studies that cover BA tasks such as customer segmentation, churn analysis, customer selection, demand forecasting, point-of-sale data, customer lifetime value, dynamic pricing, planned maintenance, service science, et cetera. The use and benefits of each of these topics will be explained, methods for practically solving the analysis tasks will be presented in an accessible, non-technical manner and focus on the validity and generalizability of the results will be laid.

Teaching and learning methods

Lectures and practical work on computer with suitable BA tools.

Literature

Slides and lecture notes will be available in addition to recommended book chapters.

Assessment

Additional performance assessment during the semester

The module does not contain an additional performance assessment during the semester

Basic principle for exams

As a rule, all standard final exams are conducted in written form. For resit exams, lecturers will communicate the exam format (written/oral) together with the exam schedule.

Standard final exam for a module and written resit exam

Kind of exam

Written exam

Duration of exam

120 minutes

Permissible aids

Aids permitted as specified below:

Permissible electronic aids

Scientific pocket calculator

Other permissible aids

Written aid of max. 20 pages with arbitrary content (format A4, 10 sheets printed on front and back or 20 pages only front-printed, can be machine-written)

Exception: In case of an electronic Moodle exam, adjustments to the permissible aids may occur. Lecturers will announce the final permissible aids prior to the exam session.

Special case: Resit exam as oral exam

Kind of exam

Oral exam

Duration of exam

30 minutes

Permissible aids

No aids permitted

Module Description, available in: EN

Computational Fluid Dynamics (CFD)

General Information

Number of ECTS Credits

3

Module code

TSM_CFD

Valid for academic year

2026-27

Last modification

2023-09-29

Coordinator of the module

Ernesto Casartelli (HSLU, ernesto.casartelli@hslu.ch)

Explanations regarding the language definitions for each location:

- Instruction is given in the language specified for each location and module execution.
- Documentation is available in the language(s) listed for each location and module execution. If the documentation is in multiple languages, the percentage distributed is indicated (100% = all documentation provided).
- The examination, including both questions and answers, is provided entirely (100%) in the language(s) specified for each location and module execution. The exams are on-site.

	Lausanne			Lugano	Zurich		
Instruction					**X** E 100%		
Documentation					**X** E 100%		
Examination					**X** E 100%		

Module Category

TSM Technical scientific module

Profile Recommendations

This module is recommended for the following profiles:

	Zurich
Profile	EnEn, ME

Lessons

2 lecture periods and 1 tutorial period per week

Entry level competences

Prerequisites, previous knowledge

- Knowledge of fluid mechanics: laminar, turbulent, compressible, incompressible, steady-state and non-steady-state flow
- Knowledge of thermodynamics: conservation of mass and energy, equation of state (ideal gas, incompressible fluid), heat capacity, thermal conductivity
- Basic knowledge of numerical methods
- Basic knowledge of CFD simulation methods and tools is desirable

Brief course description of module objectives and content

This module provides students with an introduction to CFD by imparting knowledge of state-of-the-art techniques in computational fluid dynamics, with the emphasis on fluid physics and verification/assessment.

Aims, content, methods

Learning objectives and competencies to be acquired

Students who have completed this module are able to:

- understand the potential of computational fluid dynamics for product development and be aware of its limits
- verify simulation results and critically assess simulation models
- understand the properties of the numerics behind the code

Module content with weighting of different components

- **Motivation**: objectives of computational fluid dynamics, meaning and economic benefit of numerical simulation, integration of numerical simulation in product development, possibilities and limits
- **Introduction to physical and technical systems and their describing equations**: fluid mechanics, thermodynamics, others
- **Idealization and modeling**: classification of the simulation tasks (steady-state, transition, 2D, 3D, symmetry, etc.), modeling based on geometry, flow properties, boundary conditions
- **Verification and assessment**: solving equations correctly, solving the correct equations, interpretation of simulation results, error possibilities and sources

Teaching and learning methods

Ex cathedra, practical exercises and case studies

Literature

- H.K. Versteeg, W.Malalasekera, An Introduction to Computational Fluid Dynamics, Pearson Prentice Hall, 2007, Second Edition
- F. Moukalled, L. Mangani, M. Darwish, The Finite Volume Method in Computational Fluid Dynamics, Springer, 2015
- J. H. Ferziger, M. Peric, Computational Methods for Fluid Dynamics, Springer, 2002, Third Edition

Assessment

Additional performance assessment during the semester

The module does not contain an additional performance assessment during the semester

Basic principle for exams

As a rule, all standard final exams are conducted in written form. For resit exams, lecturers will communicate the exam format (written/oral) together with the exam schedule.

Standard final exam for a module and written resit exam

Kind of exam

Written exam

Duration of exam

120 minutes

Permissible aids

Aids permitted as specified below:

Permissible electronic aids

calculator

Other permissible aids

Short summary, max 7 pages, no prepared answers to exercises and questions

Exception: In case of an electronic Moodle exam, adjustments to the permissible aids may occur. Lecturers will announce the final permissible aids prior to the exam session.

Special case: Resit exam as oral exam

Kind of exam

Oral exam

Duration of exam

30 minutes

Permissible aids

No aids permitted

Module Description, available in: EN, FR

Computational Structural Mechanics (CSM)

General Information

Number of ECTS Credits

3

Module code

TSM_CSM

Valid for academic year

2026-27

Last modification

2023-08-28

Coordinator of the module

Ralf Baumann (HSLU, ralf.baumann@hslu.ch)

Explanations regarding the language definitions for each location:

- Instruction is given in the language specified for each location and module execution.
- Documentation is available in the language(s) listed for each location and module execution. If the documentation is in multiple languages, the percentage distributed is indicated (100% = all documentation provided).
- The examination, including both questions and answers, is provided entirely (100%) in the language(s) specified for each location and module execution. The exams are on-site.

	Lausanne			Lugano	Zurich		
Instruction		**X** F 100%			**X** E 100%		
Documentation		**X** F 80%	**X** E 20%		**X** E 100%		
Examination		**X** F 100%			**X** E 100%		

Module Category

TSM Technical scientific module

Profile Recommendations

This module is recommended for the following profiles:

	Lausanne	Zurich
Profile	ME	ME

Lessons

2 lecture periods and 1 tutorial period per week

Entry level competences

Prerequisites, previous knowledge

- Very good knowledge of mechanics and strength analysis
- Knowledge of numerical methods
- Basic knowledge of simulation methods such as FEM

Brief course description of module objectives and content

The module provides students with comprehensive knowledge in the numerical simulation of demanding static and dynamic problems in structural mechanics. Special emphasis is placed on validation methods for the models and verification possibilities for the results.

Aims, content, methods

Learning objectives and competencies to be acquired

After completing this module, students will be able

- to apply in-depth knowledge of the theory of the finite element method in practice;
- to approach simulation tasks systematically;
- to exploit the possibilities of numerical simulations for structural-mechanical problems in product development, but also to know their limits;
- to verify simulation results and to validate simulation models;
- to assess the importance of nonlinear effects and to consider them in nonlinear simulations;
- to set up and carry out dynamic simulations.

Module content with weighting of different components

- **Introduction**: sophisticated numerical simulation in product development, meaning, possibilities and limits
- **Theory of the finite element method**: method of the weighted residual, principle of virtual work, discretization, approach functions and element classes, numerical integration, assembling of the equation system
- **Idealization and modeling**: classification of simulation tasks (static, dynamic, linear, nonlinear, stationary, transient, 2D, 3D, symmetry, etc.), selection of correct elements, material properties, boundary conditions, loads, equation solution
- **Verification and validation**: correct solving of correct equations, interpretation of simulation results, possible errors and error sources
- **Nonlinearities**: geometric nonlinearities, stability problems, nonlinearity of materials (material models), contact problems and their modelling
- **Dynamics**: eigenfrequency analysis, direct time integration (explicit and implicit), modal superposition, response analyses

Week	Topic
1	Introduction to numerical simulation and methods
2	Theory of FEM
3	Theory of FEM
4	Idealizations in structural mechanics
5	Modelling and solution methods
6	Interpretation, verification and validation
7	Introduction to nonlinear FE simulations
8	Geometric nonlinearities and contacts
9	Stability problems (buckling, etc.)
10	Nonlinear material models
11	Nonlinear material models
12	Natural frequency analysis, modal analysis
13	Direct explicit and implicit time integration, damping
14	Modal superposition, response analysis in the frequency domain

The module is divided into 3 courses:

Course	Title	Week
1	Theory of the Finite Element Method	1-6
2	Nonlinear structural mechanics	7-11
3	Structural dynamics	12-14

Teaching and learning methods

Lectures, exercises and case studies

Literature

- Huebner K.H., The Finite Element Method for Engineers, John Wiley & Sons Inc, 2001
- Zahavi E., Barlam D., Nonlinear Problems in Machine Design, CRC-Press, 2001
- Bathe K.J., Finite Element Procedures, 2nd ed., 2014
- Humar J.L., Dynamics of Structures, Prentice Hall, 1990

Assessment

Additional performance assessment during the semester

The module does not contain an additional performance assessment during the semester

Basic principle for exams

As a rule, all standard final exams are conducted in written form. For resit exams, lecturers will communicate the exam format (written/oral) together with the exam schedule.

Standard final exam for a module and written resit exam

Kind of exam

Written exam

Duration of exam

120 minutes

Permissible aids

Aids permitted as specified below:

Permissible electronic aids

Calculator; Laptop is not allowed

Other permissible aids

Open book

Exception: In case of an electronic Moodle exam, adjustments to the permissible aids may occur. Lecturers will announce the final permissible aids prior to the exam session.

Special case: Resit exam as oral exam

Kind of exam

Oral exam

Duration of exam

30 minutes

Permissible aids

Aids permitted as specified below:

Permissible electronic aids

Calculator; Laptop is not allowed

Other permissible aids

Open book

Description du module, disponible en: EN, FR

Mécanique numérique des structures (CSM)

Informations générales

Nombre de crédits ECTS

3

Code du module

TSM_CSM

Valable pour l'année académique

2026-27

Dernière modification

2023-08-28

Coordinateur/coordinatrice du module

Ralf Baumann (HSLU, ralf.baumann@hslu.ch)

Explications concernant les langues d'enseignement par site :

- L'enseignement est dispensé dans la langue indiquée ci-dessous pour chaque site et chaque exécution du module.
- Les supports de cours sont disponibles dans les langues indiquées ci-dessous pour chaque site et chaque exécution du module. Lorsque plusieurs langues sont utilisées, la proportion de contenu disponible dans chaque langue est précisée (100 % = ensemble des supports de cours).
- Les examens (questions et réponses) sont entièrement rédigés dans la langue indiquée ci-dessous pour le site et l'exécution du module concernés. Ils se déroulent en présentiel.

	Lausanne			Lugano	Zurich		
Leçons		**X** F 100%			**X** E 100%		
Documentation		**X** F 80%	**X** E 20%		**X** E 100%		
Examen		**X** F 100%			**X** E 100%		

Catégorie de module

TSM approfondissement technico-scientifique

Recommandations de profil

Ce module est recommandé pour les profils suivants :

	Lausanne	Zurich
Profil	ME	ME

Leçons

2 leçons et 1 leçon de pratique par semaine

Compétences préalables

Connaissances préalables, compétences initiales

- Très bonnes connaissances en mécanique des structures et résistance des matériaux
- Connaissances des méthodes numériques
- Connaissances de base des méthodes de simulation telle que la simulation FEM

Brève description du contenu et des objectifs

Le module transmet aux étudiants des connaissances étendues en simulation numérique de problèmes statiques et dynamiques avancés de la mécanique des structures. Une importance particulière est attachée à la validation des modèles de simulation et aux possibilités de vérification des résultats.

Objectifs, contenus, méthodes

Objectifs d'apprentissage, compétences à acquérir

Une fois ce module achevé, les étudiants seront capables

- d'appliquer en pratique la théorie de la méthode des éléments finis;
- d'aborder de manière systématique des problèmes de simulation numérique;
- d'exploiter, dans le cadre du développement de produits, le potentiel de la simulation numérique pour les problèmes de mécanique des structures, mais aussi d'en connaître les limitations;
- de valider un modèle de simulation et de vérifier les résultats obtenus;
- d'évaluer l'influence d'effets non-linéaires et d'en tenir compte dans le cadre de simulations non-linéaires;
- d'effectuer des simulations dynamiques.

Contenu des modules avec pondération du contenu des cours

- **Introduction**: simulation numérique avancée dans le développement de produits, importance, possibilités et limitations
- **Théorie de la méthode des éléments finis**: méthode des résidus pondérés, principe du travail virtuel, discrétisation, fonctions d'interpolation et classes d'éléments, intégration numérique, mise en place du système d'équations
- **Modélisation**: classification des types de simulation (statique, dynamique, linéaire, non-linéaire, stationnaire, non-stationnaire, 2D, 3D, symétrique, etc.), sélection des éléments appropriés, propriétés des matériaux, conditions limites, charges, résolution des équations
- **Vérification et validation**: résolution des équations, interprétation des résultats de la simulation, connaissance des erreurs possibles et des sources d'erreurs
- **Non-linéarités**: non-linéarités géométriques, problèmes de stabilité, non-linéarité du comportement des matériaux (modèles constitutifs de matériaux), problèmes de contact et leur modélisation
- **Dynamique**: analyse modale, intégration temporelle directe (explicite et implicite), superposition modale, analyses de réponse en fréquence

Semaine	Thème
1	Introduction à la simulation et aux méthodes numériques
2	Théorie de la méthode des éléments finis (FEM)
3	Théorie de la méthode des éléments finis (FEM)
4	Modélisation en mécanique des structures
5	Modélisation et procédés de résolution
6	Interprétation des résultats, vérification et validation
7	Introduction aux simulations FEM non-linéaires
8	Non-linéarités géométriques et contacts
9	Problèmes de stabilité (flambage, voilement, etc.)
10	Modèles de matériaux non-linéaires
11	Modèles de matériaux non-linéaires
12	Analyse modale, détermination des fréquences propres
13	Intégration temporelle directe (explicite et implicite, amortissement)
14	Superposition modale, analyse de réponse en fréquence

Le module est subdivisé en 3 cours.

Cours	Désignation	Semaine
1	Théorie de la méthode des éléments finis	1-6
2	Mécanique des structures non-linéaires	7-11
3	Dynamique des structures	12-14

Méthodes d'enseignement et d'apprentissage

Cours frontal, exercices et études de cas

Bibliographie

- Robert D. Cook, Concepts and applications of Finite Element Analysis, 2002
- Huebner K.H., The Finite Element Method for Engineers, John Wiley & Sons Inc, 2001
- Zahavi E., Barlam D., Nonlinear Problems in Machine Design, CRC-Press, 2001

- Bathe K.J., Finite Element Procedures, 2nd ed., 2014
- Humar J.L., Dynamics of Structures, Prentice Hall, 1990

Evaluation

Évaluation supplémentaire pendant le semestre

Le module ne comprend pas d'évaluation supplémentaire pendant le semestre

Principe pour les examens

En règle générale, tous les examens réguliers de fin de module se déroulent sous forme écrite. Concernant les examens de répétition, leur format (écrit ou oral) sera communiqué par l'enseignant-e en même temps que le calendrier des examens.

Examen de fin de module régulier et examen écrit de répétition

Type de l'examen

Examen écrit

Durée de l'examen

120 minutes

Aides autorisées

Les aides suivantes sont autorisées:

Aides électroniques autorisées

Calculatrice; pas de laptop

Autres aides autorisées

Open book

Exception : En cas d'examen électronique sur Moodle, des modifications des aides autorisées peuvent survenir. Dans ce cas, les aides autorisées seront annoncées par les enseignant-e-s avant l'examen.

Cas spécial: examen de répétition oral

Type de l'examen

Examen oral

Durée de l'examen

30 minutes

Aides autorisées

Les aides suivantes sont autorisées:

Aides électroniques autorisées

Calculatrice; pas de laptop

Autres aides

Open book

Module Description, available in: EN

Causal AI

General Information

Number of ECTS Credits

3

Module code

TSM_CausAI

Valid for academic year

2026-27

Last modification

2024-10-01

Coordinator of the module

Marco Zaffalon (SUPSI, marco.zaffalon@supsi.ch)

Explanations regarding the language definitions for each location:

- Instruction is given in the language specified for each location and module execution.
- Documentation is available in the language(s) listed for each location and module execution. If the documentation is in multiple languages, the percentage distributed is indicated (100% = all documentation provided).
- The examination, including both questions and answers, is provided entirely (100%) in the language(s) specified for each location and module execution. The exams are on-site.

	Lausanne			Lugano	Zurich		
Instruction				**X** E 100%			
Documentation				**X** E 100%			
Examination				**X** E 100%			

Module Category

TSM Technical scientific module

Profile Recommendations

This module is recommended for the following profiles:

	Lugano
Profile	DS

Lessons

2 lecture periods and 1 tutorial period per week

Entry level competences

Prerequisites, previous knowledge

Basics of probability theory and machine learning.

Brief course description of module objectives and content

Automatising causal inference is one of the main challenges for making artificial intelligence (AI) reliable and thus really useful in the real world, as more and more emphasised by scientists and practitioners:

“Machines’ lack of understanding of causal relations is perhaps the biggest roadblock to giving them human-level intelligence.” (Judea Pearl, Turing Award winner and AI pioneer.)

“Causality is very important for the next steps of progress of machine learning.” (Yoshua Bengio, Turing Award winner and “Godfather of Deep Learning”.)

“Causal AI is a key enabler of the next wave of AI, where AI moves toward greater decision automation, autonomy, robustness and common sense.” (Gartner, Analyst Firm.)

The list of applications that can be addressed by causal AI is long and important, e.g.: (medical) treatments; marketing strategies; disparity/fairness/discrimination and AI ethics more in general; information fusion; explainability; robustness; various applications in economics, medicine, epidemiology, the social sciences, etcetera.

In order to having access to these capabilities, the module will introduce students with the most important concepts in causal inference. In particular, after a review of concepts in probability and graph theory, it will focus on the treatment of interventions, counterfactual, and mediation analysis. Lectures will be constantly accompanied by examples and made very concrete through exercises based also on software for causal inference.

Aims, content, methods

Learning objectives and competencies to be acquired

This module will enable students to get a solid understanding of the most important concepts and algorithms in causal inference, and to have hands-on experience on the practical use of causal inference. At the end of the module, students will be able to model problems in a causal fashion and have them solved by state-of-the-art algorithms. They will be able to address many types of applications that are not accessible by engineers with a machine learning curriculum alone and that are more and more relevant in the industry.

Module content with weighting of different components

The module will cover the following topics. Introduction: causal inference vs machine learning; review of elementary concepts in probability and statistics; Bayesian networks. Interventions: observational vs randomised controlled studies; causal effects; causal inference in linear systems. Counterfactuals: structural causal models; personal decision making; discrimination; attribution; mediation.

The topics above will be constantly backed up with practical examples and use of software to make inference with structural causal models. Students will eventually be required to work on a (simulated) applied project where they will test their new competences all the way through the modelling of a problem to its solution and evaluation.

Teaching and learning methods

- Lectures / presence
- Tutorial / presence
- Self-study

Literature

Judea Pearl, Madelyn Glymour, Nicholas P. Jewell. Causal Inference in Statistics, a Primer. Wiley, 2016.

Assessment

Additional performance assessment during the semester

The module contains additional performance assessment(s) during the semester. The achieved mark of the additional performance assessment(s) applies to both the regular and the resit exam.

Description of additional performance assessment during the semester

Students will periodically submit parts of an overall home assignment designed to have them practice concretely with the notions studied during the frontal lectures. The overall assignment will count for 1/3 of exam results.

Basic principle for exams

As a rule, all standard final exams are conducted in written form. For resit exams, lecturers will communicate the exam format (written/oral) together with the exam schedule.

Standard final exam for a module and written resit exam

Kind of exam

Written exam

Duration of exam

120 minutes

Permissible aids

Aids permitted as specified below:

Permissible electronic aids

A calculator.

Other permissible aids

A sheet of personal notes.

Exception: In case of an electronic Moodle exam, adjustments to the permissible aids may occur. Lecturers will announce the final permissible aids prior to the exam session.

Special case: Resit exam as oral exam

Kind of exam

Oral exam

Duration of exam

30 minutes

Permissible aids

Aids permitted as specified below:

Permissible electronic aids

A calculator.

Other permissible aids

No other aids permitted

Module Description, available in: EN

Cloud Computing for Advanced

General Information

Number of ECTS Credits

3

Module code

TSM_ClComp

Valid for academic year

2026-27

Last modification

2020-02-10

Coordinator of the module

Thomas Michael Bohnert (ZHAW, thomasmichael.bohnert@zhaw.ch)

Explanations regarding the language definitions for each location:

- Instruction is given in the language specified for each location and module execution.
- Documentation is available in the language(s) listed for each location and module execution. If the documentation is in multiple languages, the percentage distributed is indicated (100% = all documentation provided).
- The examination, including both questions and answers, is provided entirely (100%) in the language(s) specified for each location and module execution. The exams are on-site.

	Lausanne			Lugano	Zurich		
Instruction					**X** E 100%		
Documentation					**X** E 100%		
Examination					**X** E 100%		

Module Category

TSM Technical scientific module

Profile Recommendations

This module is recommended for the following profiles:

	Zurich
Profile	CS

Lessons

2 lecture periods and 1 tutorial period per week

Entry level competences

Prerequisites, previous knowledge

Basic understanding of software and systems engineering, basic usage of Linux, communication technologies/networking.

Brief course description of module objectives and content

Lecture on advanced topics in the domain of Cloud Computing, more precisely covering fundamental concepts, economics, application, operation, development of and for IaaS, PaaS, as well as their application for DevOps and Cloud-Native Applications

Aims, content, methods

Learning objectives and competencies to be acquired

- Conceptual understanding of the principles and architectural design of IaaS and PaaS services, as well as concrete implementations/frameworks.
- Ability to operate and use IaaS-frameworks.
- Ability to operate and use PaaS-frameworks.
- Understanding of Infrastructure as Code and IaaS and PaaS management APIs.
- Ability to design services and service-oriented applications natively for the cloud.
- Ability to leverage features of the cloud, that is on-demand, self-service, elasticity, multi-tenancy, metered service, broadband network access.
- Ability to evaluate the economic, legal and technological advantages of cloud as well as inherent limitations.

Module content with weighting of different components

- Definitions, Motivation, Economics, Principles, Service and Deployment Models, DC Architectures
- Example Application of IaaS (OpenStack)
- Cluster Management - IaaS Resource Orchestration by Example of OpenStack
- Cluster Management - Container Orchestration by Example of Kubernetes
- Virtualization of Compute Resources / Hypervisors
- Virtualization of Compute Resources / Containers
- Virtualization of Networking Resources / Cloud Networking
- Virtualization of Storage Resources / Basic Concepts, Block, File and Object Storage Services
- Infrastructure as Code, Gitops, Declarative State
- Basic Concepts, Architecture of a PAAS, Deployments / Blue--Green, Continuous Deployment., Tools, ArgoCD
- System Design, Resilient Architectures
- Serverless Computing
- Cloud Native Architecture
- Operating Models / Monitoring, Logging, Tracing
- Operations / Rating, Charging, Billing, Product and Service Selection, Economics, Cloud-Financial Management

Teaching and learning methods

2 Lectures, 1 tutorial session per week
Self-study based on lecture material and literature (papers, books)

Literature

Assessment

Additional performance assessment during the semester

The module does not contain an additional performance assessment during the semester

Basic principle for exams

As a rule, all standard final exams are conducted in written form. For resit exams, lecturers will communicate the exam format (written/oral) together with the exam schedule.

Standard final exam for a module and written resit exam

Kind of exam

Written exam

Duration of exam

120 minutes

Permissible aids

Aids permitted as specified below:

Permissible electronic aids

No electronic aids permitted

Other permissible aids

1A4-sheet (double-sided) of hand-written notes, English dictionary

Exception: In case of an electronic Moodle exam, adjustments to the permissible aids may occur. Lecturers will announce the final permissible aids prior to the exam session.

Special case: Resit exam as oral exam

Kind of exam

Oral exam

Duration of exam

30 minutes

Permissible aids

No aids permitted

Description du module, disponible en: FR

Cloud Services and Systems

Informations générales

Nombre de crédits ECTS

3

Code du module

TSM_CloudSys

Valable pour l'année académique

2026-27

Dernière modification

2024-10-31

Coordinateur/coordinatrice du module

Nabil Abdennadher (HES-SO, nabil.abdennadher@hesge.ch)

Explications concernant les langues d'enseignement par site :

- L'enseignement est dispensé dans la langue indiquée ci-dessous pour chaque site et chaque exécution du module.
- Les supports de cours sont disponibles dans les langues indiquées ci-dessous pour chaque site et chaque exécution du module. Lorsque plusieurs langues sont utilisées, la proportion de contenu disponible dans chaque langue est précisée (100 % = ensemble des supports de cours).
- Les examens (questions et réponses) sont entièrement rédigés dans la langue indiquée ci-dessous pour le site et l'exécution du module concernés. Ils se déroulent en présentiel.

	Lausanne			Lugano	Zurich		
Leçons		**X** F 100%					
Documentation			**X** E 100%				
Examen			**X** E 100%				

Catégorie de module

TSM approfondissement technico-scientifique

Recommandations de profil

Ce module est recommandé pour les profils suivants :

	Lausanne
Profil	CS

Leçons

2 leçons et 1 leçon de pratique par semaine

Compétences préalables

Connaissances préalables, compétences initiales

Compréhension de l'ingénierie logicielle et des réseaux, usage basique de Linux, technologies de communication/networking

Brève description du contenu et des objectifs

Ce cours est une introduction aux technologies liées au Cloud et à la containerisation. Il permet à l'étudiant de découvrir et pratiquer les environnements et technologies, propriétaires et open-source, liées au Cloud.

Objectifs, contenus, méthodes

Objectifs d'apprentissage, compétences à acquérir

- Comprendre les concepts, les principes et les architectures des services IaaS, PaaS et FaaS, ainsi que les environnements de déploiement et de mise en œuvre.
- Être capable d'utiliser et de choisir les environnements IaaS, PaaS et FaaS Cloud appropriés.
- Comprendre les API permettant l'accès aux services IaaS, PaaS et SaaS.
- Être capable de choisir les mesures appropriées pour sécuriser un Cloud.
- Savoir concevoir des services et des applications « cloud-natives ».
- Savoir utiliser les caractéristiques du Cloud : ressources à la demande, élasticité, multi-utilisateurs, services mesurés, accès au réseau à large bande.
- Être capable d'évaluer les avantages/limites économiques, juridiques et technologiques du Cloud ainsi que ses limites intrinsèques.

Contenu des modules avec pondération du contenu des cours

- Définition, principes, services et modèles de déploiement (1 session)
- Etude comparative des différents IaaS, PaaS et SaaS, y compris les services de stockage (3 sessions)
- Etude comparative des technologies de conteneurs : Docker, SWARM, Kubernetes (2 sessions)
- Fonctionnement en tant que service basé sur le cloud, informatique sans serveur (1 session)
- Virtualisation des ressources réseau (1 session)
- Sécurité pour le Cloud (1 session)
- Plate-forme en tant que service (2 sessions)
- Déploiement continus (Continuous Delivery and Deployment) dans un environnement Cloud (1 session)
- Persistance et Database-as-a-Service (1 session)
- Applications Cloud-Native (1 session)

Méthodes d'enseignement et d'apprentissage

En plus des 3 périodes du cours, l’équivalent de 3 périodes de travail personnel est demandé à chaque étudiant.

Bibliographie

Evaluation

Évaluation supplémentaire pendant le semestre

Le module comprend une ou des évaluation(s) supplémentaire(s) pendant le semestre. La note obtenue pour la ou les évaluation(s) supplémentaire(s) est valable à la fois pour l'examen final et pour l'examen de répétition.

Description de l'évaluation supplémentaire pendant le semestre

Les labos compteront 1/3 de la note finale. L'examen final comptera 2/3 de la note finale.

Principe pour les examens

En règle générale, tous les examens réguliers de fin de module se déroulent sous forme écrite. Concernant les examens de répétition, leur format (écrit ou oral) sera communiqué par l’enseignant-e en même temps que le calendrier des examens.

Examen de fin de module régulier et examen écrit de répétition

Type de l'examen

Examen écrit

Durée de l'examen

120 minutes

Aides autorisées

Les aides suivantes sont autorisées:

Aides électroniques autorisées

Aucune aide électronique autorisée

Autres aides autorisées

1 page A4 de notes rédigées à la main

Exception : En cas d'examen électronique sur Moodle, des modifications des aides autorisées peuvent survenir. Dans ce cas, les aides autorisées seront annoncées par les enseignant-e-s avant l'examen.

Cas spécial: examen de répétition oral

Type de l'examen

Examen oral

Durée de l'examen

30 minutes

Aides autorisées

Sans aides

Module Description, available in: EN

Managing complexity and innovation in aviation

General Information

Number of ECTS Credits

3

Module code

TSM_CompAvi

Valid for academic year

2026-27

Last modification

2019-10-06

Coordinator of the module

Siddhartha Arora (ZHAW, xars@zhaw.ch)

Explanations regarding the language definitions for each location:

- Instruction is given in the language specified for each location and module execution.
- Documentation is available in the language(s) listed for each location and module execution. If the documentation is in multiple languages, the percentage distributed is indicated (100% = all documentation provided).
- The examination, including both questions and answers, is provided entirely (100%) in the language(s) specified for each location and module execution. The exams are on-site.

	Winterthur			
Instruction	**X** E 100%			
Documentation	**X** E 100%			
Examination	**X** E 100%			

Module Category

TSM Technical scientific module

Profile Recommendations

This module is recommended for the following profiles:

	Zurich
Profile	Avi

Lessons

2 lecture periods and 1 tutorial period per week

Entry level competences

Prerequisites, previous knowledge

Modelling methods

Brief course description of module objectives and content

Macro: Role of innovation within aviation industry, growth-driven economy, National Innovation Systems, mission oriented policies, the entrepreneurial state, role of SDGs, competitive forces

Micro: Role of innovation at firm and entrepreneur levels

Appreciation and understanding of complexity and complex systems, particularly from an innovation perspective, identifying and understanding problems and identifying solutions through entrepreneurial methods.

Measuring, visualising and modelling complex systems, including networks.

Methods for protecting and exploiting ideas, incl. patents, trade secrets, standards, lobbying.

Methods and principles of innovation incl. open innovation, technology readiness assessments (TRA), technology roadmaps, biomimicry, technological determinism and momentum, serendipity, uncertainty, risks vs. rewards, business model innovation, business model canvas.

Failures, frauds and fiascos – a closer look and where innovation can go wrong and methods of mitigation (e.g. whistleblowing).

Students will also develop and present an elevator pitch of an innovation based on techniques learned in the course.

Based on availability, experts from industry will be invited to share their experiences on related topics.

Aims, content, methods

Learning objectives and competencies to be acquired

Understand and enhance performance in complex systems. Cope with interdependence and uncertainly. Develop new solutions in a complex market.

Assess potential for innovation: Take advantage of opportunities, avoid unnecessary risks.

Balance multiple requirements: political, economic, social, technological legal and environmental.

Ultimately: understand and respect that meaning of innovation in a complex world -- and that innovation is not merely about novelty, or is it a buzzword.

Module content with weighting of different components

- Principles of Innovation

- Standards and Regulations

- Business Model Innovation & Design

- National Innovation Systems & Aviation Policies

- Frauds, Failures & Fiascos

- Principles of Complexity

Teaching and learning methods

Case Studies

Modelling

Visualization and communication

Leadership and Self-Management

Literature

Reading material will be uploaded to Course Moodle page during the semester.

Literature will be based on seminal works/papers and relevant case studies to better understand course material.

Assessment

Additional performance assessment during the semester

The module contains additional performance assessment(s) during the semester. The achieved mark of the additional performance assessment(s) applies to both the regular and the resit exam.

Description of additional performance assessment during the semester

30% of grade will be based on completing assignments during semester-

70% of grade will be based on a final exam.

Basic principle for exams

As a rule, all standard final exams are conducted in written form. For resit exams, lecturers will communicate the exam format (written/oral) together with the exam schedule.

Standard final exam for a module and written resit exam

Kind of exam

Written exam

Duration of exam

120 minutes

Permissible aids

Aids permitted as specified below:

Permissible electronic aids

- Non-programmable calculator

Other permissible aids

No other aids permitted

Exception: In case of an electronic Moodle exam, adjustments to the permissible aids may occur. Lecturers will announce the final permissible aids prior to the exam session.

Special case: Resit exam as oral exam

Kind of exam

Oral exam

Duration of exam

30 minutes

Permissible aids

No aids permitted

Module Description, available in: EN

Machine Learning in Computer Vision

General Information

Number of ECTS Credits

3

Module code

TSM_CompVis

Valid for academic year

2026-27

Last modification

2024-10-17

Coordinator of the module

Thomas Koller (HSLU, thomas.koller@hslu.ch)

Explanations regarding the language definitions for each location:

- Instruction is given in the language specified for each location and module execution.
- Documentation is available in the language(s) listed for each location and module execution. If the documentation is in multiple languages, the percentage distributed is indicated (100% = all documentation provided).
- The examination, including both questions and answers, is provided entirely (100%) in the language(s) specified for each location and module execution. The exams are on-site.

	Lausanne			Lugano	Zurich		
Instruction					**X** E 100%		
Documentation					**X** E 100%		
Examination					**X** E 100%		

Module Category

TSM Technical scientific module

Profile Recommendations

This module is recommended for the following profiles:

	Zurich
Profile	CS

Lessons

2 lecture periods and 1 tutorial period per week

Entry level competences

Prerequisites, previous knowledge

Prerequisites:

- Basic knowledge of machine learning (e.g. Andrew Ng's ML course on Coursera)
- Good command of an imperative programming language, basic knowledge of Python (the module will use Python 3).
- http://www.scipy-lectures.org/index.html Sections 1.1, 1.2, 1.3, 3.6.1, 3.6.2
- Basic knowledge of probability, statistics, linear algebra (vectors, matrices)
- Students are expected to take their laptops for the Lab activities

Brief course description of module objectives and content

Analyzing images is a complex task that has many important real-world applications. In this module, we first present some foundations of image processing, such as filters, binarization, edge detection and finding lines and objects. We then study methods based on machine learning and deep learning to classify images, detect and localize objects and segment images pixelwise for example for medical image analysis. The most important deep learning architectures are discussed as well as some advanced uses for image synthesis, such as adversarial networks and neural style transfer.

Aims, content, methods

Learning objectives and competencies to be acquired

- Students know how images and 3D data are represented and manipulated by software
- Students know the most important problems related to image analysis: e.g. image classification, segmentation and object detection and localisation
- Students can apply machine learning and deep learning techniques to solve image-related problems, and deal with practical issues arising in the field (dataset engineering, data augmentation, data normalization)
- Students have seen different examples of image analysis problems and common solution techniques, and are able to acquire additional expert knowledge from the scientific literature and online resources

Module content with weighting of different components

- Introduction
- Basic image processing methods applied to document processing: binarization; edge detection, filtering, segmentation of text into lines, words and characters; connected component analysis.
- Image classification
  - applications to OCR: handcrafted features; convolutional neural networks.
  - Image classification with small datasets.
- Segmentation
  - applications to medical images (2D, 3D)
  - fully convolutional networks for semantic segmentation.
- Object detection
  - face detection with cascading classifiers
  - pedestrian detection for autonomous driving
  - 2 stage and single shot approaches for object detection and localisation
- Generative models and Image Synthesis
  - Applications to Image Inpainting;
  - Generative Adversarial Networks;
  - Neural style transfer.

Teaching and learning methods

Classroom teaching; programming exercises using python and frameworks in python

Literature

- Computer Vision: Algorithms and Applications, Richard Szeliski, 2010
- Deep Learning with Python, Francois Chollet, early 2018, Sections 5, 8.3, 8.5

Assessment

Additional performance assessment during the semester

The module does not contain an additional performance assessment during the semester

Basic principle for exams

As a rule, all standard final exams are conducted in written form. For resit exams, lecturers will communicate the exam format (written/oral) together with the exam schedule.

Standard final exam for a module and written resit exam

Kind of exam

Written exam

Duration of exam

120 minutes

Permissible aids

Aids permitted as specified below:

Permissible electronic aids

No electronic aids permitted

Other permissible aids

10 A4 pages (2 sided)

Exception: In case of an electronic Moodle exam, adjustments to the permissible aids may occur. Lecturers will announce the final permissible aids prior to the exam session.

Special case: Resit exam as oral exam

Kind of exam

Oral exam

Duration of exam

30 minutes

Permissible aids

No aids permitted

Module Description, available in: EN

Cyber Security

General Information

Number of ECTS Credits

3

Module code

TSM_CyberSec

Valid for academic year

2026-27

Last modification

2025-10-14

Coordinator of the module

Michael Mäder (HES-SO, michael.maeder@hefr.ch)

Explanations regarding the language definitions for each location:

- Instruction is given in the language specified for each location and module execution.
- Documentation is available in the language(s) listed for each location and module execution. If the documentation is in multiple languages, the percentage distributed is indicated (100% = all documentation provided).
- The examination, including both questions and answers, is provided entirely (100%) in the language(s) specified for each location and module execution. The exams are on-site.

	Lausanne			Lugano	Zurich		
Instruction	**X** E 100%						
Documentation	**X** E 100%						
Examination	**X** E 100%						

Module Category

TSM Technical scientific module

Profile Recommendations

This module is recommended for the following profiles:

	Lausanne
Profile	CS, ICS

Lessons

2 lecture periods and 1 tutorial period per week

Entry level competences

Prerequisites, previous knowledge

- Basic concepts of cryptography
- Knowledge of at least one programming language, such as Python

Brief course description of module objectives and content

The course will first cover the basic knowledge required in the field of computer security, such as the CIA principles (confidentiality, integrity, availability), as well as data security and safety.

The module will build on this foundation to provide students with a comprehensive overview of how to identify and assess threats and risks. Students will then be able to propose and implement a set of mitigation measures. This course will be applied to three areas of security: secure software development, software security, and tool-based web security.

The course covers the following main topics:

- Review of basic security concepts.
- Secure development (DevSecOps)
- Software security
- Web security
- Cyber Threat Intelligence
- Deception techniques
- Social engineering

Aims, content, methods

Learning objectives and competencies to be acquired

- Understand and be able to select the appropriate cryptographic primitives.
- Identify and document the threats and risks to a system and propose various types of mitigation mechanisms.
- Understand, apply, and use processes and tools for secure development.
- Understand and identify vulnerabilities in software and web applications, and propose mitigation measures.

Module content with weighting of different components

Basics (20%) :

- Confidentiality, integrity, availability, authenticity, authorization, accountability.
- Threat models, malware, etc.
- Data protection under the GDPR/nLPD
- Data protection and data obfuscation techniques (pseudonymization, anonymization) in relation to the GDPR/nLPD
- Intrusion Detection and SIEM (Security Information & Event Management)
- Risk and threat analysis and standards

Secure development (40 %) :

- SDLC: DevOps fundamentals and how DevOps teams can build and deliver secure software.
- DevSecOps: how to integrate security into continuous delivery and deployment.
- Security automation tools, patterns, and techniques in DevOps.

Software Security (20 %) :

- Identifying software vulnerabilities (SANS Top 25)
- Software exploitation techniques and tools
- Software protections and mitigations

Web Application Security (20%) :

- Web Vulnerabilities (OWASP Top 10)
- Web Exploitation Techniques and Tools
- Web Security Measures and Mitigation Strategies

Teaching and learning methods

This course includes theoretical presentations and practical exercises (labs).

Literature

Course slides, references to online resources, and book references are mentioned in the module introduction and throughout the semester.

Assessment

Additional performance assessment during the semester

The module contains additional performance assessment(s) during the semester. The achieved mark of the additional performance assessment(s) applies to both the regular and the resit exam.

Description of additional performance assessment during the semester

Practical assignments (labs) will be carried out throughout the semester. These will be assessed and will account for 30% of the final grade.

Basic principle for exams

As a rule, all standard final exams are conducted in written form. For resit exams, lecturers will communicate the exam format (written/oral)

together with the exam schedule.

Standard final exam for a module and written resit exam

Kind of exam

Written exam

Duration of exam

120 minutes

Permissible aids

Aids permitted as specified below:

Permissible electronic aids

- Personal summary (limited number of pages)
- No computer
- No internet access

Other permissible aids

No other aids permitted

Exception: In case of an electronic Moodle exam, adjustments to the permissible aids may occur. Lecturers will announce the final permissible aids prior to the exam session.

Special case: Resit exam as oral exam

Kind of exam

Oral exam

Duration of exam

30 minutes

Permissible aids

No aids permitted

Module Description, available in: EN

Cyber Security Operations

General Information

Number of ECTS Credits

3

Module code

TSM_CyberSecOp

Valid for academic year

2026-27

Last modification

2023-10-07

Coordinator of the module

Hannes Spichiger (HSLU, hannes.spichiger@hslu.ch)

Explanations regarding the language definitions for each location:

- Instruction is given in the language specified for each location and module execution.
- Documentation is available in the language(s) listed for each location and module execution. If the documentation is in multiple languages, the percentage distributed is indicated (100% = all documentation provided).
- The examination, including both questions and answers, is provided entirely (100%) in the language(s) specified for each location and module execution. The exams are on-site.

	Lausanne			Lugano	Zurich		
Instruction					**X** E 100%		
Documentation					**X** E 100%		
Examination					**X** E 100%		

Module Category

TSM Technical scientific module

Profile Recommendations

This module is recommended for the following profiles:

	Zurich
Profile	ICS

Lessons

2 lecture periods and 1 tutorial period per week

Entry level competences

Prerequisites, previous knowledge

Students should have a basic understanding of the fundamentals of cybersecurity, including network security, system security, and cryptography. Additionally, they should have a good understanding of operating systems, and network architecture. Basic knowledge of OSINT would also be beneficial.

Brief course description of module objectives and content

This module is designed to provide a practical introduction to Cyber Security Operations. Students will learn about different operational security functions like SOCs, CERTs, DFIR teams, CTI and Hunt teams, Red and Blue teams, and the tools they use to detect and respond to cyber criminal activity. The module provides in depth coverage of digital forensics.

Aims, content, methods

Learning objectives and competencies to be acquired

Upon completion of the module, students should be able to:

- Understand operational cyber security roles and responsibilities within an organization,
- Explain basic concepts of detection, incident response, threat intelligence, and security testing.
- Perform digital evidence preservation and forensic analysis, conduct investigations
- Write forensic/incident reports for different recipients (police, regulators, management, technical peers)
- Understand how ethical hacking can be used to improve the security of systems

Module content with weighting of different components

DFIR: Digital Forensics and Incident Response (DFIR) is the main focus of the module. This includes securing and preserving digital evidence, forensic analysis, reconstructing past events, creating timelines, and performing investigations.

Detection: students will be introduced to logging and monitoring systems, intrusion and anomaly detection systems (HIDS and NIDS), and Security Information and Event Management (SIEM) systems, and other operational aspects of detection.

CTI: students will be introduced to Cyber Threat Intelligence (CTI), the intelligence process and lifecycle, intel sharing communities, intel / IOC exchange platforms (like MISP), and OSINT.

Security testing: The testing component covers a high level overview of penetration/Red-Team testing, security reviews, cyber excercises, and ethical hacking. The use of Bug-Bounty programs to improve security is also explained

Teaching and learning methods

Lectures with a mix of practical and theoretical exercises.

Literature

The following material is provided:

- Teacher's slides and notes
- Selected publications (papers, books)
- Relevant videos

Assessment

Additional performance assessment during the semester

The module does not contain an additional performance assessment during the semester

Basic principle for exams

As a rule, all standard final exams are conducted in written form. For resit exams, lecturers will communicate the exam format (written/oral) together with the exam schedule.

Standard final exam for a module and written resit exam

Kind of exam

Written exam

Duration of exam

120 minutes

Permissible aids

Aids permitted as specified below:

Permissible electronic aids

No electronic aids permitted

Other permissible aids

Open book, students may use the materials provided during lectures

Exception: In case of an electronic Moodle exam, adjustments to the permissible aids may occur. Lecturers will announce the final permissible aids prior to the exam session.

Special case: Resit exam as oral exam

Kind of exam

Oral exam

Duration of exam

30 minutes

Permissible aids

Aids permitted as specified below:

Permissible electronic aids

No electronic aids permitted

Other permissible aids

Open book, students may use the materials provided during lectures

Module Description, available in: EN

Multimodal Recommendation Systems and Complex Networks

General Information

Number of ECTS Credits

3

Module code

TSM_DataAnaCla

Valid for academic year

2026-27

Last modification

2025-10-13

Coordinator of the module

Michela Papandrea (SUPSI, michela.papandrea@supsi.ch)

Explanations regarding the language definitions for each location:

- Instruction is given in the language specified for each location and module execution.
- Documentation is available in the language(s) listed for each location and module execution. If the documentation is in multiple languages, the percentage distributed is indicated (100% = all documentation provided).
- The examination, including both questions and answers, is provided entirely (100%) in the language(s) specified for each location and module execution. The exams are on-site.

	Lausanne			Lugano	Zurich		
Instruction				**X** E 100%			
Documentation				**X** E 100%			
Examination				**X** E 100%			

Module Category

TSM Technical scientific module

Profile Recommendations

This module is recommended for the following profiles:

	Lugano
Profile	DS

Lessons

2 lecture periods and 1 tutorial period per week

Entry level competences

Prerequisites, previous knowledge

- Machine Learning and Data Mining
- Python programming
- Basic calculus, linear algebra and statistics concepts

Brief course description of module objectives and content

The module will address the theoretical aspects behind the realisation of Recommendation Systems and will allow students to practice over different use case scenarios. In particular it will address the following RecSys approaches:

- Traditional and Machine Learning based recommendation
- Deep Learning based recommendation
- Complex Networks based recommendation.

Aims, content, methods

Learning objectives and competencies to be acquired

Students understand the theoretical aspects behind the realization of Recommendation Systems and they will learn how to build them over different use case scenarios.

They will learn how recommendation systems work, focusing on three different approaches:

- Traditional and Machine Learning based recommendation
- Deep Learning based recommendation
- Complex Networks based recommendation.

They will learn how to deal with classical recommendation challenges like imbalanced data set problems, cold-start problems, and long tail problems. Additionally they will learn how to evaluate recommendation systems.

They will learn how to deal with complex networks and how to exploit network extracted information to enhance recommendation solutions.

Finally they will learn how to build multimodal recommendation systems exploiting social networks metrics and dynamics in order to deal with content spread and users engagement.

They know the current research directions within these domains.

They can reuse the material acquired in this course in their own working environment and apply them to solve their specific problems

Module content with weighting of different components

The content of the module includes 3 main topics.

Recommendation Systems (70%):

- Traditional and Machine Learning based Recommendation Systems (Collaborative Filtering, Content Based, Knowledge Based, Hybrid)
- Deep Learning based Recommendation Systems
- Evaluation of Recommendation Systems
- Handling challenges in Recommendation Systems (imbalanced data set problems, cold-start problems, long tail problems)

Complex Networks (20%):

- Network Elements (Handling Networks in Code, Density and Sparsity, Subnetworks, Degree, Multilayer and Temporal Networks, Network Representations)
- Network measures (Hubs, Centrality Measures, Centrality Distributions, The Friendship Paradox, Ultra-Small Worlds, Robustness, Core Decomposition, Transitivity, Similarity)
- Network models (Lattice, Random Networks, Small Worlds, Configuration Model, Preferential Attachment, Other Preferential Models)
- Community Detection
- Dynamic models (Ideas, Information, Influence, Epidemic Spreading, Opinion Dynamics, Search)
- Social Media as Networks (es. X/Twitter, Facebook and Reddit)

Multimodal Systems for Recommendation (10%):

- Complex Networks/Social Networks integration
- Use case: Recommendation Systems for Social Networks content spread and users engagement.

Teaching and learning methods

The module is delivered in a flipped classroom format, following a problem-based learning approach. During the lessons, the lecturer will present real-world problems, which the class will work on collaboratively to find solutions.

Throughout this process, the lecturer will facilitate problem solving, introducing new concepts and tools as needed to support the students' learning journey.

Practical activities will complement the theoretical content, allowing students to apply the concepts and methods studied in a hands-on, experiential way.

Literature

Lecture slides, references to internet resources and books

Assessment

Additional performance assessment during the semester

The module contains additional performance assessment(s) during the semester. The achieved mark of the additional performance assessment(s) applies to both the regular and the resit exam.

Description of additional performance assessment during the semester

The evaluation of flipped study assessments will contribute to the final mark as 30% of the final grade.

Basic principle for exams

As a rule, all standard final exams are conducted in written form. For resit exams, lecturers will communicate the exam format (written/oral) together with the exam schedule.

Standard final exam for a module and written resit exam

Kind of exam

Written exam

Duration of exam

120 minutes

Permissible aids

No aids permitted

Exception: In case of an electronic Moodle exam, adjustments to the permissible aids may occur. Lecturers will announce the final permissible aids prior to the exam session.

Special case: Resit exam as oral exam

Kind of exam

Oral exam

Duration of exam

30 minutes

Permissible aids

No aids permitted

Module Description, available in: EN

Data Management

General Information

Number of ECTS Credits

3

Module code

TSM_DataMgmt

Valid for academic year

2026-27

Last modification

2025-10-18

Coordinator of the module

Stefan Keller (OST, stefan.keller@ost.ch)

Explanations regarding the language definitions for each location:

- Instruction is given in the language specified for each location and module execution.
- Documentation is available in the language(s) listed for each location and module execution. If the documentation is in multiple languages, the percentage distributed is indicated (100% = all documentation provided).
- The examination, including both questions and answers, is provided entirely (100%) in the language(s) specified for each location and module execution. The exams are on-site.

	Lausanne			Lugano	Zurich		
Instruction	**X** E 100%				**X** E 100%		
Documentation	**X** E 100%				**X** E 100%		
Examination	**X** E 100%				**X** E 100%		

Module Category

TSM Technical scientific module

Profile Recommendations

This module is recommended for the following profiles:

	Lausanne	Zurich
Profile	DS	DS

Lessons

2 lecture periods and 1 tutorial period per week

Entry level competences

Prerequisites, previous knowledge

- UML Class Diagrams
- Relational Models, Relational Algebra, Normalization
- Relational Database Management Systems (RDBMS) e.g. Codd's 12 rules, ACID, architecture, etc.
- SQL:92 (i.e. INSERT, UPDATE, DELETE and queries with SELECT-FROM-AS-JOIN-WHERE-GROUP BY)
- Query Optimization, Indexes

- Transaction Processing, Concurrency Control
- Security in (Relational) Database Systems
- Knowledge of an operating system including shell

Brief course description of module objectives and content

This course is about Data Engineering and Information Retrieval. It covers methods and technologies for managing, processing and analyzing potentially large and distributed data collections for transactional or analytical use, including multi-model databases and NoSQL stores. And it covers also mastering data in unstructured form (full text search). The course consists of four parts: 1. Database Management; 2. Data Warehousing and Data Analytics (Business Intelligence); 3. Data Integration including Data Synthesis; and 4. Information Retrieval.

Aims, content, methods

Learning objectives and competencies to be acquired

This module covers following important aspects of Data Engineering:

- Students understand the use of modern database technologies for processing and managing potentially large and distributed data collections for transactional or analytical use.
- Students will be proficient in modern query languages such as the post-relational SQL (SQL:2023 and newer).
- Reaching beyond RDBMS, students learn about data structures (data types) and know which of these to use depending on the requirements and type of data available (polyglot persistence, multi-model databases).
- Students know NoSQL stores and selected cloud data stores and understand both the theoretical aspects, as well as some NoSQL modelling techniques.
- Students know methods and tools to integrate, to cleanse and to synthesize data.
- Students understand data warehouses and data lakehouses (features, architectures, modeling, managing volumes of data).
- Students know how to deal with full text information using databases and search engines (information retrieval; prompt engineering).
- Students can also apply the acquired knowledge in their own working environment.

Module content with weighting of different components

The course is divided into four parts:

1. Database Management (DB): New data structures (types) and alternatives to RDBMS. Storing data with post- and non-relational aspects, including NoSQL technologies (especially graph databases), and a selection of advanced topics such as cloud or vector databases.
2. Data Warehousing and Data Analytics (DW): Methods and tools for data aggregation and data analytics such as the ones involved in business intelligence.
3. Data Integration (DI): Methods and tools for data integration, data cleansing and data synthesizing (e.g. for training and testing) are explained.
4. Information Retrieval (IR): Methods and tools for finding information in full text using databases and (enterprise) search engines, including crawling.

Weighting between the parts will be confirmed at the beginning of semester. Tentative weighting:

1. DB: ~4-6 weeks
2. DW: ~2-4 weeks
3. DI: ~1-3 weeks
4. IR: ~3-5 weeks

Teaching and learning methods

Frontal teaching, case studies, exercises, discussions, (group) work assignments (i.e. laboratory work or mini-project).

Literature

Optional literature suggestions (books):

- DB: Advanced Data Management for SQL, NoSQL, Cloud and Distributed Databases. R. Wiese. De Gruyter Textbook. 2015. ISBN 978-3-11-044140-6.
- DB: SQL for Data Scientists: A Beginner's Guide for Building Datasets for Analysis. R. Teate. Wiley. 2021. ISBN 978-1-119-66936-4.
- IR: Introduction to Information Retrieval. C.D. Manning, P. Raghavan, H. Schütze. Cambridge UP, 2008.
- IR: Information Retrieval in Practice. B. Croft, D. Metzler, T. Strohman. Pearson Education, 2009.

Assessment

Additional performance assessment during the semester

The module contains additional performance assessment(s) during the semester. The achieved mark of the additional performance assessment(s) applies to both the regular and the resit exam.

Description of additional performance assessment during the semester

This module includes a performance assessment during the semester which counts for 25% of the final grade for the module.

Basic principle for exams

As a rule, all standard final exams are conducted in written form. For resit exams, lecturers will communicate the exam format (written/oral) together with the exam schedule.

Standard final exam for a module and written resit exam

Kind of exam

Written exam

Duration of exam

120 minutes

Permissible aids

Aids permitted as specified below:

Permissible electronic aids

Scientific calculator (without active communication functions).

Other permissible aids

Summary on one A4 page (possibly written on both sides).

Exception: In case of an electronic Moodle exam, adjustments to the permissible aids may occur. Lecturers will announce the final permissible aids prior to the exam session.

Special case: Resit exam as oral exam

Kind of exam

Oral exam

Duration of exam

30 minutes

Permissible aids

No aids permitted

Modulbeschreibung, verfügbar in: DE

Entwurfsprozesse und -methoden

Allgemeine Angaben

Anzahl ECTS-Credits

3

Modulkürzel

TSM_DesProc

Gültig für akademisches Jahr

2026-27

Letzte Änderung

2018-11-02

Modul-Koordinator/in

Sandra Bühler-Krebs (FHGR, sandra.buehler@fhgr.ch)

Erläuterungen zu den Sprachdefinitionen je Standort:

- Der Unterricht findet in der pro Standort und Durchführung definierten Sprache statt.
- Die Unterlagen sind in den pro Standort und Durchführung definierten Sprachen verfügbar. Bei Mehrsprachigkeit ist die prozentuale Verteilung angegeben (100% = komplette Unterlagen).
- Die Prüfungsfragen und -antworten sind in jeder pro Standort und Durchführung definierten Sprache. Die Prüfung wird vor Ort durchgeführt.

	Lausanne			Lugano	Zurich		
Unterricht						**X** D 100%	
Dokumentation						**X** D 100%	
Prüfung						**X** D 100%	

Modulkategorie

TSM Technisch-wissenschaftliche Vertiefung

Profilempfehlungen

Dieses Modul wird für die folgenden Profile empfohlen:

	Zurich
Profil	ReLa

Lektionen

2 Lektionen und 1 Übungslektion pro Woche

Eintrittskompetenzen

Vorkenntnisse, Eingangskompetenzen

Kenntnisse in Zeichnungsprogrammen (CAD, InDesign) sind hilfreich, aber nicht zwingende Voraussetzung.

Kurzbeschreibung der Inhalte und Ziele

Das Modul vermittelt methodische Grundkompetenzen für den architektonischen Entwurf. In praxisorientierten Übungen als Einzelarbeit oder in Gruppen werden theoretisches Wissen angewendet, Kenntnisse vertieft und interdisziplinäre Zusammenarbeit geübt.

Ziele, Inhalte, Methoden

Lernziele und zu erwerbende Kompetenzen

Die Studierenden erwerben die Fähigkeit, architektonische Entwurfsaufgaben eigenständig und strukturiert zu bearbeiten. Sie lernen unterschiedliche methodische Verfahren und Techniken kennen und anwenden. Einfache Projektarbeiten erstrecken sich dabei vom Einzelobjekt bis zu kleineren städtebaulichen Aufgaben.

Modulinhalt mit Gewichtung der Lehrinhalte

In einem ersten Kursteil werden verschiedene Mittel und Instrumente des architektonischen und städtebaulichen Entwurfs eingeführt und angewendet (Themenschwerpunkte: Ortsbauliche Werte-Analyse, Erarbeiten von Entwurfs-Konzepten, prozessuale Projektentwicklung). Zu jeder Vorlesung ist eine thematisch entsprechende Kurzübung angelegt.
Raumwahrnehmung und Raumbildung sowie unterschiedliche methodische Verfahren bilden den ersten Teil des Moduls. Im zweiten Teil wird eine entwerferische Übung über fünf Wochen entwickelt. Im Zentrum des Kurses stehen Anwendung und Umsetzung von theoretischen Erkenntnissen in der praxisorientierten Übung und der Diskurs unter Studierenden und Dozierenden.

Lehr- und Lernmethoden

Der Kurs umfasst Wissensvermittlung in Form von Vorlesungen und die Vertiefung erworbener Kenntnisse durch Anwendung in betreuten Entwurfsübungen (Atelierunterricht). Gruppenarbeiten dienen der gemeinsamen Erarbeitung von Themen und der Verbesserung der kommunikativen Kompetenz.

Bibliografie

Unterlagen zu Vorlesungen, Fachliteratur (auszugsweise)

Bewertung

Zusätzliche Leistungsbewertung während des Semesters

Das Modul beinhaltet keine zusätzliche Leistungsbewertung während des Semesters.

Grundsatz Prüfungen

Grundsätzlich werden alle regulären Abschlussprüfungen in schriftlicher Form durchgeführt. Bei den Wiederholungsprüfungen teilen die Dozierenden das Prüfungsformat (schriftlich/mündlich) zusammen mit dem Prüfungsplan mit.

Reguläre Modulschlussprüfung und schriftliche Wiederholungsprüfung

Art der Prüfung

Schriftliche Prüfung

Prüfungsdauer

120 Minuten

Erlaubte Hilfsmittel

Erlaubt sind die aufgeführten Hilfsmittel:

Zulässige elektronische Hilfsmittel

Keine elektronischen Hilfsmittel zulässig

Weitere erlaubte Hilfsmittel

Skizzenbuch

Ausnahme: Im Falle einer elektronischen Moodle-Prüfung können Änderungen der Hilfsmittel vorkommen. Dozierende werden die endgültig zulässigen Hilfsmittel vor der Prüfung bekanntgeben.

Spezialfall: Wiederholungsprüfung als mündliches Examen

Art der Prüfung

Mündliche Prüfung

Prüfungsdauer

30 Minuten

Erlaubte Hilfsmittel

Ohne Hilfsmittel

Module Description, available in: EN

DevOps of Cloud-native Applications

General Information

Number of ECTS Credits

3

Module code

TSM_DevOps

Valid for academic year

2026-27

Last modification

2023-11-26

Coordinator of the module

Tiziano Leidi (SUPSI, tiziano.leidi@supsi.ch)

Explanations regarding the language definitions for each location:

- Instruction is given in the language specified for each location and module execution.
- Documentation is available in the language(s) listed for each location and module execution. If the documentation is in multiple languages, the percentage distributed is indicated (100% = all documentation provided).
- The examination, including both questions and answers, is provided entirely (100%) in the language(s) specified for each location and module execution. The exams are on-site.

	Lausanne			Lugano	Zurich		
Instruction				**X** E 100%			
Documentation				**X** E 100%			
Examination				**X** E 100%			

Module Category

TSM Technical scientific module

Profile Recommendations

This module is recommended for the following profiles:

	Lugano
Profile	CS

Lessons

2 lecture periods and 1 tutorial period per week

Entry level competences

Prerequisites, previous knowledge

Programming skills in Java
Ground software engineering skills (in particular design pattern, concurrent programming and application development for the web)

Brief course description of module objectives and content

This course focus on software technologies, architectures, and methodologies for development of cloud-native applications.

Aims, content, methods

Learning objectives and competencies to be acquired

This course provides detailed skills on contemporary software solutions that allow developing cloud-native applications. The course will introduce and deepen the recent evolution of technologies, architectures and methodologies for microservice-based systems, by taking advantage of a DevOps approach.

The course goal is the consolidation of required advanced technical skills for modern software development in the cloud, with particular care on the role played by the recent innovations.

The course will be proposed as a combination of lectures and exercises, including practical demonstrations and laboratory development. Readings will be assigned to students as complementary deepening material.

Module content with weighting of different components

The student will be provided knowledge about modern development methodologies, frameworks and tools, including:

- Introduction to cloud computing technologies (IaaS, PaaS, SaaS and other fundamentals) - 5%
- Tools and methodologies for DevOps and CI/CD - 10%
- Container technologies (Docker) - 10%
- Infrastructures for container orchestration (Kubernetes) - 20%
- Cloud native and micro services oriented development - 15%
- Protocols and technologies for micro services communication - 5%
- Serverless computing technologies (FaaS) - 10%
- Techniques for infrastructure as a code (Terraform) - 10%
- Service mesh, storage orchestration, monitoring and logging - 5%
- Authentication and security - 10%

Teaching and learning methods

Frontal theoretical lessons, demonstrations, examples, exercises

Literature

Assessment

Additional performance assessment during the semester

The module does not contain an additional performance assessment during the semester

Basic principle for exams

As a rule, all standard final exams are conducted in written form. For resit exams, lecturers will communicate the exam format (written/oral) together with the exam schedule.

Standard final exam for a module and written resit exam

Kind of exam

Written exam

Duration of exam

120 minutes

Permissible aids

No aids permitted

Exception: In case of an electronic Moodle exam, adjustments to the permissible aids may occur. Lecturers will announce the final permissible aids prior to the exam session.

Special case: Resit exam as oral exam

Kind of exam

Oral exam

Duration of exam

30 minutes

Permissible aids

No aids permitted

Module Description, available in: EN

Digital health systems

General Information

Number of ECTS Credits

3

Module code

TSM_DigHealth

Valid for academic year

2026-27

Last modification

2022-10-21

Coordinator of the module

Thomas Bürkle (BFH, thomas.buerkle@bfh.ch)

Explanations regarding the language definitions for each location:

- Instruction is given in the language specified for each location and module execution.
- Documentation is available in the language(s) listed for each location and module execution. If the documentation is in multiple languages, the percentage distributed is indicated (100% = all documentation provided).
- The examination, including both questions and answers, is provided entirely (100%) in the language(s) specified for each location and module execution. The exams are on-site.

	Lausanne			Lugano	Zurich		
Instruction					**X** E 100%		
Documentation					**X** E 100%		
Examination					**X** E 100%		

Module Category

TSM Technical scientific module

Profile Recommendations

This module is recommended for the following profiles:

	Zurich
Profile	Med

Lessons

2 lecture periods and 1 tutorial period per week

Entry level competences

Prerequisites, previous knowledge

The following will be helpful to follow the course:

- knowledge about sensor-based - structured data acquisition
- knowledge of database concepts and information systems

Brief course description of module objectives and content

This course provides an in-depth overview of data management in digital healthcare.

Special features and challenges of medical documentation will be discussed including underlying ontologies, classifications and scoring systems. Particular emphasis will be placed on a deeper understanding of different dimensions of interoperability. This knowledge will be used to address exemplary specific tasks in group based case studies. Challenges for software development in the context of the Medical Device Regulation (“MDR”) are covered.

The particular challenges of digital transformation in healthcare are discussed. In particular, the inclusion of empowered patients in future will be discussed and demonstrated, as well as the potential of the merging of lifestyle data, vital data and medical documentation. The topic of data reuse from the different medical applications combined with security issues within the emerging data science centers is also a subject of this module.

Aims, content, methods

Learning objectives and competencies to be acquired

The aim of this lecture is to understand,

- how Data are collected in medicine,
- how these data are organized in a structured and interoperable way,
- the importance of information systems in this context,
- the role of these systems as a basis for digital transformation in the healthcare sector,
- how information systems can be linked with eHealth, mHealth (“mobile Health”), pHealth (“personalized Health”)
- how future active assisted living can be supported
- and the impact of MDR on the professionalization of medical software and apps.

Module content with weighting of different components

- Medical & Health Data Documentation
- Medical Ontologies and Classification
- Hospital & Health Care Information Management Systems
- Dimensions of Interoperability in Health Care Systems
- mHealth ecosystem and participatory design
- case study presentations
- UX design
- Home monitoring
- Using predictive analytics to improve healthcare outcomes
- Digital Health system examples

Teaching and learning methods

Lectures and practical work on computer. Partial flipped classroom teaching with clinical cases which are to be worked up and presented in groups with tasks regarding digital handling of such cases. Site visit of a hospital.

Literature

Slides and lecture notes will be available in addition to recommended book chapters.

Assessment

Additional performance assessment during the semester

The module contains additional performance assessment(s) during the semester. The achieved mark of the additional performance assessment(s) applies to both the regular and the resit exam.

Description of additional performance assessment during the semester

- performance assessment during semester 30%
- written final exam 70%

Basic principle for exams

As a rule, all standard final exams are conducted in written form. For resit exams, lecturers will communicate the exam format (written/oral) together with the exam schedule.

Standard final exam for a module and written resit exam

Kind of exam

Written exam

Duration of exam

120 minutes

Permissible aids

Aids permitted as specified below:

Permissible electronic aids

examination on paper, no electronic or other aids

Other permissible aids

No further aids permitted

Exception: In case of an electronic Moodle exam, adjustments to the permissible aids may occur. Lecturers will announce the final permissible aids prior to the exam session.

Special case: Resit exam as oral exam

Kind of exam

Oral exam

Duration of exam

30 minutes

Permissible aids

No aids permitted

Module Description, available in: EN

Digitalisation in industry

General Information

Number of ECTS Credits

3

Module code

TSM_DigInd

Valid for academic year

2026-27

Last modification

2022-01-14

Coordinator of the module

Felix Nyffenegger (OST, felix.nyffenegger@ost.ch)

Explanations regarding the language definitions for each location:

- Instruction is given in the language specified for each location and module execution.
- Documentation is available in the language(s) listed for each location and module execution. If the documentation is in multiple languages, the percentage distributed is indicated (100% = all documentation provided).
- The examination, including both questions and answers, is provided entirely (100%) in the language(s) specified for each location and module execution. The exams are on-site.

	Lausanne			Lugano	Zurich		
Instruction					**X** E 100%		
Documentation					**X** E 100%		
Examination					**X** E 100%		

Module Category

TSM Technical scientific module

Profile Recommendations

This module is recommended for the following profiles:

	Zurich
Profile	ME

Lessons

2 lecture periods and 1 tutorial period per week

Entry level competences

Prerequisites, previous knowledge

None.

Brief course description of module objectives and content

This modules enables the students to contribute to digital transformaion in the industry. They learn about the fundamental concepts,technical and organisational requirements for digital transformation. They will be able to ask the right questions in a conceptual discussion.

This module offers an overview of digitization in industry from several perspectives.

Aims, content, methods

Learning objectives and competencies to be acquired

- The students obtain an overview of the processes, data structures and information flows based on different product strategies inside a company.
- They are qualified to evaluate different approaches to organize a company regarding the product strategy, product architecture, the production processes and the deployed IT solutions. Relying on this, they are able to identify and apply optimization strategies.
- They are familiar with state-of-the-art concepts of digitization in order to classify efficiency and transparency in production processes (industry 4.0).
- They are familiar with the basic concepts of digitized products, incl. the Internet of Things, and how these are linked to the processes and data streams of the original company in order to increase the range of product related services or business models.
- They can rationally decide between "digital" and "non-digital" solution concepts.

Module content with weighting of different components

Content

The module is structured in three focus areas:

1. Digital Product Development
2. Digitalization in Production
3. Product Service Systems

You will learn the concepts/theory and its industrial application for each focus area. A group project throughout the semester will help you to integrate and apply your knowledge.

Teaching and learning methods

This module will be taught in a flipped classroom setup. Students meet in content groups to elaborate the theory and later meet in project groups, where they introduce the theory to their peers. The process will be closely supervised by the lecturers during on-site/online meetings.

There are 3 fixed on-site appointments (presence required), the other meetings can be arranged according to your/the groups preferences.

Literature

Assessment

Additional performance assessment during the semester

The module contains additional performance assessment(s) during the semester. The achieved mark of the additional performance assessment(s) applies to both the regular and the resit exam.

Description of additional performance assessment during the semester

1/3 Project work

2/3 Written exam

Basic principle for exams

As a rule, all standard final exams are conducted in written form. For resit exams, lecturers will communicate the exam format (written/oral) together with the exam schedule.

Standard final exam for a module and written resit exam

Kind of exam

Written exam

Duration of exam

120 minutes

Permissible aids

Aids permitted as specified below:

Permissible electronic aids

Open Book,
Devices must be in offline mode.

Other permissible aids

No other aids permitted

Exception: In case of an electronic Moodle exam, adjustments to the permissible aids may occur. Lecturers will announce the final permissible aids prior to the exam session.

Special case: Resit exam as oral exam

Kind of exam

Oral exam

Duration of exam

30 minutes

Permissible aids

No aids permitted

Description du module, disponible en: FR

Dynamique des structures

Informations générales

Nombre de crédits ECTS

3

Code du module

TSM_Dynamics

Valable pour l'année académique

2026-27

Dernière modification

2025-10-21

Coordinateur/coordinatrice du module

Abdelkrim Bennani (HES-SO, abdelkrim.bennani@hesge.ch)

Explications concernant les langues d'enseignement par site :

- L'enseignement est dispensé dans la langue indiquée ci-dessous pour chaque site et chaque exécution du module.
- Les supports de cours sont disponibles dans les langues indiquées ci-dessous pour chaque site et chaque exécution du module. Lorsque plusieurs langues sont utilisées, la proportion de contenu disponible dans chaque langue est précisée (100 % = ensemble des supports de cours).
- Les examens (questions et réponses) sont entièrement rédigés dans la langue indiquée ci-dessous pour le site et l'exécution du module concernés. Ils se déroulent en présentiel.

	Lausanne			Lugano	Zurich		
Leçons		**X** F 100%					
Documentation		**X** F 100%					
Examen		**X** F 100%					

Catégorie de module

TSM approfondissement technico-scientifique

Recommandations de profil

Ce module est recommandé pour les profils suivants :

	Lausanne
Profil	CE

Leçons

2 leçons et 1 leçon de pratique par semaine

Compétences préalables

Connaissances préalables, compétences initiales

Bases de la mécanique technique, principe fondamental de la dynamique
Calcul vectoriel et matriciel simple, nombres complexes

Brève description du contenu et des objectifs

Le module fournit des méthodes et des procédures pour comprendre, calculer et mesurer le comportement dynamique des structures mécaniques et montre leur importance pour le développement des structures porteuses.

Objectifs, contenus, méthodes

Objectifs d'apprentissage, compétences à acquérir

Les étudiants comprennent les méthodes de calcul et d'expérimentations de la dynamique des structures et connaissent leurs possibilités et limites.

Contenu des modules avec pondération du contenu des cours

- Oscillateur mono-masse à 1 degré de liberté : Etablissement des équations de mouvement, solution des équations de mouvement homogènes (oscillations libres) et non-homogènes (oscillations forcées), détermination des valeurs propres du système, fonction de transfert (réception, mobilité, accélération), réponse aux signaux d'entrée simples,
- Réduction d'un système complexe à un système à un ddl
- Oscillateurs multi-masses à N degrés de liberté : Etablissement d'équations de mouvement, solution d'équations de mouvement homogènes (oscillations libres) et non homogènes (oscillations forcées) ; solution du problème de la valeur propre et analyse des valeurs propres et des vecteurs propres, fonctions de transfert (réception, mobilité, accélération), réduction modale,
- Analyse modale expérimentale : motivation et objectifs, chaîne de mesure pour les mesures vibratoires, traitement du signal, identification, présentation d'exemples pratiques,
- Modèles d'amortissement pour oscillateurs multi-masses, amortissement modal, amortissement de Rayleigh, détermination de l'amortissement sur la demi-largeur

Méthodes d'enseignement et d'apprentissage

- Cours magistraux
- Expériences pratiques
- Discussions de cas pratiques

Bibliographie

Woernle, C.: Mehrkörpersysteme. Springer-Verlag Berlin, Heidelberg, 2011; ISBN 978-3-642-15981-7

Skript Mehrkörpermechanik und Rotordynamik

Dynamique des structures - Bases et applications pour le génie civil – Pierino Lestuzzi,Ian F.C. Smith – PPUR
Dynamique des structures - Applications aux ouvrages de génie civil – Patrick Paultre – Presses internationales polytechnique

Evaluation

Évaluation supplémentaire pendant le semestre

Le module ne comprend pas d'évaluation supplémentaire pendant le semestre

Principe pour les examens

En règle générale, tous les examens réguliers de fin de module se déroulent sous forme écrite. Concernant les examens de répétition, leur format (écrit ou oral) sera communiqué par l'enseignant-e en même temps que le calendrier des examens.

Examen de fin de module régulier et examen écrit de répétition

Type de l'examen

Examen écrit

Durée de l'examen

120 minutes

Aides autorisées

Les aides suivantes sont autorisées:

Aides électroniques autorisées

Support de cours au format papier

Autres aides autorisées

Aucune autre aide autorisée

Exception : En cas d'examen électronique sur Moodle, des modifications des aides autorisées peuvent survenir. Dans ce cas, les aides autorisées seront annoncées par les enseignant-e-s avant l'examen.

Cas spécial: examen de répétition oral

Type de l'examen

Examen oral

Durée de l'examen

30 minutes

Aides autorisées

Sans aides

Description du module, disponible en: FR

Ecodesign of sustainable and efficient mechanical systems

Informations générales

Nombre de crédits ECTS

3

Code du module

TSM_EcoSysSus

Valable pour l'année académique

2026-27

Dernière modification

2024-10-29

Coordinateur/coordinatrice du module

Claude Jeannerat (HES-SO, claude.jeannerat@he-arc.ch)

Explications concernant les langues d'enseignement par site :

- L'enseignement est dispensé dans la langue indiquée ci-dessous pour chaque site et chaque exécution du module.
- Les supports de cours sont disponibles dans les langues indiquées ci-dessous pour chaque site et chaque exécution du module. Lorsque plusieurs langues sont utilisées, la proportion de contenu disponible dans chaque langue est précisée (100 % = ensemble des supports de cours).
- Les examens (questions et réponses) sont entièrement rédigés dans la langue indiquée ci-dessous pour le site et l'exécution du module concernés. Ils se déroulent en présentiel.

	Lausanne			Lugano	Zurich		
Leçons		**X** F 100%					
Documentation		**X** F 100%					
Examen		**X** F 100%					

Catégorie de module

TSM approfondissement technico-scientifique

Recommandations de profil

Ce module est recommandé pour les profils suivants :

	Lausanne
Profil	ME

Leçons

2 leçons et 1 leçon de pratique par semaine

Compétences préalables

Connaissances préalables, compétences initiales

Culture générale mécanique, bases scientifiques et techniques principalement en conception de machines

Brève description du contenu et des objectifs

On connait les défis que représentent pour nous les enjeux climatiques et plus généralement environnementaux. L'ingénieur d'aujourd'hui doit pouvoir situer son action dans ce contexte.

Les étudiants obtiennent une méthode d'éco-conception appliquée permettant d'appréhender un projet de développement en mettant en adéquation tous les paramètres permettant l'obtention d'un produit technique durable, sociétalement acceptable et performant.

- Ils sont qualifiés pour élargir le champ des paramètres influents d'un CDC et évaluer différentes approches pluridisciplinaires pour réaliser une conception performante, efficiente et efficace (approche du juste besoin*). Le choix et l'intégration optimale de composants à haute performance seront particulièrement étudiés et expérimentés. Cette méthode mettra en évidence la force et la pertinence des outils d'optimisation topologique, compétences spécifiques déployées dans le cours « analyse, simulation et optimisation ».
- Ils connaissent les concepts de pointe de l'écoconception afin de faire bénéficier l'industrie des nouvelles compétences indispensables qui permettront de relever les nouveaux défis environnementaux et sociétaux dans un contexte manufacturier performant et novateur.
- Ils apportent un nouveau sens critique et par les connaissances acquises sont capables de réaliser en autonomie un projet de développement d'une machine selon les qualités et le comportement intrinsèque attendus.

*Définition du juste besoin : Cible pertinente qui associe les besoins conjoints du cahier des charges fonctionnel, des coûts engendrés, de l'acceptabilité d'un maximum d'usagers et des exigences liée au développement durable.

Objectifs, contenus, méthodes

Objectifs d'apprentissage, compétences à acquérir

Ce cours utilise comme fil rouge l'éco-démonstrateur Micro5 développé dans le cadre d'un programme thématique HES-SO (2013-2016).

- Expérimentation au travers d'usinages dynamiques monitorés et qualifiants
- Qualification métrologique et visuelle du produit usiné (validation des paradigmes initiaux)
- Spécificités du comportement des machines-outils de haute précision
- Recherche et analyse du juste besoin (définition et dimensionnement qualitatif)
- Architectures performantes
- Broches haute vitesse (usinage UGV)
- Méthodologie d'écoconception avancée ? Veille technologique « composants » à haute performance, choix et intégration
- Etudes de cas (sens critique – adéquation dimensionnement/besoin, propositions d'amélioration)
- ACV (méthodologie et étude comparative par liste de contrôle entre le concept Micro5 et une machine d'atelier)
- Reconception performante et durable d'un axe complet de machine-outil

Contenu des modules avec pondération du contenu des cours

- Introduction à la conception durable et performante
  - Qu'est-ce qu'une machine éco-conçue
  - Quels sont les critères importants
  - Développement d'un nouveau sens critique
  - Le « juste besoin » comme vecteur marketing
  - Les thématiques principales (bâtis et broches haute vitesse)
  - Sobriété industriel – retour à la "simple" performance
  - Les Low-tech – accès au plus grand nombre / reconfiguration
  - Proposition de thématiques pour futur exposés
  - Propositions mini-projets
- Concept Micro5 (étude de cas)
  - Spécificités - Performances
  - Retour au temps du paysan-horloger ?
  - Une nouvelle génération de machines adaptées aux nouveaux besoins et défis
  - Expérimentation d'usinage
- Ecoconception appliquée
  - Les bonnes pratiques en écoconception
  - Minimisation de la masse et de la taille de la machine => quels gains?
  - Composants à haut rendement
  - Veille technologique - Architecture triangulée
  - minimisation de la boucle des efforts
  - Etude de cas
  - Restitution
  - Broche très haute vitesse
  - Mise en évidence des phénomènes physiques spécifiques
  - Simplification pour plus de performance (externalisation des fonctions)
  - Etat de l'art & diverses recherches
- Travail sur mini projet
  - Application sur mini projet
  - Mise en pratique

- Rendu avec rapport

Méthodes d'enseignement et d'apprentissage

Apport théorique (70%)

Pratique (EC et mini-projets) (30%)

Bibliographie

ANALYSE DU CYCLE DE VIE / Comprendre et réaliser un écobilan / O.JOLLIET M.SAADE P.CRETTAZ S.SHAKED EPFL ISBN 978-2-88074-886-9.

L'Analyse du Cycle de Vie d'un produit ou d'un service - Applications et mise en pratique / Auteur(s) : L. Grisel, P.Osset / ISBN : 2-12-475091-7.

Pour un développement industriel inclusif et durable / Document ONU /

https://www.onu-tn.org/uploads/documents/14029188850.pdf

DIRECTIVE 2009/125/CE DU PARLEMENT EUROPÉEN ET DU CONSEIL du 21 octobre 2009 établissant un cadre pour la fixation d'exigences en matière d'écoconception applicables aux produits liés à l'énergie /

https://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2009:285:0010:0035:fr:PDF

L'Âge des low tech - Vers une civilisation techniquement soutenable ; Philippe Bihouix ; Editions du Seuil Collection Anthropocène ; Parution: mai 2014 ; EAN13:9782021160741

Evaluation

Évaluation supplémentaire pendant le semestre

Le module comprend une ou des évaluation(s) supplémentaire(s) pendant le semestre. La note obtenue pour la ou les évaluation(s) supplémentaire(s) est valable à la fois pour l'examen final et pour l'examen de répétition.

Description de l'évaluation supplémentaire pendant le semestre

L'évaluation supplémentaire sera réalisée par le biais d'un projet réalisé en groupe (max. 5 étudiants (es).

Le travail demandé va permettre d'expérimenter en situation la matière enseignée.

La valorisation sera basée sur une présentation orale de 20 min (idéalement format ppt). Celle-ci sera également transmise au collège de professeurs(es).

La notation par groupe sera réalisée sur la base de la présentation.

Si un étudiant(e) n'est pas actif sur le projet, il peut être sanctionné dans un cas extrême par la note de 1.

Il en va de même si un étudiant(e) ne réalise pas le projet mentionné.

La notation de ce travail représente le 30% de la note du module. En conséquence, l'examen représente 70% de la note finale.

Principe pour les examens

En règle générale, tous les examens réguliers de fin de module se déroulent sous forme écrite. Concernant les examens de répétition, leur format (écrit ou oral) sera communiqué par l'enseignant-e en même temps que le calendrier des examens.

Examen de fin de module régulier et examen écrit de répétition

Type de l'examen

Examen écrit

Durée de l'examen

120 minutes

Aides autorisées

Les aides suivantes sont autorisées:

Aides électroniques autorisées

Aucune aide électronique autorisée

Autres aides autorisées

supports de cours + 2 feuillets A4 de prises de notes personnelles

Exception : En cas d'examen électronique sur Moodle, des modifications des aides autorisées peuvent survenir. Dans ce cas, les aides autorisées seront annoncées par les enseignant-e-s avant l'examen.

Cas spécial: examen de répétition oral

Type de l'examen

Examen oral

Durée de l'examen

30 minutes

Aides autorisées

Les aides suivantes sont autorisées:

Aides électroniques autorisées

Aucune aide électronique autorisée

Autres aides

supports de cours + 2 feuillets A4 de prises de notes personnelles

Module Description, available in: EN, FR

Design of Embedded Hardware and Firmware

General Information

Number of ECTS Credits

3

Module code

TSM_EmbHardw

Valid for academic year

2026-27

Last modification

2019-07-22

Coordinator of the module

Hans Dermot Doran (ZHAW, hans.doran@zhaw.ch)

Explanations regarding the language definitions for each location:

- Instruction is given in the language specified for each location and module execution.
- Documentation is available in the language(s) listed for each location and module execution. If the documentation is in multiple languages, the percentage distributed is indicated (100% = all documentation provided).
- The examination, including both questions and answers, is provided entirely (100%) in the language(s) specified for each location and module execution. The exams are on-site.

	Lausanne			Lugano	Zurich		
Instruction		**X** F 100%			**X** E 100%		
Documentation			**X** E 100%		**X** E 100%		
Examination		**X** F 100%			**X** E 100%		

Module Category

TSM Technical scientific module

Profile Recommendations

This module is recommended for the following profiles:

	Lausanne	Zurich
Profile	EIE	EIE

Lessons

2 lecture periods and 1 tutorial period per week

Entry level competences

Prerequisites, previous knowledge

The students have a working knowledge of programming embedded systems in C.
The students have a working knowledge of basic hardware design including VHDL coding

Brief course description of module objectives and content

This module introduces the student to advanced concepts in modern embedded systems engineering. The module is divided into two sections. The first section is practical/theoretical and is designed to get the student familiar with implementing System on Chip (SoC) designs. The second part discusses formal Hardware/Software Co-Design including design and implementation of advanced embedded architectures as well as the verification and test of the resulting system.

Aims, content, methods

Learning objectives and competencies to be acquired

- The student will know some of the forces driving the design of modern embedded architectures.
- The student will understand and be able to apply the V-Model and structured HW/SW Co-Design methodologies including strategies for the verification and test of embedded systems.
- The student will be able to design and implement complete SoC designs including using soft-core microprocessors and IP cores in an FPGA.
- The student will be able to apply loop optimisations using both SW techniques and optimised cache in single- and multi-processor architectures.
- The students will be able to understand and apply pipeline architectures in processors (super-pipelined, superscalar), HW and SW.

Module content with weighting of different components

- Introduction
  - V-Model, specification and test
  - HW-SW Co-Design
- SoC design, implementation and test
  - FPGA technology, SoC design, soft-core processors, design, implementation and reuse of custom IP cores
  - Bus systems
- Optimisation Strategies
  - Advanced peripherals, DMA, scheduling
  - Software loop optimisations, custom instructions, co-processors,
  - Memory hierarchy (cache, scratch pad memories)
  - Pipeline, multiprocessing
- Review
  - Exercises and laboratories using an FPGA board

Teaching and learning methods

Lectures
Accompanied exercises
Self-study

Literature

No mandatory literature

Assessment

Additional performance assessment during the semester

The module contains additional performance assessment(s) during the semester. The achieved mark of the additional performance assessment(s) applies to both the regular and the resit exam.

Description of additional performance assessment during the semester

Part 1: Voluntary test or presentation of Practical Work - SoC Implementation (15%)

Part 2: Voluntary test or presentation of Practical Work - Formal Processes and Optimisation Methods (15%)

Basic principle for exams

As a rule, all standard final exams are conducted in written form. For resit exams, lecturers will communicate the exam format (written/oral) together with the exam schedule.

Standard final exam for a module and written resit exam

Kind of exam

Written exam

Duration of exam

120 minutes

Permissible aids

Aids permitted as specified below:

Permissible electronic aids

No electronic aids permitted

Other permissible aids

Lecture notes and VHDL reference

Exception: In case of an electronic Moodle exam, adjustments to the permissible aids may occur. Lecturers will announce the final permissible aids prior to the exam session.

Special case: Resit exam as oral exam

Kind of exam

Oral exam

Duration of exam

30 minutes

Permissible aids

Aids permitted as specified below:

Permissible electronic aids

No electronic aids permitted

Other permissible aids

Lecture notes and VHDL reference

Description du module, disponible en: EN, FR

Conception de hardware et firmware embarqués

Informations générales

Nombre de crédits ECTS

3

Code du module

TSM_EmbHardw

Valable pour l'année académique

2026-27

Dernière modification

2019-07-22

Coordinateur/coordinatrice du module

Hans Dermot Doran (ZHAW, hans.doran@zhaw.ch)

Explications concernant les langues d'enseignement par site :

- L'enseignement est dispensé dans la langue indiquée ci-dessous pour chaque site et chaque exécution du module.
- Les supports de cours sont disponibles dans les langues indiquées ci-dessous pour chaque site et chaque exécution du module. Lorsque plusieurs langues sont utilisées, la proportion de contenu disponible dans chaque langue est précisée (100 % = ensemble des supports de cours).
- Les examens (questions et réponses) sont entièrement rédigés dans la langue indiquée ci-dessous pour le site et l'exécution du module concernés. Ils se déroulent en présentiel.

	Lausanne			Lugano	Zurich		
Leçons		**X** F 100%			**X** E 100%		
Documentation			**X** E 100%		**X** E 100%		
Examen		**X** F 100%			**X** E 100%		

Catégorie de module

TSM approfondissement technico-scientifique

Recommandations de profil

Ce module est recommandé pour les profils suivants :

	Lausanne	Zurich
Profil	EIE	EIE

Leçons

2 leçons et 1 leçon de pratique par semaine

Compétences préalables

Connaissances préalables, compétences initiales

Les étudiants jouissent de connaissances professionnelles des systèmes de programmation en C.
Les étudiants jouissent de connaissances professionnelles des bases de la conception matérielle y compris le codage VHDL

Brève description du contenu et des objectifs

Le présent module donne aux étudiants un aperçu sur les concepts avancés de technologies modernes d'ingénierie embarquée. Le module se subdivise en deux parties. La première partie est consacrée à la pratique/théorie et vise à familiariser l'étudiant à mettre en oeuvre des systèmes de conception de puces. La deuxième partie aborde la conception conjointe formelle matérielle et logicielle, y compris la conception et la mise en œuvre d'architectures embarquées et la vérification des systèmes créés.

Objectifs, contenus, méthodes

Objectifs d'apprentissage, compétences à acquérir

- L'étudiant connaîtra quelques-unes des forces intervenant dans la direction des architectures embarquées modernes.
- L'étudiant comprendra et sera capable d'appliquer des méthodes de co-design matériel et logiciel, ainsi que des stratégies de test et de vérification des systèmes embarqués (vérification conjointe HW/SW).
- L'étudiant sera capable de concevoir et de mandater des designs SoC complet sur un FPGA.
- L'étudiant sera capable de concevoir des SoC au moyen des technologies suivantes- processeurs softcore (multiples), co-processeurs (instructions programmables, coprocesseurs fortement couplés, processeurs de signal) et accélération matérielle.
- L'étudiant comprendra et appliquera les techniques d'optimisation logicielle avancées.
- L'étudiant devra réaliser des exercices pertinents sur une carte de développement adéquate.

Contenu des modules avec pondération du contenu des cours

- Introduction
  - Technologie FPGA
  - conception SoC, processeurs soft-core, modules auto-conçus
  - systèmes de bus, DMA, hiérarchie mémoire (caches, SPM)
- Architectures des automates
  - Processeurs softcore, instructions programmables, coprocesseurs, architectures de processeurs
  - Firm/software embarqués et techniques d'optimisation
  - Interfaçage périphérique, accélération matérielle
- Test et vérification
  - Vérification conjointe matérielle et logicielle et stratégies de contrôle
- Examen
  - Exercises et laboratoire utilisant une carte FPGA

Méthodes d'enseignement et d'apprentissage

Cours magistraux
Travaux dirigés
Etude autonome

Bibliographie

Pas de bibliographie obligatoire

Evaluation

Évaluation supplémentaire pendant le semestre

Le module comprend une ou des évaluation(s) supplémentaire(s) pendant le semestre. La note obtenue pour la ou les évaluation(s) supplémentaire(s) est valable à la fois pour l'examen final et pour l'examen de répétition.

Description de l'évaluation supplémentaire pendant le semestre

Partie 1 : Épreuve volontaire ou présentation d'un travail pratique
- Mise en œuvre d'un SoC (15 %)

Partie 2 : Épreuve volontaire ou présentation de travaux pratiques
- Processus formels et méthodes d'optimisation (15%)

Principe pour les examens

En règle générale, tous les examens réguliers de fin de module se déroulent sous forme écrite. Concernant les examens de répétition, leur format (écrit ou oral) sera communiqué par l'enseignant-e en même temps que le calendrier des examens.

Examen de fin de module régulier et examen écrit de répétition

Type de l'examen

Examen écrit

Durée de l'examen

120 minutes

Aides autorisées

Les aides suivantes sont autorisées:

Aides électroniques autorisées

Aucune aide électronique autorisée

Autres aides autorisées

Lecture notes and VHDL reference

Exception : En cas d'examen électronique sur Moodle, des modifications des aides autorisées peuvent survenir. Dans ce cas, les aides autorisées seront annoncées par les enseignant-e-s avant l'examen.

Cas spécial: examen de répétition oral

Type de l'examen

Examen oral

Durée de l'examen

30 minutes

Aides autorisées

Les aides suivantes sont autorisées:

Aides électroniques autorisées

Aucune aide électronique autorisée

Autres aides

Lecture notes and VHDL reference

Module Description, available in: EN

Embedded Real-time Software

General Information

Number of ECTS Credits

3

Module code

TSM_EmbReal

Valid for academic year

2026-27

Last modification

2025-10-17

Coordinator of the module

Simon Künzli (ZHAW, simon.kuenzli@zhaw.ch)

Explanations regarding the language definitions for each location:

- Instruction is given in the language specified for each location and module execution.
- Documentation is available in the language(s) listed for each location and module execution. If the documentation is in multiple languages, the percentage distributed is indicated (100% = all documentation provided).
- The examination, including both questions and answers, is provided entirely (100%) in the language(s) specified for each location and module execution. The exams are on-site.

	Lausanne			Lugano	Zurich		
Instruction					**X** E 100%		
Documentation					**X** E 100%		
Examination					**X** E 100%		

Module Category

TSM Technical scientific module

Profile Recommendations

This module is recommended for the following profiles:

	Zurich
Profile	EIE

Lessons

2 lecture periods and 1 tutorial period per week

Entry level competences

Prerequisites, previous knowledge

- Knowledge of C programming language and object-oriented programming in a programming language
- Good knowledge of computer and microprocessor architectures
- Experience in implementing a project on a microcontroller in C
- Basic knowledge of Operating Systems necessary, basic knowledge of RTOS recommended
- Basic knowledge of concurrent programming

Brief course description of module objectives and content

Embedded Systems, although they are not visible, have become integral parts of this world. Embedded Systems essentially consist of two components: hardware and software. In contrast to information systems e.g. in the banking world, hardware is more application specific. Due to this fact, the software that interacts directly with the hardware is more specific as well. Real-time and concurrency are important issues in Embedded System development, which come on top of the generally valid requirements for correctness and reliability.

The module teaches methods to develop Real-Time Embedded System Software and deals with the following complementary aspects:

- Real-Time Operating Systems, Applications and Modelling
- Modern C++ for microcontrollers, focusing on programming close to hardware with and without dynamic memory allocation
- Software concepts for asymmetric multiprocessor systems

Aims, content, methods

Learning objectives and competencies to be acquired

Based on requirements, the students will be able to apply the optimal method to develop and verify an Embedded System,

- on the boundary between hard- and software using modern C++ and RTOS features
- on application layer using modeling methods.

Module content with weighting of different components

The module provides insights at real-time embedded systems from various perspectives, consisting of three major parts.

In the first part, we discuss SW modelling and implementation aspects using real-time operating systems

- Introduction to RTOS
- Task Models and Real-Time Scheduling
- Concurrency
- Modeling & Code Generation
- Testing & Debugging

In part II, we focus on C++ for embedded systems with focus on the use on microcontrollers.

- Using C++: showing the huge advantages of C++ for Embedded Systems
- Point out where C++ uses dynamic memory allocation and how to deal with it on microcontrollers.

In the last part, the focus is on software development for asymmetric multi-core embedded systems:

- Inter-Processor communication
- Multi-core programming

Teaching and learning methods

- Ex-cathedra teaching
- Exercises
- Self-study (study of papers, case studies)
- practical exercises: programming embedded software on embedded systems

Literature

Assessment

Additional performance assessment during the semester

The module does not contain an additional performance assessment during the semester

Basic principle for exams

As a rule, all standard final exams are conducted in written form. For resit exams, lecturers will communicate the exam format (written/oral) together with the exam schedule.

Standard final exam for a module and written resit exam

Kind of exam

Written exam

Duration of exam

120 minutes

Permissible aids

Aids permitted as specified below:

Permissible electronic aids

No electronic aids permitted.

Other permissible aids

Up to 4 A4 pages of a self-written summary are permitted.

Exception: In case of an electronic Moodle exam, adjustments to the permissible aids may occur. Lecturers will announce the final permissible aids prior to the exam session.

Special case: Resit exam as oral exam

Kind of exam

Oral exam

Duration of exam

30 minutes

Permissible aids

No aids permitted

Module Description, available in: EN, FR

Environmental Remediation Technologies: soil, groundwater and atmosphere

General Information

Number of ECTS Credits

3

Module code

TSM_EnReTe

Valid for academic year

2026-27

Last modification

2025-10-17

Coordinator of the module

Pamela Principi (SUPSI, pamela.principi@supsi.ch)

Explanations regarding the language definitions for each location:

- Instruction is given in the language specified for each location and module execution.
- Documentation is available in the language(s) listed for each location and module execution. If the documentation is in multiple languages, the percentage distributed is indicated (100% = all documentation provided).
- The examination, including both questions and answers, is provided entirely (100%) in the language(s) specified for each location and module execution. The exams are on-site.

	Lausanne			Lugano	Zurich		
Instruction		**X** F 100%			**X** E 100%		
Documentation		**X** F 70%	**X** E 30%		**X** E 100%		
Examination		**X** F 100%			**X** E 100%		

Module Category

TSM Technical scientific module

Profile Recommendations

This module is recommended for the following profiles:

	Lausanne	Zurich
Profile	EnEn	EnEn

Lessons

2 lecture periods and 1 tutorial period per week

Entry level competences

Prerequisites, previous knowledge

Basics in chemistry and physics

Brief course description of module objectives and content

This course will provide the student with the background knowledge useful to address different sources of pollution, of measures and technologies to prevent pollution and of contaminated systems and the available technologies for remediation. General aim is knowing the main factors and processes affecting contaminants distribution in the environment and remediation technologies for soil and groundwater.

Aims, content, methods

Learning objectives and competencies to be acquired

The student will acquire the tools to be able to understand environmental problems, know the key-factors of remediation and the challenges of the near future, integrate knowledge of chemistry, biotechnology and ecology and read and understand up to date literature on remediation topics

Module content with weighting of different components

General concepts of:

- environment, ecosystem, pollution, remediation.
- contaminants and emerging contaminants characteristics.
- representative sampling and monitoring.

Environmental compartments and contaminants:

- physical chemical and biological characteristics of soil;
- physical chemical and biological characteristics of groundwater;
- physical chemical and biological characteristics of atmosphere;
- contaminant transport and fate: physical chemical and biological processes in soil, water and atmosphere.

Remediation:

- containment technologies;
- removal technologies;
- treatment technologies.

Teaching and learning methods

Front lecturing theory lessons, exercises and student active involvement.

The parts biological and chemical weight each 50% of the content

Literature

- Slides given at the course from the Lecturers
- Reference books details will be given at the beginning of the course

Assessment

Additional performance assessment during the semester

The module does not contain an additional performance assessment during the semester

Basic principle for exams

As a rule, all standard final exams are conducted in written form. For resit exams, lecturers will communicate the exam format (written/oral) together with the exam schedule.

Standard final exam for a module and written resit exam

Kind of exam

Written exam

Duration of exam

120 minutes

Permissible aids

Aids permitted as specified below:

Permissible electronic aids

No electronic aids permitted

Other permissible aids

The appendix provided in moodle containing the periodic table, constant values for chemical compounds and important equations, as well as a copy of the Contaminated Sites Ordinance (CSO) may be used during the exam. Students must bring their own copy to the exam.

Exception: In case of an electronic Moodle exam, adjustments to the permissible aids may occur. Lecturers will announce the final permissible aids prior to the exam session.

Special case: Resit exam as oral exam

Kind of exam

Oral exam

Duration of exam

30 minutes

Permissible aids

No aids permitted

Description du module, disponible en: EN, FR

Technologies d'assainissement de l'environnement : sol, eaux souterraines et atmosphère

Informations générales

Nombre de crédits ECTS

3

Code du module

TSM_EnReTe

Valable pour l'année académique

2026-27

Dernière modification

2025-10-17

Coordinateur/coordinatrice du module

Pamela Principi (SUPSI, pamela.principi@supsi.ch)

Explications concernant les langues d'enseignement par site :

- L'enseignement est dispensé dans la langue indiquée ci-dessous pour chaque site et chaque exécution du module.
- Les supports de cours sont disponibles dans les langues indiquées ci-dessous pour chaque site et chaque exécution du module. Lorsque plusieurs langues sont utilisées, la proportion de contenu disponible dans chaque langue est précisée (100 % = ensemble des supports de cours).
- Les examens (questions et réponses) sont entièrement rédigés dans la langue indiquée ci-dessous pour le site et l'exécution du module concernés. Ils se déroulent en présentiel.

	Lausanne			Lugano	Zurich		
Leçons		**X** F 100%			**X** E 100%		
Documentation		**X** F 70%	**X** E 30%		**X** E 100%		
Examen		**X** F 100%			**X** E 100%		

Catégorie de module

TSM approfondissement technico-scientifique

Recommandations de profil

Ce module est recommandé pour les profils suivants :

	Lausanne	Zurich
Profil	EnEn	EnEn

Leçons

2 leçons et 1 leçon de pratique par semaine

Compétences préalables

Connaissances préalables, compétences initiales

Bases en chimie et physique

Brève description du contenu et des objectifs

Ce cours permettra à l'étudiant-e d'acquérir les connaissances de base requises pour traiter les différentes sources de pollution; des mesures et des technologies pour prévenir la pollution et des systèmes contaminés et des technologies disponibles pour l'assainissement. L'objectif général est de connaître les principaux facteurs et processus liés à la distribution des contaminants dans l'environnement et les technologies d'assainissement des sols, des eaux souterraines et de l'atmosphère.

Objectifs, contenus, méthodes

Objectifs d'apprentissage, compétences à acquérir

L'étudiant-e se familiarisera avec les outils permettant de comprendre les problèmes environnementaux, de connaître les facteurs clés de l'assainissement et les défis du futur, d'intégrer les connaissances en chimie, biotechnologie et écologie et de lire et comprendre la littérature récente en matière d'assainissement

Contenu des modules avec pondération du contenu des cours

Concepts généraux concernant:

- l'environnement, l'écosystème, la pollution, l'assainissement.
- les caractéristiques des contaminants et des nouveaux polluants.
- l'échantillonnage représentatif et la surveillance.

Le milieux naturels et les contaminants :

- les caractéristiques physiques, chimiques et biologiques du sol ;
- les caractéristiques physiques, chimiques et biologiques des eaux souterraines ;
- les caractéristiques physiques, chimiques et biologiques de l'air ;
- le transport et la transformation des contaminants : processus physiques, chimiques et biologiques dans le sol et l'eau.

L'assainissement :

- les technologies de confinement ;
- les technologies d'élimination ;
- les technologies de traitement.

Méthodes d'enseignement et d'apprentissage

cours magistraux avec participation active des étudiantes.

Les parties biologiques et chimiques pèsent chacune 50 % du conte*nu*

Bibliographie

Diapositives données lors du cours par les enseignant-e-s

Les détails des ouvrages de référence seront donnés au début du cours

Evaluation

Évaluation supplémentaire pendant le semestre

Le module ne comprend pas d'évaluation supplémentaire pendant le semestre

Principe pour les examens

En règle générale, tous les examens réguliers de fin de module se déroulent sous forme écrite. Concernant les examens de répétition, leur format (écrit ou oral) sera communiqué par l'enseignant-e en même temps que le calendrier des examens.

Examen de fin de module régulier et examen écrit de répétition

Type de l'examen

Examen écrit

Durée de l'examen

120 minutes

Aides autorisées

Les aides suivantes sont autorisées:

Aides électroniques autorisées

Aucune aide électronique autorisée

Autres aides autorisées

L'annexe Moodle contenant le tableau périodique, les valeurs constantes des composés chimiques et les équations importantes, ainsi qu'un exemplaire de l'Ordonnance sur les sites contaminés (OSC), peut être utilisée pendant l'examen. Les étudiants doivent apporter leur propre exemplaire.

Exception : En cas d'examen électronique sur Moodle, des modifications des aides autorisées peuvent survenir. Dans ce cas, les aides autorisées seront annoncées par les enseignant-e-s avant l'examen.

Cas spécial: examen de répétition oral

Type de l'examen

Examen oral

Durée de l'examen

30 minutes

Aides autorisées

Sans aides

Description du module, disponible en: FR

Fluid Mechanics and Heat Transfer

Informations générales

Nombre de crédits ECTS

3

Code du module

TSM_FMechHeat

Valable pour l'année académique

2026-27

Dernière modification

2025-10-08

Coordinateur/coordinatrice du module

Ricardo Lima (HES-SO, ricardo.lima@hesge.ch)

Explications concernant les langues d'enseignement par site :

- L'enseignement est dispensé dans la langue indiquée ci-dessous pour chaque site et chaque exécution du module.
- Les supports de cours sont disponibles dans les langues indiquées ci-dessous pour chaque site et chaque exécution du module. Lorsque plusieurs langues sont utilisées, la proportion de contenu disponible dans chaque langue est précisée (100 % = ensemble des supports de cours).
- Les examens (questions et réponses) sont entièrement rédigés dans la langue indiquée ci-dessous pour le site et l'exécution du module concernés. Ils se déroulent en présentiel.

	Lausanne			Lugano	Zurich		
Leçons		**X** F 100%					
Documentation		**X** F 100%					
Examen		**X** F 100%					

Catégorie de module

TSM approfondissement technico-scientifique

Recommandations de profil

Ce module est recommandé pour les profils suivants :

	Lausanne
Profil	EnEn, ME

Leçons

2 leçons et 1 leçon de pratique par semaine

Compétences préalables

Connaissances préalables, compétences initiales

Brève description du contenu et des objectifs

Au début du cours, les étudiants se familiariseront avec les bases de la dynamique des fluides et du transfert de chaleur.

Par la suite, des outils spécialisés seront présentés afin d'offrir aux futurs ingénieurs les compétences nécessaires à la modélisation des écoulements fluides.

Le cours se concentrera ensuite sur des phénomènes thermiques et fluidiques plus complexes, rencontrés dans les applications du génie mécanique.

Enfin, il se terminera par une introduction aux écoulements diphasiques et à leurs applications dans de nombreux domaines (industrie, bâtiment, électronique, etc.).

Objectifs, contenus, méthodes

Objectifs d'apprentissage, compétences à acquérir

Les objectifs du cours sont les suivants :

- Donner aux étudiants une connaissance solide des phénomènes de mécanique des fluides et de transfert thermique, afin de leur permettre de développer une approche critique vis-à-vis des systèmes mécaniques et énergétiques complexes.
- Former les étudiants à la conception et au développement de systèmes fluidiques et énergétiques.
- Permettre aux étudiants de comprendre, d'analyser et de réaliser des systèmes thermiques et fluidiques complexes.

Contenu des modules avec pondération du contenu des cours

Théorème de Vaschy-Buckingham : différentes applications seront présentées, dans le but d'introduire également les nombres sans dimension fondamentaux (par ex. nombres de Reynolds, Strouhal, Mach).

Équations de Navier-Stokes et de Bernoulli : à partir des lois de conservation de la masse, de l'énergie et de la quantité de mouvement, les équations de base de la mécanique des fluides sont présentées pour des phénomènes simples dans les phases gazeuse et liquide (par ex. profils de vitesse et pertes de charge dans les conduites).

Phénomènes fluidiques de base

- Forces induites par l'écoulement (portance, traînée et moments) pour différentes géométries (profils et ailes 3D, corps émoussés) et pour différents types d'écoulement (avec/sans pertes, incompressible ou compressible).
- Écoulements turbulents et laminaires.
- Écoulements pariétaux (couches limites et conduites) ; pertes de charge (généralisation du théorème de Bernoulli). Séparation laminaire ou turbulente.
- Phénomènes instationnaires.

Phénomènes thermiques de base

- Conduction, convection et rayonnement.
- Échange de chaleur (corrélations de Nusselt, Reynolds et Prandtl, performance).

Bases de la modélisation des systèmes fluidiques et thermiques.

Introduction aux écoulements diphasiques

- Régimes d'écoulement et cartes caractéristiques.
- Transfert de chaleur et modèles de prédiction.
- Pertes de charge et modèles de prédiction.

Méthodes d'enseignement et d'apprentissage

L'approche pédagogique relie la compréhension conceptuelle à des exemples et exercices pratiques, permettant aux étudiants de consolider leurs connaissances théoriques à travers des applications issues de contextes réels.

Bibliographie

Evaluation

Évaluation supplémentaire pendant le semestre

Le module ne comprend pas d'évaluation supplémentaire pendant le semestre

Principe pour les examens

En règle générale, tous les examens réguliers de fin de module se déroulent sous forme écrite. Concernant les examens de répétition, leur format (écrit ou oral) sera communiqué par l'enseignant-e en même temps que le calendrier des examens.

Examen de fin de module régulier et examen écrit de répétition

Type de l'examen

Examen écrit

Durée de l'examen

120 minutes

Aides autorisées

Les aides suivantes sont autorisées:

Aides électroniques autorisées

Aucune aide électronique autorisée

Autres aides autorisées

Pour une partie de l'examen (définie durant le cours avant l'examen), les étudiants sont autorisés à apporter et utiliser une feuille d'aide personnelle, manuscrite, au format A4 recto verso, contenant uniquement des équations. Aucun élément graphique, exemple, exercice ou autre contenu n'est autorisé.

Exception : En cas d'examen électronique sur Moodle, des modifications des aides autorisées peuvent survenir. Dans ce cas, les aides autorisées seront annoncées par les enseignant-e-s avant l'examen.

Cas spécial: examen de répétition oral

Type de l'examen

Examen oral

Durée de l'examen

30 minutes

Aides autorisées

Sans aides

Module Description, available in: EN

Fatigue Design

General Information

Number of ECTS Credits

3

Module code

TSM_FaDes

Valid for academic year

2026-27

Last modification

2023-09-22

Coordinator of the module

Davide Valtorta (SUPSI, davide.valtorta@supsi.ch)

Explanations regarding the language definitions for each location:

- Instruction is given in the language specified for each location and module execution.
- Documentation is available in the language(s) listed for each location and module execution. If the documentation is in multiple languages, the percentage distributed is indicated (100% = all documentation provided).
- The examination, including both questions and answers, is provided entirely (100%) in the language(s) specified for each location and module execution. The exams are on-site.

	Lausanne			Lugano	Zurich		
Instruction				**X** E 100%			
Documentation				**X** E 100%			
Examination				**X** E 100%			

Module Category

TSM Technical scientific module

Profile Recommendations

This module is recommended for the following profiles:

	Lugano
Profile	ME

Lessons

2 lecture periods and 1 tutorial period per week

Entry level competences

Prerequisites, previous knowledge

- Mathematics, Calculus and Mathematical Analysis
- Linear algebra and analytical geometry
- Material Science and Engineering
- Solid Mechanics
- Basics of mechanics of composite materials

- Basics of computational mechanics, including finite element methods

Brief course description of module objectives and content

The course addresses fundamental and technical issues related to the design and maintenance of structures that shall not fail under cyclic loading. Students will be taught the principles of fatigue testing and fatigue failure analysis of mechanical structures, addressing the issues of how fatigue behavior is characterized, how fatigue failure is predicted, which physical mechanisms are responsible for the initiation and propagation of fatigue in various materials, with particular emphasis on metals and structural alloys, and how this behavior is related to the microstructure of the material. This course will also present the most important applications of fatigue design in industry, including failure analysis, fatigue life calculation, experimental techniques, destructive and non-destructive methods of damage detection and characterization.

Aims, content, methods

Learning objectives and competencies to be acquired

- Understand the theory of fracture mechanics applied to brittle, ductile and quasi-brittle materials;
- Learn experimental techniques for the characterization of the propertie affecting crack onset and propagation;
- Understand the fatigue phenomenon of materials, including factors that affect the residual life of structures under cyclic loading and analytical methods for fatigue strenght assessment;
- Use computational mechanics as a tool to solve fracture mechanics problems and prediction of fatigue life;
- Apply the knowledge of fatigue and fracture mechanics in the design of structures and to investigate possible causes of structural failure;

Module content with weighting of different components

Introduction to Fracture Mechanics

Linear Elastic Fracture mechanics

- Griffith's analysis, 1st law of thermodynamics and crack growth, Energy release rate (ERR)
- Stress analysis and stress intensity factor (SIF). Failure modes (mode I, II and III)
- Relation between the SIF and ERR
- Mixed-mode propagation
- Plane stress, plane strain, R-curve, and stability of the propagation
- Experimental determination of the Fracture toughness: standard and non-standard methods

Elasto-plastic fracture mechanics

- Crack opening displacement (COD)
- J integral
- Relation between J-integral, COD and ERR

Fatigue of metals, plastic and composite materials

- Fatigue limit
- Factors affecting the crack propagation process
- Fatigue in brittle and ductile solids
- Low Cycle Fatigue and High Cycle Fatigue: application of strain- or stress-life approach in different scenarios
- Analytical and numerical methods for fatigue strength assessment
- Fatigue and random vibration analyses
- Fatigue of welded structures
- Fatigue of composite and plastic materials
- Experimental assessment of the fatigue behaviour
- Application of the theory concepts to the fatigue strength assessment in real industrial case studies

Computational fracture mechanics

- Determination of the SIF
- Determination of the J-Integral
- Virtual Crack Closure technique
- Cohesive elements

Teaching and learning methods

- Lectures in presence
- Tutorial in presence
- Self-study

Literature

Lecture notes and learning material will be distributed to students during the semester, along with references to books and scientific papers for the specific topics discussed.

Assessment

Additional performance assessment during the semester

The module does not contain an additional performance assessment during the semester

Basic principle for exams

As a rule, all standard final exams are conducted in written form. For resit exams, lecturers will communicate the exam format (written/oral) together with the exam schedule.

Standard final exam for a module and written resit exam

Kind of exam

Written exam

Duration of exam

120 minutes

Permissible aids

Aids permitted as specified below:

Permissible electronic aids

Scientific calculator

WiFi off

Other permissible aids

The formula sheet provided by the module coordinator

Exception: In case of an electronic Moodle exam, adjustments to the permissible aids may occur. Lecturers will announce the final permissible aids prior to the exam session.

Special case: Resit exam as oral exam

Kind of exam

Oral exam

Duration of exam

30 minutes

Permissible aids

Aids permitted as specified below:

Permissible electronic aids

Scientific calculator

WiFi off

Other permissible aids

The formula sheet provided by the module coordinator

Module Description, available in: EN

Factory Planning

General Information

Number of ECTS Credits

3

Module code

TSM_FactPlan

Valid for academic year

2026-27

Last modification

2019-10-11

Coordinator of the module

Luca Canetta (SUPSI, luca.canetta@supsi.ch)

Explanations regarding the language definitions for each location:

- Instruction is given in the language specified for each location and module execution.
- Documentation is available in the language(s) listed for each location and module execution. If the documentation is in multiple languages, the percentage distributed is indicated (100% = all documentation provided).
- The examination, including both questions and answers, is provided entirely (100%) in the language(s) specified for each location and module execution. The exams are on-site.

	Lausanne			Lugano	Zurich		
Instruction				**X** E 100%			
Documentation				**X** E 100%			
Examination				**X** E 100%			

Module Category

TSM Technical scientific module

Profile Recommendations

This module is recommended for the following profiles:

	Lugano
Profile	BE

Lessons

2 lecture periods and 1 tutorial period per week

Entry level competences

Prerequisites, previous knowledge

No specific previous knowledge is required, considering that for each topic a short introduction is proposed before moving to the concept application.

Brief course description of module objectives and content

The course will describe Production Systems Configuration and Management as well as the drivers influencing the choice of a given layout and the rules adopted for managing it. Various typical layouts will be described also highlighting their benefits and pitfalls, while eliciting the characteristics of the manufacturing environments justifying their choice. Well known Production Planning & Control (PPC) methods will be presented and applied. Basis on market demand forecasting will be provided.

Aims, content, methods

Learning objectives and competencies to be acquired

Being able to understand:

- The basics of product layouts and process layouts
- Push production systems
- Inventory management methods
- Simple forecasting methods

Being able to:

- Solve simple line-balancing problems
- Dimension simple cellular layout
- Select the suitable PPC method and dimension it
- Create forecast and evaluate their quality

Module content with weighting of different components

Introduction to Factory Planning

- Production models and production systems
- The influence of product structure and Customer delivery lead time
- Classification: MTS, ATO, MTO, ETO
- Levers of action for production system configuration
- Product-Process matrix
- Performance Indexes (KPI)
- Job Shop
- Production Line Balancing
- Group technology and manufacturing cells

PUSH Production Planning and Control

- Sales and Operations Planning (S&OP)
- Master Production Schedule (MPS)
- Material Requirement Planning (MRP)
- Capacity Planning (Rough Cut Capacity Planning; Capacity Requirement Planning)
- Dispatching rule

Inventory Management and Forecasting

- Inventory Management costs and Economic Order Quantity (EOQ)
- Power-of-Two method, EOQ Price discount, Production Economic Order Quantity
- Inventory Management Methods; Replenishment, Periodic Order Quantity (POQ)
- Safety Stock
- Forecasting methods (time series analysis)

Teaching and learning methods

Frontal theoretical lessons integrated with interactive exercises

Literature

The material distributed by the lecturer is enough, reference books can be suggested if the students want to deepen the knowledge of specific subjects, for instance:

- Factory Physics, Wallace J. Hopp and Mark L. Spearman, Waveland Pr Inc; 3 edition (August 31, 2011)
- Manufacturing Planning and Control for Supply Chain Management: The CPIN Reference, F. Robert Jacobs, William Berry, D. Clay Whybark, Thomas Vollmann, McGraw-Hill Professional; 2nd edition (July 23, 2018)
- Forecasting: Methods and Applications, Spyros G. Makridakis, Steven C. Wheelwright, Rob J Hyndman, Wiley; 3 edition (December 1997)

Assessment

Additional performance assessment during the semester

The module does not contain an additional performance assessment during the semester

Basic principle for exams

As a rule, all standard final exams are conducted in written form. For resit exams, lecturers will communicate the exam format (written/oral) together with the exam schedule.

Standard final exam for a module and written resit exam

Kind of exam

Written exam

Duration of exam

120 minutes

Permissible aids

Aids permitted as specified below:

Permissible electronic aids

No electronic aids permitted

Other permissible aids

A4 recto/verso with hand written formulas, no numeric example allowed

Exception: In case of an electronic Moodle exam, adjustments to the permissible aids may occur. Lecturers will announce the final permissible aids prior to the exam session.

Special case: Resit exam as oral exam

Kind of exam

Oral exam

Duration of exam

30 minutes

Permissible aids

Aids permitted as specified below:

Permissible electronic aids

No electronic aids permitted

Other permissible aids

As for the written exam: A4 recto/verso with hand written formulas, no numeric example allowed

Description du module, disponible en: FR

Fondements de l'énergie et du génie environnemental

Informations générales

Nombre de crédits ECTS

3

Code du module

TSM_FundEnEn

Valable pour l'année académique

2026-27

Dernière modification

2021-03-05

Coordinateur/coordinatrice du module

Nikos Zarkadis (HES-SO, nikos.zarkadis@hes-so.ch)

Explications concernant les langues d'enseignement par site :

- L'enseignement est dispensé dans la langue indiquée ci-dessous pour chaque site et chaque exécution du module.
- Les supports de cours sont disponibles dans les langues indiquées ci-dessous pour chaque site et chaque exécution du module. Lorsque plusieurs langues sont utilisées, la proportion de contenu disponible dans chaque langue est précisée (100 % = ensemble des supports de cours).
- Les examens (questions et réponses) sont entièrement rédigés dans la langue indiquée ci-dessous pour le site et l'exécution du module concernés. Ils se déroulent en présentiel.

	Lausanne			Lugano	Zurich		
Leçons		**X** F 100%					
Documentation		**X** F 50%	**X** E 50%				
Examen		**X** F 100%					

Catégorie de module

TSM approfondissement technico-scientifique

Recommandations de profil

Ce module est recommandé pour les profils suivants :

	Lausanne
Profil	EnEn

Leçons

2 leçons et 1 leçon de pratique par semaine

Compétences préalables

Connaissances préalables, compétences initiales

Comme conditions préalables, les notions fondamentales de puissance, d'énergie et les lois de conservation qui s'y rapportent doivent être maîtrisées. En parallèle, les notions de base de la thermodynamique et de la science des matériaux doivent être acquises au moins sur le plan conceptuel.

Brève description du contenu et des objectifs

- Présenter tous les vecteurs énergétiques en fonction de leur utilisation aux niveaux temporel, spatial et sectoriel
- Introduire toutes les technologies de conversion de l'énergie dans une perspective historique et systémique, sur la base d'une description technique solide des caractéristiques, du fonctionnement, du dimensionnement et de la conception
- Développer la sensibilité aux échelles, aux niveaux de température des processus liés à l'énergie, à l'exploitation des ressources en s'appuyant sur des exemples concrets issus notamment des secteurs résidentiel et industriel
- Découvrir le caractère multidimensionnel des impacts environnementaux sur l'air, le sol et l'eau, y compris les méthodes d'évaluation quantitative de base pour certains polluants
- Discussion sur les facteurs d'empreinte environnementale et leur comparaison dans une perspective tant quantitative que qualitative

Objectifs, contenus, méthodes

Objectifs d'apprentissage, compétences à acquérir

Les objectifs du présent module d'introduction sont multiples :

- Donner un aperçu comparatif et à plusieurs échelles de tous les vecteurs énergétiques et des technologies de conversion
- Identifier les secteurs d'utilisation de l'énergie et leurs besoins spécifiques
- Insister sur l'importance des échelles spatio-temporelles dans l'étude des systèmes énergétiques
- Introduire le concept d'impact environnemental basé sur des indicateurs quantitatifs et qualitatifs

Contenu des modules avec pondération du contenu des cours

1. L'importance de l'énergie dans l'histoire de l'être humain
2. Energies primaires et vecteurs énergétiques, y compris unités
3. Conservation de l'énergie et conversions
4. Détermination de la demande énergétique (résidentiel, industries, mobilité)
5. Environnement et biosphère
6. Concept d'impact environnemental
7. Introduction aux mesures de rémédiation et de minimisation des impacts, monitoring, impact environnemental de la génération et de l'utilisation d'énergie

Méthodes d'enseignement et d'apprentissage

- Cours ex-catheadra
- Exercices
- Etude de cas concrets
- Visite d'une installation

Bibliographie

1. G. Sarlos et al, Systèmes énergétiques, Traité de génie civil Vol. 21, PPUR
2. M. Moran et al, Fundamentals of Engineering Thermodynamics, Wiley
3. G. Boyle, Renewable Energy: Power for a Sustainable Future, Oxford
4. G. Boyle, Energy Systems and Sustainability: Power for a Sustainable Future, Oxford
5. R. von Euw et al, Installations du bâtiment - Planification interdisciplinaire, EnDK et SuisseEnergie, 2014

Evaluation

Évaluation supplémentaire pendant le semestre

Le module ne comprend pas d'évaluation supplémentaire pendant le semestre

Principe pour les examens

En règle générale, tous les examens réguliers de fin de module se déroulent sous forme écrite. Concernant les examens de répétition, leur format (écrit ou oral) sera communiqué par l'enseignant-e en même temps que le calendrier des examens.

Examen de fin de module régulier et examen écrit de répétition

Type de l'examen

Examen écrit

Durée de l'examen

120 minutes

Aides autorisées

Sans aides

Exception : En cas d'examen électronique sur Moodle, des modifications des aides autorisées peuvent survenir. Dans ce cas, les aides autorisées seront annoncées par les enseignant-e-s avant l'examen.

Cas spécial: examen de répétition oral

Type de l'examen

Examen oral

Durée de l'examen

30 minutes

Aides autorisées

Sans aides

Module Description, available in: EN

Heat Transfer

General Information

Number of ECTS Credits

3

Module code

TSM_Heat

Valid for academic year

2026-27

Last modification

2019-09-07

Coordinator of the module

Jörg Worlitschek (HSLU, joerg.worlitschek@hslu.ch)

Explanations regarding the language definitions for each location:

- Instruction is given in the language specified for each location and module execution.
- Documentation is available in the language(s) listed for each location and module execution. If the documentation is in multiple languages, the percentage distributed is indicated (100% = all documentation provided).
- The examination, including both questions and answers, is provided entirely (100%) in the language(s) specified for each location and module execution. The exams are on-site.

	Lausanne			Lugano	Zurich		
Instruction					**X** E 100%		
Documentation					**X** E 100%		
Examination					**X** E 100%		

Module Category

TSM Technical scientific module

Profile Recommendations

This module is recommended for the following profiles:

	Zurich
Profile	BT

Lessons

2 lecture periods and 1 tutorial period per week

Entry level competences

Prerequisites, previous knowledge

Basic knowledge of thermodynamics and fluid dynamics.

Brief course description of module objectives and content

The basic theories of heat transfer by conduction, convection and thermal radiation are presented. However, this study-unit focuses on solving practical heat transfer problems in different fields of engineering such as architectural and HVAC engineering, mechanical and process engineering, electrical as well as environmental engineering.

Aims, content, methods

Learning objectives and competencies to be acquired

Students shall learn how to solve engineering problems in the field of heat transfer.

Module content with weighting of different components

- Overview of Heat Transfer Modes
- Introduction to Conduction
- One-Dimensional, Steady-State Conduction
- Two-Dimensional, Steady-State Conduction
- Transient Conduction
- Introduction to Convection
- External Flow
- Internal Flow
- Free Convection
- Introduction to Radiation
- Radiation: Processes and Properties
- Radiation: Exchange Between Surfaces

Teaching and learning methods

Presentation of theory and practical examples of heat transfer problems, problem solving

Literature

F. Incropera, D. DeWitt, T. L. Bergman, A. S. Lavine. Incropera's Principles of Heat and Mass Transfer: Global Edition. Wiley, 2017-11-01.

Assessment

Additional performance assessment during the semester

The module does not contain an additional performance assessment during the semester

Basic principle for exams

As a rule, all standard final exams are conducted in written form. For resit exams, lecturers will communicate the exam format (written/oral) together with the exam schedule.

Standard final exam for a module and written resit exam

Kind of exam

Written exam

Duration of exam

120 minutes

Permissible aids

Aids permitted as specified below:

Permissible electronic aids

Pocket calculator

Other permissible aids

- Personal summary of 6 A4 pages
- Printed copy of Appendix A - of the Textbook - without NOTES on it, only markers are allowed
- Band emission table - without NOTES on it, only markers are allowed
- If graphs are required in the exam they will be handed out!

Exception: In case of an electronic Moodle exam, adjustments to the permissible aids may occur. Lecturers will announce the final permissible aids prior to the exam session.

Special case: Resit exam as oral exam

Kind of exam

Oral exam

Duration of exam

30 minutes

Permissible aids

No aids permitted

Module Description, available in: EN

Human Centered Production Systems

General Information

Number of ECTS Credits

3

Module code

TSM_HuCePSys

Valid for academic year

2026-27

Last modification

2023-06-20

Coordinator of the module

Andrea Bettoni (SUPSI, Andrea.Bettoni@supsi.ch)

Explanations regarding the language definitions for each location:

- Instruction is given in the language specified for each location and module execution.
- Documentation is available in the language(s) listed for each location and module execution. If the documentation is in multiple languages, the percentage distributed is indicated (100% = all documentation provided).
- The examination, including both questions and answers, is provided entirely (100%) in the language(s) specified for each location and module execution. The exams are on-site.

	Lausanne			Lugano	Zurich		
Instruction				**X** E 100%			
Documentation				**X** E 100%			
Examination				**X** E 100%			

Module Category

TSM Technical scientific module

Profile Recommendations

This module is recommended for the following profiles:

	Lugano
Profile	BE

Lessons

2 lecture periods and 1 tutorial period per week

Entry level competences

Prerequisites, previous knowledge

- **Basic concepts of production design and management**: Familiarity with fundamental manufacturing processes, such as machining, assembly, and material handling, is essential. Students should understand the basics of how products are manufactured and how manufacturing systems are designed and managed.
- **Basic programming and automation skills**: students should have basic programming skills. Knowledge of languages like Python or familiarity with automation concepts would be advantageous.

Brief course description of module objectives and content

Human-Centred Production Systems refers to an approach in engineering and manufacturing where the design, development, and operation of production systems are centered around human needs, capabilities, and experiences. This concept emphasizes the importance of considering human factors such as ergonomics, cognitive abilities, social interactions, and user preferences in the design and optimization of production processes and systems.

In a Human-Centred Production System, the goal is to create efficient and effective production processes that not only **maximize productivity and quality** but also ensure the **well-being and satisfaction of the workers involved**. This approach takes into account the physical and mental well-being of the workers and promotes a safe and comfortable working environment.

By providing an understanding of its key principles, this course provides students with the competences to design and manage a Human-Centred Production System, in which a **harmonious balance between technological advancements and the well-being of the people involved** is found, ultimately leading to more sustainable, efficient, and socially responsible manufacturing practices.

Aims, content, methods

Learning objectives and competencies to be acquired

- **Undertanding Human Factors and Ergonomics in Production Systems:**
  - **Objective:** To gain a deep understanding of human factors and ergonomics in the context of production systems, focusing on the physical aspects of human capabilities and limitations, and the application of ergonomic principles in industrial settings.
  - **Learning Outcomes:** Students should be able to analyze the physical aspects of human performance, assess ergonomic challenges in industrial environments, and propose engineering solutions to enhance worker safety, comfort, and productivity. Additionally, students should understand the importance of worker upskilling and be able to design training programs that align with human-centered production practices and technologies.

- **Integration of Automation and Human-Centred Design:**
  - **Objective:** To explore the integration of automation technologies, including collaborative robotics, artificial intelligence, and machine learning, within the framework of human-centered design principles.
  - **Learning Outcomes:** Students should be capable of evaluating appropriate applications of automation technologies in production systems, understanding the interaction between humans and robots, and designing interfaces that facilitate seamless collaboration between human workers and automated systems.

- **Implementing Ethical and Sustainable Practices:**
  - **Objective:** To instill a sense of ethical and social responsibility in the design and management of production systems, considering the social implications and ethical dilemmas arising from technology implementation.
  - **Learning Outcomes:** Students should be able to assess the ethical implications of production decisions on workers, communities, and society at large. They should also understand the social consequences of automation on the workforce, including issues related to employment, diversity, and inclusivity. Additionally, students should be capable of proposing strategies to promote social sustainability within production systems, fostering a positive impact on the community and the workforce.

Module content with weighting of different components

1. Introduction to human-centered production systems: This includes an overview of the principles and objectives of human-centered production systems, as well as the benefits and challenges of implementing these systems in manufacturing and other industries.

2. Human factors: This topic focuses on the ways in which the design of production systems and equipment can affect the comfort, safety, and performance of human workers.

3. Ergonomics: Human-centered production systems are designed with ergonomics in mind, taking into account the physical capabilities and limitations of human workers. This can include designing workstations and equipment to reduce strain and fatigue and providing adequate lighting, ventilation, and other environmental factors to support human comfort and performance.

4. Human-machine interaction: This topic delves into the ways in which humans and machines, particularly robots and AGV, can work together effectively in a production stetting, supported by artifical intelligence in their interaction, and including issues related to safety, trustworthiness, communication, and task allocation.

5. Collaborative robotics: This topic covers the basics of collaborative robotics, including different types of collaborative robots and their capabilities, the collaboration modes and the benefits and potential challenges of integrating these robots into production systems.

6. Safety in human-centred production systems and in collaborative robotics: Human-centered production systems prioritize the safety of human workers, implementing measures such as barriers, guards, and other protective devices to reduce the risk of accidents and injuries.

7. Ethical Decision-Making in Human-Centred Production Systems: This topic explores the ethical dilemmas and decision-making processes faced by engineers and managers when designing and implementing human-centered production systems.

Teaching and learning methods

- **Lectures and Discussions:** Traditional lectures in presence to deliver foundational knowledge on human-centered production systems and structured discussions to encourage active participation and critical thinking.
- **Case Studies:** Analyzing real-world case studies related to the implementation of human-centered production systems in various industries so providing valuable insights into challenges, solutions, and ethical dilemmas.
- **Hands-On Exercises:** Real-world problems for which students are asked to design or optimize a production system with a focus on human factors, ergonomics, and collaborative robotics.

Literature

Assessment

Additional performance assessment during the semester

The module does not contain an additional performance assessment during the semester

Basic principle for exams

As a rule, all standard final exams are conducted in written form. For resit exams, lecturers will communicate the exam format (written/oral) together with the exam schedule.

Standard final exam for a module and written resit exam

Kind of exam

Written exam

Duration of exam

120 minutes

Permissible aids

No aids permitted

Exception: In case of an electronic Moodle exam, adjustments to the permissible aids may occur. Lecturers will announce the final permissible aids prior to the exam session.

Special case: Resit exam as oral exam

Kind of exam

Oral exam

Duration of exam

30 minutes

Permissible aids

No aids permitted

Module Description, available in: EN

Thermal Hydraulic Methods for Energy Systems in Buildings and other applications

General Information

Number of ECTS Credits

3

Module code

TSM_HydMeth

Valid for academic year

2026-27

Last modification

2024-10-18

Coordinator of the module

Natasa Vulic (FHNW, natasa.vulic@fhnw.ch)

Explanations regarding the language definitions for each location:

- Instruction is given in the language specified for each location and module execution.
- Documentation is available in the language(s) listed for each location and module execution. If the documentation is in multiple languages, the percentage distributed is indicated (100% = all documentation provided).
- The examination, including both questions and answers, is provided entirely (100%) in the language(s) specified for each location and module execution. The exams are on-site.

	Lausanne			Lugano	Zurich		
Instruction					**X** E 100%		
Documentation					**X** E 100%		
Examination					**X** E 100%		

Module Category

TSM Technical scientific module

Profile Recommendations

This module is recommended for the following profiles:

	Zurich
Profile	BT

Lessons

2 lecture periods and 1 tutorial period per week

Entry level competences

Prerequisites, previous knowledge

Basic knowledge of thermodynamics, heat transfer and fluid dynamics.

Brief course description of module objectives and content

The course imparts knowledge on practical design methods for thermal energy systems such as heating and cooling circuits, solar thermal systems, large extensive pipe networks, and heat pump evaporators. Special emphasis is placed on the conditions for safe operation. The design and integration of storage tanks and heat pumps into thermal networks are also discussed. Furthermore, building physical aspects and practical rules regarding pipe routing, building integration, and maintenance are discussed as well. You will find more information under this link here:

Aims, content, methods

Learning objectives and competencies to be acquired

Practical design problems are best solved in a holistic approach. It is therefore advantageous to solve thermodynamic and hydraulic dimensioning problems in conjunction. This approach is expressed by the term “thermal hydraulics”. As you will see, thermal hydraulic methods constitute a powerful toolset for the design of energy efficient, cost effective as well as maintenance friendly thermal energy systems and their components.

Through numerous examples, you will learn how to derive analytical models and how to translate them into practically applicable computer codes, which form the basis of the toolsets. You will use this toolset to solve thermal hydraulic engineering problems.

Module content with weighting of different components

A short introduction into thermodynamics, fluid mechanics as well as mass and heat transfer will be given, tailored to the needs of this course. The theory of two-phase flow is taught to the degree necessary to deal with ventability of pipe networks, stagnation of solar thermal plants, and refrigerant evaporators.

Free open-source computer programmes are provided for each topic. You can use them to solve the exercises, and in your future professional practice.

Teaching and learning methods

The content is presented by frontal teaching.
All topics are motivated by practical use-cases.

Homework exercises are solved by pen and paper and using the provided VBA codes running under Excel.

Literature

The script is provided in the form of Powerpoint presentations, scientific articles and literature extracts.

Assessment

Additional performance assessment during the semester

The module does not contain an additional performance assessment during the semester

Basic principle for exams

As a rule, all standard final exams are conducted in written form. For resit exams, lecturers will communicate the exam format (written/oral) together with the exam schedule.

Standard final exam for a module and written resit exam

Kind of exam

Written exam

Duration of exam

120 minutes

Permissible aids

Aids permitted as specified below:

Permissible electronic aids

Pocket calculator.

Other permissible aids

Your own documentation, e.g. collection of formulas, in paper form. The number of pages is not limited.

Laptops or notepads are not permitted.
Exception: In case of an electronic Moodle exam, adjustments to the permissible aids may occur. Lecturers will announce the final permissible aids prior to the exam session.

Special case: Resit exam as oral exam

Kind of exam

Oral exam

Duration of exam

30 minutes

Permissible aids

No aids permitted

Module Description, available in: EN

Industrial Control

General Information

Number of ECTS Credits

3

Module code

TSM_IndContr

Valid for academic year

2026-27

Last modification

2025-09-28

Coordinator of the module

Emanuele Carpanzano (SUPSI, emanuele.carpanzano@supsi.ch)

Explanations regarding the language definitions for each location:

- Instruction is given in the language specified for each location and module execution.
- Documentation is available in the language(s) listed for each location and module execution. If the documentation is in multiple languages, the percentage distributed is indicated (100% = all documentation provided).
- The examination, including both questions and answers, is provided entirely (100%) in the language(s) specified for each location and module execution. The exams are on-site.

	Lausanne			Lugano	Zurich		
Instruction				**X** E 100%			
Documentation				**X** E 100%			
Examination				**X** E 100%			

Module Category

TSM Technical scientific module

Profile Recommendations

This module is recommended for the following profiles:

	Lugano
Profile	MA

Lessons

2 lecture periods and 1 tutorial period per week

Entry level competences

Prerequisites, previous knowledge

n/a

Brief course description of module objectives and content

The Machine and Production Operations Control is the core of the module, with focus on continuous time, motion and discrete event control of industrial systems. Laboratory activities are developed for Continuous Time Control modelling and simulation, as well as CNC (Computer Numerical Control) and PLC (Programmable Logic Control) programming and testing.

Aims, content, methods

Learning objectives and competencies to be acquired

- to understand tasks and generic architecture of a machine and production operations control system
- to learn which are the functions of a generic driver, CNC and PLC necessary to control manufacturing plants
- to learn modelling and simulating continous time control systems, i.e. PID closed loop controllers
- to learn configuring and programming PLC and CNC systems through standard IEC and ISO languages
- to develop practical exercises on industrial drivers, PLC and CNC targets

Module content with weighting of different components

The PLC, CNC and drivers roles and functions in production systems. Modelling, design and simulation of continuous time control systems (PID controllers). The architecture of a PLC and a CNC. Configuration and programming of PLC and CNC systems. Exercises on part program (CNC) and logic control (PLC) solutions development and testing.

Teaching and learning methods

Frontal theoretical lessons, exercises and practical lab activities.

Literature

Course notes provided by the lecturer.

Assessment

Additional performance assessment during the semester

The module does not contain an additional performance assessment during the semester

Basic principle for exams

As a rule, all standard final exams are conducted in written form. For resit exams, lecturers will communicate the exam format (written/oral) together with the exam schedule.

Standard final exam for a module and written resit exam

Kind of exam

Written exam

Duration of exam

120 minutes

Permissible aids

Aids permitted as specified below:

Permissible electronic aids

No electronic aids permitted

Other permissible aids

You can use a double-sided A4 form that summarises the essential contents of the course.

Exception: In case of an electronic Moodle exam, adjustments to the permissible aids may occur. Lecturers will announce the final permissible aids prior to the exam session.

Special case: Resit exam as oral exam

Kind of exam

Oral exam

Duration of exam

30 minutes

Permissible aids

Aids permitted as specified below:

Permissible electronic aids

No electronic aids permitted

Other permissible aids

You can use a double-sided A4 form that summarises the essential contents of the course.

Module Description, available in: EN

Engineering of Industrial Robots

General Information

Number of ECTS Credits

3

Module code

TSM_IndRobot

Valid for academic year

2026-27

Last modification

2024-10-03

Coordinator of the module

Anna Valente (SUPSI, anna.valente@supsi.ch)

Explanations regarding the language definitions for each location:

- Instruction is given in the language specified for each location and module execution.
- Documentation is available in the language(s) listed for each location and module execution. If the documentation is in multiple languages, the percentage distributed is indicated (100% = all documentation provided).
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	Lausanne			Lugano	Zurich		
Instruction				**X** E 100%			
Documentation				**X** E 100%			
Examination				**X** E 100%			

Module Category

TSM Technical scientific module

Profile Recommendations

This module is recommended for the following profiles:

	Lugano
Profile	MA

Lessons

2 lecture periods and 1 tutorial period per week

Entry level competences

Prerequisites, previous knowledge

- Linear algebra
- Basics of mechanics (statics and kinematics)
- Mechanical design (recommended)
- Basic programming skills
- Basics of robotics (recommended)

Brief course description of module objectives and content

The course targets technical and application challenges related to the design of advanced robotic solutions for industrial and service applications. It addresses the design, engineering and optimization of serial and parallel kinematics robotic arms, as well as of mobile platforms.

The course will cover theoretical content and practical activities of mechanical design, programming and simulation, as well as laboratory experiences with real hardware

Industrial use cases and service use cases will be addressed during the application/laboratory activities, specifically dealing with cutting-edge solutions and challenging markets demanding advanced robotic platform.

The laboratory ctivities will involve the use of industrial robots, cobots, and both commercial and experimental mobile platforms (wheeled and legged), to demonstrate course topics and to support the students in developing their projects and testing some of the designed hardware solutions.

Aims, content, methods

Learning objectives and competencies to be acquired

The learning objectives are:

- Ability to select a robotic platform starting from specific use cases requirements as well as productivity and safety KPIs
- Design, engineer, analyze statically and dynamically a robotic solution
- Design accessories (tools, fixturing, sensors), including vision-based perception systems

Module content with weighting of different components

Robotics basics review

- Position and orientation
- Kinematics
- Dynamics
- Trajectory and motion planning

Engineering of arm-type robots

- Problem statement: reference industrial task
- Serial and parallel robot architectures
- Workcell configuration: kinematic model, reach, tools, sensors
- Structural design, computation of inertias
- Design and dimensioning of actuators and transmission mechanisms
- Tool, fixturing, services design
- Motion simulation and optimization
- Design of vision-based sensing solutions

Engineering of mobile robots

- Problem statement: reference industrial task
- Kinematic models for wheeled robots
- Kinematic models for legged robots
- Robot configuration: kinematic model, tools, sensors
- Locomotion system design
- Path planning and motion simulation
- Design of vision-based navigation system

Teaching and learning methods

- Interactive lectures
- Tutorials in presence with lab equipment
- Self-study with exercises and assignments

Literature

P. Corke, “Robotics, Vision and Control”. Springer Cham, 2nd edition (2017).

B. Siciliano, O. Khatib, “Springer Handbook of Robotics”. Springer Berlin, Heidelberg (2008).

Assessment

Additional performance assessment during the semester

The module contains additional performance assessment(s) during the semester. The achieved mark of the additional performance assessment(s) applies to both the regular and the resit exam.

Description of additional performance assessment during the semester

Two assignments given during the course count 30% of the final mark.

Basic principle for exams

As a rule, all standard final exams are conducted in written form. For resit exams, lecturers will communicate the exam format (written/oral) together with the exam schedule.

Standard final exam for a module and written resit exam

Kind of exam

Written exam

Duration of exam

120 minutes

Permissible aids

No aids permitted

Exception: In case of an electronic Moodle exam, adjustments to the permissible aids may occur. Lecturers will announce the final permissible aids prior to the exam session.

Special case: Resit exam as oral exam

Kind of exam

Oral exam

Duration of exam

30 minutes

Permissible aids

No aids permitted

Module Description, available in: EN

Information Visualization

General Information

Number of ECTS Credits

3

Module code

TSM_InfVis

Valid for academic year

2026-27

Last modification

2023-07-28

Coordinator of the module

Susanne Bleisch (FHNW, susanne.bleisch@fhnw.ch)

Explanations regarding the language definitions for each location:

- Instruction is given in the language specified for each location and module execution.
- Documentation is available in the language(s) listed for each location and module execution. If the documentation is in multiple languages, the percentage distributed is indicated (100% = all documentation provided).
- The examination, including both questions and answers, is provided entirely (100%) in the language(s) specified for each location and module execution. The exams are on-site.

	Lausanne			Lugano	Zurich		
Instruction					**X** E 100%		
Documentation					**X** E 100%		
Examination					**X** E 100%		

Module Category

TSM Technical scientific module

Profile Recommendations

This module is recommended for the following profiles:

	Zurich
Profile	Geo

Lessons

2 lecture periods and 1 tutorial period per week

Entry level competences

Prerequisites, previous knowledge

Basic programming knowledge (any programming language)

Basic knowledge of data visualization and data graphics (e.g. Wong 2010)

Brief course description of module objectives and content

More and more complex data is collected in a wide range of application areas. Thus, with the goal of gaining insight into the data and information as well as communicating the resulting knowledge, the need for efficient visual methods is growing rapidly. We need to know the options for effective and efficient visual representations, for example for communication and fact-based decision making, as well as to develop new methods for visual data exploration to gain insight and learn from the collected data. Specifically also new user interfaces are needed to allow the interaction with and exploration of big, dynamic and multidimensional data sets as well as contextual information.

The module Information Visualization builds on basic knowledge of data visualization and data graphics (e.g. Wong 2010). It starts with an introduction before going into the details of important concepts (i.e., cognition) that influence the development and usage of information visualizations. Options and techniques for different visualization tasks as well as the design of static and dynamic visual user interfaces are considered. A specific focus is given to the visual analysis of uni- and multidimensional data as well as the communication of information (infographics). Typical questions that shall be answered through visual data analysis include the perspectives 'What?', 'When?', 'Where?' and also often 'With whom?'. Thematic, temporal, spatial and network data sets all have specific characteristics that need to be considered when designing suitable representations for visual analysis and communication. In addition to learning and teaching the basic and applied visualization knowledge, content from current research in information visualization are included in the module (advanced visualization topics).

The theoretical contents of the module are complemented with a series of exercises. These allow to deepen and broaden the theoretical knowledge through practical application. The visualization tools used in the module exercises are open. It is thus possible to try out a range of visualization tools (e.g., Vega-Altair, R, D3.js or Python Bokeh) or otherwise to select one and use it for (almost) all exercises.

Aims, content, methods

Learning objectives and competencies to be acquired

- The students can apply the theory and the knowledge of visualization methods for the support of efficient and effective visual analysis and communication of different data sets, including thematic (what), temporal (when), spatial (where) and network (with whom) data, from a range of scientific, technical and other application areas.
- The students understand and can apply the most important concepts of colour, layout, typography and other visualization dimensions as well as the knowledge of human perception and cognition for the design of suitable information visualizations.
- The students can apply their knowledge to implement iterative visualization projects to develop effective and goal- and user-oriented data and information visualizations for a range of application areas.
- The students understand different methods for the evaluation of information visualizations as well as their respective opportunities and limitations.
- The students know about the challenges of data preparations and problems such as missing data and can devise and apply suitable coping strategies.
- The students are able to use their knowledge of visualization methods, technologies and concepts to design, implement, and evaluate complex and advanced information visualizations for the analysis of specific data and research questions.
- The students know the current and ongoing topics and questions of information visualization research and are able to assess and suitably include new research results into their visualization work.

Module content with weighting of different components

- Repetition and overview of the basics of data and information visualization: data types, dimensions, analysis questions, purpose and audience, visual variables as well as data graphic types, colour, layout, typography, history of (information) visualization
- Principles of the human perception and cognition, applications and limitations, influences on the design of information representations and user interfaces
- Processes of visual data analysis and visual information communication, combination of visualization with other data analysis techniques (statistics, data mining), concepts and techniques of interaction
- Evaluation of information visualizations, usefulness, usability, utility, readability, efficiency and effectiveness
- Data preparation, strategies for missing and unsuitable data, concepts for the visualization of uncertainty
- Simple as well as more complex visualization types and techniques for the visualization of thematic, temporal, spatial, and network data to analyse the main questions of what, when, where and with whom and combinations thereof
- Applications and exercises of using the different concepts, methods and technologies for different questions and application areas, such as visual analytics, business intelligence, dashboards and information graphics

Teaching and learning methods

Lectures, exercises (individual and group work)

Literature

Dona M. Wong (2010). *The Wall Street Journal Guide to Information Graphics: The Dos and Don'ts of Presenting Data, Facts, and Figures*. W. W. Norton & Company, Inc.

Assessment

Additional performance assessment during the semester

The module contains additional performance assessment(s) during the semester. The achieved mark of the additional performance assessment(s) applies to both the regular and the resit exam.

Description of additional performance assessment during the semester

The students complete a graded visualization project during the semester (25% of final mark).

Basic principle for exams

As a rule, all standard final exams are conducted in written form. For resit exams, lecturers will communicate the exam format (written/oral) together with the exam schedule.

Standard final exam for a module and written resit exam

Kind of exam

Written exam

Duration of exam

120 minutes

Permissible aids

Aids permitted as specified below:

Permissible electronic aids

None

Other permissible aids

Maximum 2 A4-pages (1 sheet of A4 paper) summary of theory content

Exception: In case of an electronic Moodle exam, adjustments to the permissible aids may occur. Lecturers will announce the final permissible aids prior to the exam session.

Special case: Resit exam as oral exam

Kind of exam

Oral exam

Duration of exam

30 minutes

Permissible aids

No aids permitted

Module Description, available in: EN

Novel Innovation and Design Principles

General Information

Number of ECTS Credits

3

Module code

TSM_InnoDes

Valid for academic year

2026-27

Last modification

2020-01-22

Coordinator of the module

Patrick Link (HSLU, patrick.link@hslu.ch)

Explanations regarding the language definitions for each location:

- Instruction is given in the language specified for each location and module execution.
- Documentation is available in the language(s) listed for each location and module execution. If the documentation is in multiple languages, the percentage distributed is indicated (100% = all documentation provided).
- The examination, including both questions and answers, is provided entirely (100%) in the language(s) specified for each location and module execution. The exams are on-site.

	Lausanne			Lugano	Zurich		
Instruction					**X** E 100%		
Documentation					**X** E 100%		
Examination					**X** E 100%		

Module Category

TSM Technical scientific module

Profile Recommendations

This module is recommended for the following profiles:

	Zurich
Profile	BE

Lessons

2 lecture periods and 1 tutorial period per week

Entry level competences

Prerequisites, previous knowledge

BSc Business Engineering.
Other with basic knowledge of business principles such as marketing, accounting and controlling

Brief course description of module objectives and content

NOVEL INNOVATION & DESIGN PRINCIPLES. In order to keep generating competitive advantage through innovation, both manufacturing and service industries are in need to apply novel innovation and design principles. This module will focus on reuniting the study and practice of entrepreneurship and innovation. It takes a process-oriented view of agile Innovation.
First it starts with recognizing the opportunity and understanding the problem space using design thinking and selecting appropriate tools and methods. After achieving the Problem/Solution-Fit with the Lean Start-up approach an MVP is further developed and the using agile product and customer development, business design the venture can be scaled.
Alongside this journey, different tools are selected, e.g 5Wh, customer journey, big data Analytics, business ecosystem design canvas, Lean Canvas are applied.
Approaches such as Design Thinking, user-driven innovation, lean startup and lean entrepreneurship, corporate venturing, jugaad innovation will be used to work on one real-life business cases. Different excursions complete the module to see how novel design and innovation principles are applied in practice.

Aims, content, methods

Learning objectives and competencies to be acquired

- What is agile innovation?
- what are the differences to traditional innovation processes?
- How to apply Design Thinking, Lean Start-up and other user centered approaches
- Select the right tools to achieve the targets for a given Innovation challenge
- The nature of creativity and the creative process
- Moderation of a creatity workshop
- Where innovations come from – the wide range of different source which offer opportunities
- Combine intuitive and analytical problem solving techniques
- Apply key tools like customer journey, Lean Canvas and Business Ecosystem Design Canvas
- The need for a strategy to guide search for opportunities
- Developing and using a business plan to attract resources

Module content with weighting of different components

WK1	WK2	WK3	WK4	WK5	WK6	WK7
Introduction	System Thinking	Design Thinking	Project Work	Experiments and Prototypes	Creativity Techniques	Project Work
Case presentation	Types of Innovation	Customer Journey	Project Work	First presentation	Workshop Facilitation	Project Work
Teamforming	Teamwork	Teamwork	Teamwork	Teamwork	Teamwork	Teamwork

WK8	WK9	WK10	WK11	WK12	WK13	WK14
Creativity Workshop	Innovation Culture	Lean Canvas	Backlog and User Stories	Business Ecosystem Design	Project Work	Final Presentation
Creativity Workshop	Project Work	Project Work	Second presentation	Concept Map	Project Work	Concept Maps
Teamwork	Teamwork	Teamwork	Problem Solution Fit	Teamwork	Teamwork	Final Q&A

Teaching and learning methods

Flipped Classroom didactic approach complemented by case studies, workshops and guest lectures. Units of 2x45min and 1x45 min case study. Cases are briefed and presented biweekly.
As part of the module we conduct several workshops (e.g. Design Thinking Workshop, Creativity Workshop). The student moderate their own workshop as part of the semester project.
In addition we conduct 2-3 excursions during the semester(in the past to Google, Zühlke Engineering, Trihow).

Literature

Lewrick, Link and Leifer (2018): The Design Thinking Playbook, Wiley.
Lewrick, Link and Leifer (2020): The Design Thinking Toolbox, Wiley.

Also available in German

Lewrick, Link und Leifer (2018): Das Design Thinking Playbook, 2. Aufl., Vahlen Verlag.

Lewrick, Link und Leifer (2019): Das Design Thinking Toolbook, Vahlen Verlag.

Assessment

Additional performance assessment during the semester

The module contains additional performance assessment(s) during the semester. The achieved mark of the additional performance assessment(s) applies to both the regular and the resit exam.

Description of additional performance assessment during the semester

During the semester, the student develop an own innovation project in groups. The following tasks are evaluated:
- A Journal Report about all the used methods and tools (15%)
- A management summary of the elaborated project idea (15%)

Basic principle for exams

As a rule, all standard final exams are conducted in written form. For resit exams, lecturers will communicate the exam format (written/oral) together with the exam schedule.

Standard final exam for a module and written resit exam

Kind of exam

Written exam

Duration of exam

120 minutes

Permissible aids

Aids permitted as specified below:

Permissible electronic aids

Slides and templates available on Moodle

Lewrick, Link and Leifer (2018): The Design Thinking Playbook, Wiley.
Lewrick, Link and Leifer (2020): The Design Thinking Toolbox, Wiley.

Other permissible aids

Concept Maps (2 pages A3)

Lewrick, Link and Leifer (2018): The Design Thinking Playbook, Wiley.
Lewrick, Link and Leifer (2020): The Design Thinking Toolbox, Wiley.

Exception: In case of an electronic Moodle exam, adjustments to the permissible aids may occur. Lecturers will announce the final permissible aids prior to the exam session.

Special case: Resit exam as oral exam

Kind of exam

Oral exam

Duration of exam

30 minutes

Permissible aids

No aids permitted

Module Description, available in: EN

Integrated Automation

General Information

Number of ECTS Credits

3

Module code

TSM_IntAuto

Valid for academic year

2026-27

Last modification

2019-07-04

Coordinator of the module

Katrin Lohan (OST, katrin.lohan@ost.ch)

Explanations regarding the language definitions for each location:

- Instruction is given in the language specified for each location and module execution.
- Documentation is available in the language(s) listed for each location and module execution. If the documentation is in multiple languages, the percentage distributed is indicated (100% = all documentation provided).
- The examination, including both questions and answers, is provided entirely (100%) in the language(s) specified for each location and module execution. The exams are on-site.

	Lausanne			Lugano	Zurich		
Instruction					**X** E 100%		
Documentation					**X** E 100%		
Examination					**X** E 100%		

Module Category

TSM Technical scientific module

Profile Recommendations

This module is recommended for the following profiles:

	Zurich
Profile	MA

Lessons

2 lecture periods and 1 tutorial period per week

Entry level competences

Prerequisites, previous knowledge

- Basic principles of automation technology
- Basic principles of communication technology, e.g. OSI Reference Model, Ethernet, TCP/IP etc.
- Basic principles of statistics and random variables

Brief course description of module objectives and content

In an automation system in manufacturing technology or process automation, sensors measure non-electric values and actuators, such as drives, influence the process. The individual components are controlled by control systems and automatic controllers, connected with industrial networks, and supervised by humans.

The emphasis of this module is on the selection and determination of the individual components, bearing in mind functional aspects, with special attention to functional safety.

Aims, content, methods

Learning objectives and competencies to be acquired

The student will be able to :

- establish the specifications of an integrated mechatronic system, including the sensors, the actuators, and the control systems;
- master the operation of electric drives for automated processes; be able to choose a motor with its controls according to the applications;
- select and to integrate technologies of sensors according to applications;
- determine a suitable communication system for an automation task on the basis of functions and performance parameters;
- designate the evaluation criteria for the application of user interfaces;
- plan and size an Ethernet-based network;
- calculate comprehensive parameters (MTBF, MTTF, MTU…) on the basis of statistical data;
- complete a risk analysis

Module content with weighting of different components

The module is divided in three courses:

1. *Drives and Sensors (ca. 35%)*
    - Functionality, calculation, and operational behavior of motors
    - Functionality and choice of sensors
    - Drive design and regulation
    - Decentralized drive systems
    - Application examples
2. *Communication and Networks (ca. 30%)*
    - Functionality and integration of automation components (bus systems, automation devices, communication modules, process control systems)
    - Networked automation technology
    - Service and monitoring systems, Human Machine Interface
    - Planning and the basic principles of project planning with Profinet / industrial Ethernet-based networks
    - Application examples
3. *Safety Engineering in Automation Technology (ca. 35%)*
    - Project planning for an error-proof automation system
    - Error-proof communication and programming
    - Remote diagnostics, elimination of errors, and remote maintenance
    - Application examples

Teaching and learning methods

- Lecture, presentations and discussion of theoretical topics
- Discussion of practical applications and examples form the industry
- Exercises and self-study of selected topics

Literature

The lecturers' scripts will contain references to current literature.

Assessment

Additional performance assessment during the semester

The module does not contain an additional performance assessment during the semester

Basic principle for exams

As a rule, all standard final exams are conducted in written form. For resit exams, lecturers will communicate the exam format (written/oral) together with the exam schedule.

Standard final exam for a module and written resit exam

Kind of exam

Written exam

Duration of exam

120 minutes

Permissible aids

Aids permitted as specified below:

Permissible electronic aids

All **OFFLINE** electronic devices (e.g. laptops, tablets, calculators) are **allowed**

Other permissible aids

Open book

Exception: In case of an electronic Moodle exam, adjustments to the permissible aids may occur. Lecturers will announce the final permissible aids prior to the exam session.

Special case: Resit exam as oral exam

Kind of exam

Oral exam

Duration of exam

30 minutes

Permissible aids

No aids permitted

Module Description, available in: EN

Internet of Things

General Information

Number of ECTS Credits

3

Module code

TSM_IoT

Valid for academic year

2026-27

Last modification

2019-08-31

Coordinator of the module

Daniele Puccinelli (SUPSI, daniele.puccinelli@supsi.ch)

Explanations regarding the language definitions for each location:

- Instruction is given in the language specified for each location and module execution.
- Documentation is available in the language(s) listed for each location and module execution. If the documentation is in multiple languages, the percentage distributed is indicated (100% = all documentation provided).
- The examination, including both questions and answers, is provided entirely (100%) in the language(s) specified for each location and module execution. The exams are on-site.

	Lausanne			Lugano	Zurich		
Instruction				**X** E 100%			
Documentation				**X** E 100%			
Examination				**X** E 100%			

Module Category

TSM Technical scientific module

Profile Recommendations

This module is recommended for the following profiles:

	Lugano
Profile	CS

Lessons

2 lecture periods and 1 tutorial period per week

Entry level competences

Prerequisites, previous knowledge

Familiarity with networking and TCP/IP

Basic knowledge in Python, HTML and JavaScript

Brief course description of module objectives and content

This course covers all the topics related to the Internet of Things: from the sensors level to the higher layer of data rapresentation and manipulation. It is intended to give the student the technical knowledge and skills needed for building up an Internet of Things (IoT) system.

Aims, content, methods

Learning objectives and competencies to be acquired

Students attending this module

- have an overview of the IoT world: the technologies, application contexts, development strategies, implementation problems, and the possible solutions
- gain familiarity with the key technologies and protocols employed at each layer of the stack
- learn how to plan and implement real-world applications that involve heterogeneous devices
- Understand where the IoT concept fits within the broader ICT industry and possible future trends
- Appreciate the role of big data, cloud computing and data analytics in a typical IoT system

Module content with weighting of different components

Part 1 (25%):

- Introduction to the Internet of Things
- Edge and gateway devices (microcontroller, sensors, and actuators)
- Communication technologies
- Communication protocols

Part 2 (30%):

- Embedded programming (Arduino, RaspberryPi)
- Deploy an IoT infrastructure

Part 3 (30%):

- Heterogeneous IoT devices integration
- Data acquisition, management, and mining
- IoT in the real world

Part 4 (15%):

- Connect the IoT infrastructure with the data world

Teaching and learning methods

Lecture and practical work on computer and dedicated hardware

Literature

Assessment

Additional performance assessment during the semester

The module does not contain an additional performance assessment during the semester

Basic principle for exams

As a rule, all standard final exams are conducted in written form. For resit exams, lecturers will communicate the exam format (written/oral) together with the exam schedule.

Standard final exam for a module and written resit exam

Kind of exam

Written exam

Duration of exam

120 minutes

Permissible aids

Aids permitted as specified below:

Permissible electronic aids

No electronic aids permitted

Other permissible aids

Slides and lecture notes in addition to recommended book chapters

Exception: In case of an electronic Moodle exam, adjustments to the permissible aids may occur. Lecturers will announce the final permissible aids prior to the exam session.

Special case: Resit exam as oral exam

Kind of exam

Oral exam

Duration of exam

30 minutes

Permissible aids

No aids permitted

Module Description, available in: EN

Laser and laser applications

General Information

Number of ECTS Credits

3

Module code

TSM_Laser

Valid for academic year

2026-27

Last modification

2019-10-11

Coordinator of the module

Ronald Holtz (FHNW, ronald.holtz@fhnw.ch)

Explanations regarding the language definitions for each location:

- Instruction is given in the language specified for each location and module execution.
- Documentation is available in the language(s) listed for each location and module execution. If the documentation is in multiple languages, the percentage distributed is indicated (100% = all documentation provided).
- The examination, including both questions and answers, is provided entirely (100%) in the language(s) specified for each location and module execution. The exams are on-site.

	Lausanne			Lugano	Zurich		
Instruction					**X** E 100%		
Documentation					**X** E 100%		
Examination					**X** E 100%		

Module Category

TSM Technical scientific module

Profile Recommendations

This module is recommended for the following profiles:

	Zurich
Profile	Pho

Lessons

2 lecture periods and 1 tutorial period per week

Entry level competences

Prerequisites, previous knowledge

Optics: Basics of wave and geometrical optics; without optics basics during bachelor studies, the EVA "Fundamentals of light" should be visited before visiting further TSM modules.
Physics: Basics for engineers (bachelor niveau)

Brief course description of module objectives and content

TSM module “Laser and Laser applications” provides a broad overview about the fascinating field of state-of-the-art Laser technology and its applications in industry, R&D, medicine and communication. The modul provides a comprehensive insight into the Laser and applications market, Laser types and devices, Beam deliveries, Laser machines, Physics of interaction between laser and material, and real industrial application examples presented by experts with industrial background. Module objective is to increase and enhance the technological competences on laser generation, control, and laser-material interaction.physical/ technological limits and competing technology.

Aims, content, methods

Learning objectives and competencies to be acquired

After successfully completing this course the student:

- knows the concepts of the most important laser types with their respective advantages and disadvantages and will be informed about future trends.
- will be skilled to decide between Laser-based technology or other manufacturing technology based on knowledge in technology, efficiency, economical, and ecological reasons
- knows industrial relevant beam guiding and delivery systems and technologies
- will be skilled to make decision on suitable laser source and beam delivery depending on application process.
- thoroughly understands important laser applications and can design the most relevant features of the systems required for them
- knows the most relevant physical effects which happen during the interaction between laser and material
- will be skilled to determine processing strategy, basic parameters and supporting technology
- knows basics methods of beam diagnostics, process monitoring, and industry 4.0 technology

Module content with weighting of different components

Laser [7 weeks]

1. Basics [2 wk]
   Repetition of basics, Resonators, Laser modes, etc.
2. Technical realization of Lasers [3 wk]
   Design concepts of significant laser sources, Pulse generation, Wavelength conversion,
3. Beam Delivery and Optics [1 wk]
   hard optics, fibers, working head concepts, beam forming, Scanners, fast and ultra-fast optics etc.
4. Laser Safety and health protection [1 wk]

Laser Applications [7 weeks]

1. Industrial Laser Applications [4 wk]Market description, Applications (Welding, Cutting, Drilling, Structuring, Hardening, Marking, Additive Manufacturing etc.), Laser – materal interaction, parameters, process properties and limits, laser machine concepts
2. Lasers in Medicine, Measuring Technology, Communication and Science [2 wk]
   Interferometry, Spectroscopy, Surgery, Ophthalmology, Displays and Communication, Microscopy
3. Beam and process diagnostics [1 wk]
   Methods of beam analytics and validations, Methods of process monitoring and control, lasers and industry 4.0

Teaching and learning methods

- Lectures and self-study
- Practical and theoretical exercises

Literature

1) William Silfvast: Laser fundamantals

2) Rainer Dohlus: Lasertechnik

3) Helmut Hügel, Thomas Graf: Laser in der Fertigung

4) Saleh, Teich: Photonics

5) Fritz Kneubühl: Laser

Assessment

Additional performance assessment during the semester

The module does not contain an additional performance assessment during the semester

Basic principle for exams

As a rule, all standard final exams are conducted in written form. For resit exams, lecturers will communicate the exam format (written/oral) together with the exam schedule.

Standard final exam for a module and written resit exam

Kind of exam

Written exam

Duration of exam

120 minutes

Permissible aids

Aids permitted as specified below:

Permissible electronic aids

- calculator

Other permissible aids

- personal formulary 4 A4 pages

Exception: In case of an electronic Moodle exam, adjustments to the permissible aids may occur. Lecturers will announce the final permissible aids prior to the exam session.

Special case: Resit exam as oral exam

Kind of exam

Oral exam

Duration of exam

30 minutes

Permissible aids

Aids permitted as specified below:

Permissible electronic aids

specified by the lecturers

Other permissible aids

specified by the lecturers

Module Description, available in: EN

International Logistics

General Information

Number of ECTS Credits

3

Module code

TSM_Logistic

Valid for academic year

2026-27

Last modification

2022-01-09

Coordinator of the module

Luca Canetta (SUPSI, luca.canetta@supsi.ch)

Explanations regarding the language definitions for each location:

- Instruction is given in the language specified for each location and module execution.
- Documentation is available in the language(s) listed for each location and module execution. If the documentation is in multiple languages, the percentage distributed is indicated (100% = all documentation provided).
- The examination, including both questions and answers, is provided entirely (100%) in the language(s) specified for each location and module execution. The exams are on-site.

	Lausanne			Lugano	Zurich		
Instruction					**X** E 100%		
Documentation					**X** E 100%		
Examination					**X** E 100%		

Module Category

TSM Technical scientific module

Profile Recommendations

This module is recommended for the following profiles:

	Zurich
Profile	BE

Lessons

2 lecture periods and 1 tutorial period per week

Entry level competences

Prerequisites, previous knowledge

- Basic knowledge of logistics
- Basic knowledge in operations management
- Good knowledge of English

Brief course description of module objectives and content

The module starting from the analysis of the whole Supply Chain configuration and management process, underlines in particular the greater importance role that logistics and procurement are assuming in modern collaborative Supply Chain. Procurement is a strategic business driver that allows companies to efficiently focus on their key competences and activities while leveraging competences and cost advantage stemming from a complex supplier network, which provides products and services. Logistics activities are crucial for modern Supply Chains, ensuring a smooth sharing of information and materials among manufacturers and their globalized supplier networks. Moreover, distribution logistics plays a crucial role in delivering customer experiences and value, thanks to differentiated options and services. The evolution of Supply Chain activities in reaction to new paradigms, such as sustainability and mass customization, and thanks to technological innovations, such as Industry and SCM 4.0, will be analysed in order to better understand future challenges and opportunities.

Aims, content, methods

Learning objectives and competencies to be acquired

The module prepares for a professional career in industrial Supply Chain Management (SCM). Possible fields of activity include business development, innovation, business processes and quality improvement, the management of Supply Chains at national and international level.

The module will provides the necessary knowledge to understand the variety of possible SCM concepts, including sourcing, logistics and outsourcing/offshoring. An overview of the potential alternatives will be achieved through the analysis and knowledge acquisition about strategies, management processes, structures and technical elements, based on the design principles of different operational procurement and distribution needs of multiple branches.

The students will be able to manage strategical, tactical and operational decisions; starting from the establishment of correct strategies suitable for given targets, design a possible operating strategy for the planned issues and implement at tactical and operational level the required coordination and management mechanisms. For this reason, methodological tools for deriving and implementing suitable strategies (understanding of the influence of the industrial sector context, establishment of realistic targets, identification of decision drivers and key processes, designing of suitable strategies, managing and controlling of internal processes and their integration with those of the supply chain partners) will be introduced.

In order to deepen the level of knowledge and competences, while dealing with practical aspects and comparison of alternatives, quantitative methods will be presented and applied by the students through examples and tasks. Case studies, presented by industrial and scientific experts, will allow to better understand the complexity linked to the application in real contexts of the proposed methodologies and to face these challenges.

Module content with weighting of different components

SCM integrates all activities involved in the flow of goods and services from providers to the final customers and is fundamental for achieving company success in a globalized, dynamic and uncertain business environment. The ability to react to customer requirements and matching them with the network resources is critically important in SCM and requires among other things focusing on core competences, making coherent outsourcing/offshoring decisions as well as choosing suitable configurations of the distribution network. Aside from those strategic considerations, decisions have to be made on the tactical and operational levels. The module will deal with models and concepts of international logistics, including sourcing and outsourcing/offshoring, e.g.:

- SCM strategy and internationalization including outsourcing/offshoring

- Contract management (statement of requirements)

- SCM management and controlling

- Models and concepts of international logistics including warehousing and transport

- Rules and regulations in international logistics

- Governance, Corporate Social Responsibility, and quality assurance in SCM

Under the umbrella provided by the macro areas listed above a variety of topics will be addressed, such as:

- SCM introduction (definitions, 7 principles, 8 key activities, etc.)
- Supply Chain design, configuration and coordination
- Sustainable SCM
- Decision Support Tools in SCM
- Risk Management in SCM
- Innovation in SCM (Industry and SCM 4.0, new services, etc.)
- International Logistics (air, sea, rail, road)
- Inter-modality
- Last Mile distribution and Omnichannel
- Procurement Strategy Development
- (Strategic) Sourcing Lifecycle
- Supply market competitiveness appraisal
- Supplier Relationship Management
- Outsourcing/Offshoring (and Insourcing/Nearshoring)
- Purchasing negotiation

Teaching and learning methods

- Lectures / presence
- Tutorial / presence
- Self-study

Literature

- The presentations distributed by the lecturers will be the main source
- Specific scientific and “magazine” articles will be uploaded for covering specific topics and applications

Additional material for in-depth analysis can be found for instance in the following books:

- Logistics & Supply Chain Management, 5th Edition, Martin Christopher, 2016, Pearson Education
- Purchasing and Supply Chain Management: Analysis, Strategy, Planning and Practice, A.J. Van Weele, 2009, Cengage
- The Handbook of Global Outsourcing and Offshoring 3rd edition, I. Oshri, J. Kotlarsky, L.P. Willcocks, 2015, Palgrave

Assessment

Additional performance assessment during the semester

The module does not contain an additional performance assessment during the semester

Basic principle for exams

As a rule, all standard final exams are conducted in written form. For resit exams, lecturers will communicate the exam format (written/oral) together with the exam schedule.

Standard final exam for a module and written resit exam

Kind of exam

Written exam

Duration of exam

120 minutes

Permissible aids

Aids permitted as specified below:

Permissible electronic aids

PDF version of the slide lessons and/or written personal summaries.

No other material or information search is allowed (PC in flight mode, no connection available)

Other permissible aids

Open book. Printed documents (all lectures) and/or written personal summaries

Exception: In case of an electronic Moodle exam, adjustments to the permissible aids may occur. Lecturers will announce the final permissible aids prior to the exam session.

Special case: Resit exam as oral exam

Kind of exam

Oral exam

Duration of exam

30 minutes

Permissible aids

Aids permitted as specified below:

Permissible electronic aids

PDF version of the slide lessons and/or written personal summaries.

No other material or information search is allowed (PC in flight mode, no connection available)

Other permissible aids

Open book. Printed documents (all lectures) and/or written personal summaries

Module Description, available in: EN

New Design Methodologies for Microengineering Products

General Information

Number of ECTS Credits

3

Module code

TSM_MTProdDes

Valid for academic year

2026-27

Last modification

2022-01-10

Coordinator of the module

Sylvain Hugon (HES-SO, sylvain.hugon@heig-vd.ch)

Explanations regarding the language definitions for each location:

- Instruction is given in the language specified for each location and module execution.
- Documentation is available in the language(s) listed for each location and module execution. If the documentation is in multiple languages, the percentage distributed is indicated (100% = all documentation provided).
- The examination, including both questions and answers, is provided entirely (100%) in the language(s) specified for each location and module execution. The exams are on-site.

	Lausanne			Lugano	Zurich		
Instruction	**X** E 100%						
Documentation	**X** E 100%						
Examination	**X** E 100%						

Module Category

TSM Technical scientific module

Profile Recommendations

This module is recommended for the following profiles:

	Lausanne
Profile	Mic

Lessons

2 lecture periods and 1 tutorial period per week

Entry level competences

Prerequisites, previous knowledge

Basic knowledge of design methodologies

Brief course description of module objectives and content

By the end of this course, students will have acquired the skills to analyse, understand and identify the design process environment for microengineering devices. The course includes concepts specific to design processes in microengineering, such as the specificities due to the size of devices and microfabrication tools.

Students will be trained to understand the customer's need, formalise the problem, establish the requirements and derive the primary specifications. They will also know how to build the functional and physical architectures, and, if necessary, simulate, predict and validate the behaviours and performances to analyse the safety of operation. The course is designed to integrate concrete cases, allowing students to build a reference base.

Aims, content, methods

Learning objectives and competencies to be acquired

- Know how to apply design methods (writing functional specifications, functional analysis, FMECA, FAST, APTE, V-Model) and how to choose the most suitable in a given design process.
- Integrate into the design the specificities of the physical phenomena of microengineering products by implementing, if necessary, on a multi-criterias and product management software. For this module, "Knowllence: Robust Engineering Suite - Medical Device Suite" is used.
- Understand and consider microengineering interactions for the production and maintenance of prototypes or series products.
- At the end of the course, the student will be able to apply and critically examine design techniques in microengineering in order to produce solutions that take into account health and safety aspects while respecting environmental and economic constraints.

Module content with weighting of different components

- *(a+b) a theoretical periods + b practical exercises/application periods*
- (3+3) Design methods
    - Structures of companies in the microengineering field
    - Product life cycle
    - user needs
    - functional analysis : writing functional specifications
    - choice of the most suitable method in a given design process (examples and application cases)
    - presentation of typical software (Knowllence: Robust Engineering Suite - Medical Device Suite)
- (3+3) Specificities of microengineering products
    - Products specifications - URS
    - Solutions research
    - Patent review
- (3+3) Value analysis
    - Value analysis calculation
    - FAST + APTE methods
- (3+3) Microengineering interactions for production and maintenance - Project management
    - prototype vs. series products - (traceability, documentation, design master file, standards, V-model)
    - Management driving tools, (projects review and milestones)
    - FMEA - FMECA
- (3+3) Design to cost
    - Design calculation
    - First approach of DFM - Design for manufacturing - including production environnement
- (0+3) Product design validation - validation of all design steps
    - Open technology transfer

Teaching and learning methods

Lecture-type classes, illustrated with videos and models

Red thread (an application project that follows the course progression: throughout the semester, students construct their project, step by step, while following the course program)

Literature

- La conception mécanique, 2e Edition, Méthodologie et optimisation, Philippe Boisseau, Editions Dunod.
- Reference works for the choice of professors.

Assessment

Additional performance assessment during the semester

The module does not contain an additional performance assessment during the semester

Basic principle for exams

As a rule, all standard final exams are conducted in written form. For resit exams, lecturers will communicate the exam format (written/oral) together with the exam schedule.

Standard final exam for a module and written resit exam

Kind of exam

Written exam

Duration of exam

120 minutes

Permissible aids

Aids permitted as specified below:

Permissible electronic aids

Allowed: Computer, common software, internet access

Not allowed: Telephone, access to social networks

Other permissible aids

Allowed: Personal notes, reference works

Exception: In case of an electronic Moodle exam, adjustments to the permissible aids may occur. Lecturers will announce the final permissible aids prior to the exam session.

Special case: Resit exam as oral exam

Kind of exam

Oral exam

Duration of exam

30 minutes

Permissible aids

Aids permitted as specified below:

Permissible electronic aids

Length of exam:

30 minutes presentation and 30 minutes preparation

Allowed: Computer, common software, internet access, personal notes, reference works

Other permissible aids

Allowed: Personal notes, reference works

Module Description, available in: EN

Machine Learning and Data in Operation

General Information

Number of ECTS Credits

3

Module code

TSM_MachLeData

Valid for academic year

2026-27

Last modification

2023-06-20

Coordinator of the module

Vanni Galli (SUPSI, vanni.galli@supsi.ch)

Explanations regarding the language definitions for each location:

- Instruction is given in the language specified for each location and module execution.
- Documentation is available in the language(s) listed for each location and module execution. If the documentation is in multiple languages, the percentage distributed is indicated (100% = all documentation provided).
- The examination, including both questions and answers, is provided entirely (100%) in the language(s) specified for each location and module execution. The exams are on-site.

	Lausanne			Lugano	Zurich		
Instruction	**X** E 100%				**X** E 100%		
Documentation	**X** E 100%				**X** E 100%		
Examination	**X** E 100%				**X** E 100%		

Module Category

TSM Technical scientific module

Profile Recommendations

This module is recommended for the following profiles:

	Lausanne	Zurich
Profile	DS	DS

Lessons

2 lecture periods and 1 tutorial period per week

Entry level competences

Prerequisites, previous knowledge

- Basic knowledge of machine learning, deep learning, data management and data engineering.
- Good command of an imperative programming language, basic knowledge of Python.
- Basic knowledge of probability, statistics, linear algebra (vectors, matrices).

Brief course description of module objectives and content

This module presents powerful techniques to manage the lifecycle of machine learning models, covering in particular baseline models, infrastructure (clusters, cloud, edge AI and resource management) and tooling (frameworks), model training and debugging, model evaluation and tuning, data management (sources, storage, versioning, privacy), systems testing (CI/CD) and explainability, deployment (batch, service, edge), monitoring (data drift) and continual learning. Emphasis is placed on practical tools, real use-case scenarios, and the relevant hardware and software platforms.

Additional topics such as business requirements and objectives, project management for ML, team structure, user experience as well as responsible use of ML systems, including sustainable AI, are also considered.

Aims, content, methods

Learning objectives and competencies to be acquired

- Recognising the complete lifecycle of machine learning projects, from data requirements to development, deployment, and monitoring.
- Demonstrating skills in maintaining ML code and data, version and integrate it, and define appropriate environments, with emphasis on practical applications such as data cleaning and preprocessing.
- Deploying ML models at scale, monitoring their performance and adapting models to changing requirements, with a focus on assessing and adjusting to data drift and shifts in data distribution.
- Analysing relevant tools and real use-case scenarios, such as real-time services management; critically analysing the implications and applications in practical scenarios.
- Selecting software and hardware platforms based on the requirements of different scenarios, demonstrating a thorough understanding of the needs and constraints of each.
- Extracting and integrating insights from guest lectures by industry professionals (subject to availability), demonstrating the ability to interpret expert knowledge from scientific literature and online resources, and applying it effectively to complement their hands-on experience.

Module content with weighting of different components

- Brief recap of machine learning and deep learning.
- Introduction to the lifecycle of a Machine Learning project.
- Understanding data needs and requirements for ML projects (e.g. versioning, storage, processing, labeling, augmentation, simulation).
- ML Development: defining the environment, maintaining the ML code, integrating ML code (versioning, evaluation, baselines).
- ML Deployment: running models at scale (e.g. batch vs online, model compression, cloud / edge deployment), ensuring system availability, monitoring performance, adapting to changes (data distribution shifts, failures, metrics, logging, continual learning).
- Exploration of tools and real-world scenarios.
- Overview of relevant hardware and software platforms.
- Selection of advanced topics such as:
    - Trustworthy AI (incl. regulatory aspects).
    - Guest lecture(s) from industry professionals (subject to availability).
    - Project management and business perspective (e.g. job roles, teams).

Teaching and learning methods

Classroom teaching; programming exercises using MLOps tools and Python (among others); guest lectures from industry professionals (subject to availability).

Literature

- Chip Huyen , “Designing Machine Learning Systems: An Iterative Process for Production-Ready Application”, O-Reily, 2022
- Noah Gift & Alfredo Deza, “Practical MLOps - Operationalizing Machine Learning Models”, O’Reilly, 2021
- Scientific literature and articles as discussed during the lectures

Assessment

Additional performance assessment during the semester

The module contains additional performance assessment(s) during the semester. The achieved mark of the additional performance assessment(s) applies to both the regular and the resit exam.

Description of additional performance assessment during the semester

Group project development: conducted throughout the semester with the final presentation taking place during the last lecture of the module.
The group project contributes to 1/3 of the final grade.

Basic principle for exams

As a rule, all standard final exams are conducted in written form. For resit exams, lecturers will communicate the exam format (written/oral) together with the exam schedule.

Standard final exam for a module and written resit exam

Kind of exam

Written exam

Duration of exam

120 minutes

Permissible aids

Aids permitted as specified below:

Permissible electronic aids

No electronic aids permitted

Other permissible aids

Two A4 pages of self-made notes.

Exception: In case of an electronic Moodle exam, adjustments to the permissible aids may occur. Lecturers will announce the final permissible aids prior to the exam session.

Special case: Resit exam as oral exam

Kind of exam

Oral exam

Duration of exam

30 minutes

Permissible aids

No aids permitted

Description du module, disponible en: FR

Maintenance des structures porteuses

Informations générales

Nombre de crédits ECTS

3

Code du module

TSM_MaintStruc

Valable pour l'année académique

2026-27

Dernière modification

2023-09-18

Coordinateur/coordinatrice du module

Daia Zwicky (HES-SO, Daia.Zwicky@hefr.ch)

Explications concernant les langues d'enseignement par site :

- L'enseignement est dispensé dans la langue indiquée ci-dessous pour chaque site et chaque exécution du module.
- Les supports de cours sont disponibles dans les langues indiquées ci-dessous pour chaque site et chaque exécution du module. Lorsque plusieurs langues sont utilisées, la proportion de contenu disponible dans chaque langue est précisée (100 % = ensemble des supports de cours).
- Les examens (questions et réponses) sont entièrement rédigés dans la langue indiquée ci-dessous pour le site et l'exécution du module concernés. Ils se déroulent en présentiel.

	Lausanne			Lugano	Zurich		
Leçons		**X** F 100%					
Documentation		**X** F 90%	**X** E 10%				
Examen		**X** F 100%					

Catégorie de module

TSM approfondissement technico-scientifique

Recommandations de profil

Ce module est recommandé pour les profils suivants :

	Lausanne
Profil	CE

Leçons

2 leçons et 1 leçon de pratique par semaine

Compétences préalables

Connaissances préalables, compétences initiales

Bonnes connaissances en analyse structurale, technologie des matériaux. Connaissances de base (Bachelor) en construction en béton et en construction en bois.

Brève description du contenu et des objectifs

Une grande partie des travaux futurs de construction se fera dans le bâti existant. Ce module apporte aux étudiant-e-s du master les méthodes et les procédés nécessaires dans la maintenance d'ouvrages.

Toute remise en état, modification ou renforcement d'ouvrages et d'infrastructures nécessite un relevé spécifique et fondé de l'état actuel. L'identification des dégâts et des outils appliqués, l'actualisation des informations y.c. l'évaluation de la capacité porteuse ainsi que les méthodes de réparation et de renforcement constituent les points de mire de la formation. Des exemples typiques tirés de la construction en béton armé et de la construction en bois servent de réflexion aux étudiant-e-s pour la découverte de la méthodologie et des spécialités.

Objectifs, contenus, méthodes

Objectifs d'apprentissage, compétences à acquérir

Les étudiant-e-s acquièrent des compétences de base dans l'examen d'ouvrages existants. Pour ce faire, durant les cours magistraux, le déroulement et l'étendue d'un examen sont enseignées et le degré de détail nécessaire est abordé.

Les étudiant-e-s se familiarisent avec les méthodes d'auscultation usuelles (destructives et non destructives) pour le béton armé et pour le bois. Ils se voient dispensés pendant les cours des informations sur les applications et les limites de ces méthodes.

Les étudiant-e-s sont sensibilisé-e-s aux principaux mécanismes de dégradations et aux défauts usuels des constructions en béton armé et en bois, et ils acquièrent des connaissances sur l'analyse et l'évaluation structurales des structures existantes.

Les étudiant-e-s acquièrent des connaissances sur les procédés les plus courants de remise en état et de renforcement. Ces derniers sont enseignés à l'aide d'exemples pratiques de construction. Des exemples choisis pour les exercices permettront d'approfondir les connaissances acquises.

Contenu des modules avec pondération du contenu des cours

Le module est divisé en trois parties :

1. Bases communes (env. 10 %)
   - Caractère et fonction du relevé de l'état / de l'examen d'ouvrages
   - Principes d'une évaluation de l'état, degré de raffinement requis
   - Procédure d'un relevé de l'état / d'un examen (préparation, exécution, appréciation, évaluation)

2. Structures en béton (env. 60%)
   - Défauts, dommages typiques, causes des dommages, mécanismes de détérioration, étendue des dommages
   - Méthodes d'auscultation non destructives et destructives
   - Analyse et évaluation de l'état physique
   - Analyse et évaluation de la sécurité structurale
   - Méthodes d'intervention (remise en état et de renforcement)

3. Structures en bois (env. 30%)
   - Défauts, dommages typiques, causes des dommages, mécanismes de détérioration, étendue des dommages
   - Méthodes d'auscultation non destructives et destructives
   - Analyse et évaluation de l'état physique
   - Analyse et évaluation de la sécurité structurale
   - Méthodes d'intervention (remise en état et de renforcement)

Méthodes d'enseignement et d'apprentissage

- Cours magistraux
- Discussion de cas pratiques
- Exercices et étude autonome de sujets sélectionnés

Bibliographie

Supports D. Zwicky / A. Bernasconi (PowerPoint), articles spécialisés, autres documentations

Evaluation

Évaluation supplémentaire pendant le semestre

Le module ne comprend pas d'évaluation supplémentaire pendant le semestre

Principe pour les examens

En règle générale, tous les examens réguliers de fin de module se déroulent sous forme écrite. Concernant les examens de répétition, leur format (écrit ou oral) sera communiqué par l'enseignant-e en même temps que le calendrier des examens.

Examen de fin de module régulier et examen écrit de répétition

Type de l'examen

Examen écrit

Durée de l'examen

120 minutes

Aides autorisées

Les aides suivantes sont autorisées:

Aides électroniques autorisées

Examen "Open Book" : tout support admis sous forme papier et électronique, avec ce dernier en mode "hors ligne".

Autres aides autorisées

Open Book

Exception : En cas d'examen électronique sur Moodle, des modifications des aides autorisées peuvent survenir. Dans ce cas, les aides autorisées seront annoncées par les enseignant-e-s avant l'examen.

Cas spécial: examen de répétition oral

Type de l'examen

Examen oral

Durée de l'examen

30 minutes

Aides autorisées

Les aides suivantes sont autorisées:

Aides électroniques autorisées

Examen "Open Book" : tout support admis sous forme papier et électronique, avec ce dernier en mode "hors ligne".

Autres aides

Open Book

Module Description, available in: EN

Manufacturing Technologies

General Information

Number of ECTS Credits

3

Module code

TSM_ManTech

Valid for academic year

2026-27

Last modification

2024-10-07

Coordinator of the module

Gregor Burkhard (FHNW, gregor.burkhard@fhnw.ch)

Explanations regarding the language definitions for each location:

- Instruction is given in the language specified for each location and module execution.
- Documentation is available in the language(s) listed for each location and module execution. If the documentation is in multiple languages, the percentage distributed is indicated (100% = all documentation provided).
- The examination, including both questions and answers, is provided entirely (100%) in the language(s) specified for each location and module execution. The exams are on-site.

	Lausanne			Lugano	Zurich		
Instruction					**X** E 100%		
Documentation					**X** E 100%		
Examination					**X** E 100%		

Module Category

TSM Technical scientific module

Profile Recommendations

This module is recommended for the following profiles:

	Zurich
Profile	ME

Lessons

2 lecture periods and 1 tutorial period per week

Entry level competences

Prerequisites, previous knowledge

- Knowledge of the product development process (conception phase, realization phase).
- Knowledge of manufacturing processes and material properties.

Brief course description of module objectives and content

Selected future-oriented manufacturing technologies and procedures with economic aspects of these technologies. Including the improvement of productivity and quality.

Aims, content, methods

Learning objectives and competencies to be acquired

To learn about and to understand modern manufacturing methods and systems used to improve productivity and quality.

Module content with weighting of different components

Polymer processing	
• Special technologies for injection moulding	4 lecture periods
• Trends in Composite processing	6 lecture periods
Reverse Engineering, Additive Manufacturing	2 lecture periods
Lightweight Design (Sandwich Structures, Hybrid Technologies)	2 lecture periods
Cutting process	
• Abrasive tools	3 lecture periods
• Tools and coating: Trends	1 lecture periods
• Multiaxis machining: Trends	1 lecture periods
Sheet metal forming	5 lecture periods
(Design for) **Automated Assembly**	4 lecture periods
TOTAL:	28 lecture periods

Teaching and learning methods

Contact hours during the lectures (2 lesson periods per week)

Literature

Lecturers' scripts, which will contain references to current literature.

Assessment

Additional performance assessment during the semester

The module does not contain an additional performance assessment during the semester

Basic principle for exams

As a rule, all standard final exams are conducted in written form. For resit exams, lecturers will communicate the exam format (written/oral) together with the exam schedule.

Standard final exam for a module and written resit exam

Kind of exam

Written exam

Duration of exam

120 minutes

Permissible aids

No aids permitted

Exception: In case of an electronic Moodle exam, adjustments to the permissible aids may occur. Lecturers will announce the final permissible aids prior to the exam session.

Special case: Resit exam as oral exam

Kind of exam

Oral exam

Duration of exam

30 minutes

Permissible aids

No aids permitted

Module Description, available in: EN

Market Analysis and Forecasting

General Information

Number of ECTS Credits

3

Module code

TSM_MarkFor

Valid for academic year

2026-27

Last modification

2025-11-04

Coordinator of the module

Christoph Imboden (BFH, christoph.imboden@hslu.ch)

Explanations regarding the language definitions for each location:

- Instruction is given in the language specified for each location and module execution.
- Documentation is available in the language(s) listed for each location and module execution. If the documentation is in multiple languages, the percentage distributed is indicated (100% = all documentation provided).
- The examination, including both questions and answers, is provided entirely (100%) in the language(s) specified for each location and module execution. The exams are on-site.

	Lausanne			Lugano	Zurich		
Instruction					**X** E 100%		
Documentation					**X** E 100%		
Examination					**X** E 100%		

Module Category

TSM Technical scientific module

Profile Recommendations

This module is recommended for the following profiles:

	Zurich
Profile	BE

Lessons

2 lecture periods and 1 tutorial period per week

Entry level competences

Prerequisites, previous knowledge

Good knowledge of English.
Bachelor degree in Business Administration or Engineering.

Brief course description of module objectives and content

A proper understanding of the current state and probable future development of a market is key to any successful business development. The module Market Analysis and Forecasting provides the foundations of analysis of complex socio-economic systems. It puts students in place to autonomously plan, design and execute their own qualitative and quantitative analysis. Development of well-founded forecasts and scenarios completes the understanding of customer data, markets and the socio-economic environment. Tools for the definition and the analysis of company reactions to potential future market scenarios will complete the module, allowing for transformation of market inputs into strategic choices.

Aims, content, methods

Learning objectives and competencies to be acquired

Students possess the knowledge and ability to understand and analyze markets as complex socio-economic systems. They can identify the most relevant factors determining the market behavior, to establish causal relations among these factors, and to describe techno-socio-economic systems by means of qualitative and quantitative modelling.

Students understand and apply key concepts of the theory of complex systems such as observability, controllability, time variance or invariance, randomness or determinacy of factors, linear or nonlinear, static or dynamic behavior, and they assess how these properties influence the overall system behavior.

Students apply qualitative and quantitative methods for model development and validation, including statistical analysis. Through practical examples, they learn to analyze, forecast, and control such systems. Finally, students are able to present the analytical results using different visualization techniques.

Module content with weighting of different components

The module includes the following topics:

1. Market Modelling

- Understanding the market as a complex, socio-economic system
- Outlook: system modelling in a broader context
- Understanding the role of critical success factors in the theory of complex systems
- Identification of key factors determining the dynamic, time variant and stochastic behavior of a market
- Systemic market analysis
- Experiencing complex market behavior, steering complex systems
- From qualitative to quantitative models
- Model validation
- Developing scenarios describing the market future
- Prospects and limits of modelling

2. Applications of Quantitative Methods for Market Analysis

Applications that cover topics in market analysis, for instance:

- Customer segmentation for, e.g., marketing campaign planning
- Customer feedback analysis, e.g., for service improvement planning
- Demand prediction for, e.g., electricity production planning and agricultural planning
- Credit card default prediction
- Customer life-time value consideration

Using basic quantitative methods such as:

- Data structuring, cleaning, and management
- k-Means clustering, RFM segmentation
- Decision trees
- Multiple linear- and non-linear regression, Lasso and Ridge regression
- Time series forecasting using ARIMA and LSTM models

The relevance and practical benefits of each topic will be illustrated through examples and applications. Analytical methods for problem solving will be introduced in a conceptually accessible yet methodologically rigorous manner. Particular emphasis will be placed on assessing the validity, robustness, and generalizability of analytical results, as well as on interpreting their implications for evidence-based decision making.

Teaching and learning methods

The module is taught by theory inputs, case studies and a software tool.

Literature

[1] Sterman, J. D. (2000). Business Dynamics. Systems Thinking and Modeling for a Complex World. Boston: McGraw-Hill. ISBN 978-0071241076. (Recommended.)

[2] Rob J. Hyndman, George Athanasopoulos, Forecasting: principles and practice, OTexts, 2013. The book is freely available as an online book at www.otexts.org/fpp. Alternatively, a print version is available: ISBN # 0987507109. (Required.)

Assessment

Additional performance assessment during the semester

The module does not contain an additional performance assessment during the semester

Basic principle for exams

As a rule, all standard final exams are conducted in written form. For resit exams, lecturers will communicate the exam format (written/oral) together with the exam schedule.

Standard final exam for a module and written resit exam

Kind of exam

Written exam

Duration of exam

120 minutes

Permissible aids

Aids permitted as specified below:

Permissible electronic aids

No electronic aids permitted

Other permissible aids

Self-written summary of 4 pages A4 for a part of the exam.

Exception: In case of an electronic Moodle exam, adjustments to the permissible aids may occur. Lecturers will announce the final permissible aids prior to the exam session.

Special case: Resit exam as oral exam

Kind of exam

Oral exam

Duration of exam

30 minutes

Permissible aids

No aids permitted

Module Description, available in: EN

Material Mechanics and Plasticity in Structural and Geotechnical Engineering

General Information

Number of ECTS Credits

3

Module code

TSM_MatPla

Valid for academic year

2026-27

Last modification

2025-11-04

Coordinator of the module

Ivan Markovic (OST, ivan.markovic@ost.ch)

Explanations regarding the language definitions for each location:

- Instruction is given in the language specified for each location and module execution.
- Documentation is available in the language(s) listed for each location and module execution. If the documentation is in multiple languages, the percentage distributed is indicated (100% = all documentation provided).
- The examination, including both questions and answers, is provided entirely (100%) in the language(s) specified for each location and module execution. The exams are on-site.

	Lausanne			Lugano	Zurich		
Instruction					**X** E 100%		
Documentation					**X** E 100%		
Examination					**X** E 100%		

Module Category

TSM Technical scientific module

Profile Recommendations

This module is recommended for the following profiles:

	Zurich
Profile	CE

Lessons

2 lecture periods and 1 tutorial period per week

Entry level competences

Prerequisites, previous knowledge

- Knowledge of structural analysis of frame structures and plate structures, as well as knowledge of the design and construction of load-bearing structures made of reinforced concrete and steel.
- Knowledge of soil mechanics, as well as of the calculation and design of geotechnical structures.

- Knowledge of matrix algebra and differential equations.

Brief course description of module objectives and content

1. Contents: Introduction to continuum mechanics and plasticity theory; analysis of constitutive laws for soils and construction materials in structural engineering; application of plasticity theory for ultimate load calculations in geotechnical and structural engineering.

2. Objectives: After completing this module, students should have developed an in-depth understanding of the constitutive laws governing soils and structural materials used in civil engineering. They should be able to correctly apply these laws in the calculation of ultimate loads for specific engineering structures. Furthermore, students should understand the methods for determining load-bearing capacity based on plasticity theory in both geotechnical and structural engineering and be able to apply them to appropriate practical problems.

Aims, content, methods

Learning objectives and competencies to be acquired

After completing this module, students should be able to:

a) develop an in-depth understanding of the constitutive laws of soils and structural materials used in civil engineering;

b) correctly assess which constitutive law is appropriate to apply in a given practical situation;

c) understand the purpose and significance of the limit load method and the limit theorems in plasticity theory;

d) understand and apply methods for determining load-bearing capacity using the limit load method in both geotechnical and structural engineering;

e) apply constitutive laws to calculate realistic load-bearing capacities for geotechnical structures as well as for structures in structural engineering;

f) interpret and validate the results of load-bearing capacity calculations.

Module content with weighting of different components

Introduction to Continuum Mechanics and Material Mechanics (approx. 35%)

- Introduction to static and kinematic relationships; introduction to material behavior (linear-elastic, ideally plastic behavior, plastic potential, yield criteria) (approx. 10%)
- Constitutive laws for soils (elasticity; failure criteria and plastic flow, hardening, critical state) (approx. 15%)
- Constitutive laws for structural materials used in civil engineering (steel, reinforced concrete, fiber-reinforced concrete, ultra-high-performance concrete (UHPC), glass) (approx. 10%)

2. Application of Plasticity Theory in Structural Engineering (approx. 40%)

- Limit theorems of plasticity theory
- Elastoplastic systems
- Limit load methods for frame structures, including practical examples: static and kinematic approaches
- Limit load methods for plate structures, including practical examples: simple moment fields, yield-line analysis, and the strip method

3. Application of Plasticity Theory and Nonlinear Material Behavior in Geotechnical Engineering (approx. 25%)

- Selected practical case studies of geotechnical problems (retaining walls, slope stability, shallow foundations, deep excavations)

Teaching and learning methods

- Lectures and seminar-style instruction
- Independent exercises

Literature

- Theory of Structures: Fundamentals, Framed Structures, Plates and Shells, by Prof. Dr. Peter Marti, 2013, Online ISBN:9783433602638 |DOI:10.1002/9783433602638, Wilhelm Ernst & Sohn
- "Constitutive laws for soil", Prof. Dr. Carlo Rabaiotti, OST Ostschweizer Fachhochschule Rapperswil, 2017/2025

- Further teaching materials from the lectures

Assessment

Additional performance assessment during the semester

The module does not contain an additional performance assessment during the semester

Basic principle for exams

As a rule, all standard final exams are conducted in written form. For resit exams, lecturers will communicate the exam format (written/oral) together with the exam schedule.

Standard final exam for a module and written resit exam

Kind of exam

Written exam

Duration of exam

120 minutes

Permissible aids

Aids permitted as specified below:

Permissible electronic aids

No electronic aids permitted

Other permissible aids

Summary of course material on ten A4 pages for the Materials course and ten A4 pages for the Plasticity course.

Additional aids as agreed upon with the instructor.
Exception: In case of an electronic Moodle exam, adjustments to the permissible aids may occur. Lecturers will announce the final permissible aids prior to the exam session.

Special case: Resit exam as oral exam

Kind of exam

Oral exam

Duration of exam

30 minutes

Permissible aids

Aids permitted as specified below:

Permissible electronic aids

No electronic aids permitted

Other permissible aids

Permitted aids as agreed upon with the instructor.

Module Description, available in: EN

Materials Selection and Design

General Information

Number of ECTS Credits

3

Module code

TSM_MatSelDes

Valid for academic year

2026-27

Last modification

2018-11-05

Coordinator of the module

Alberto Ortona (SUPSI, alberto.ortona@supsi.ch)

Explanations regarding the language definitions for each location:

- Instruction is given in the language specified for each location and module execution.
- Documentation is available in the language(s) listed for each location and module execution. If the documentation is in multiple languages, the percentage distributed is indicated (100% = all documentation provided).
- The examination, including both questions and answers, is provided entirely (100%) in the language(s) specified for each location and module execution. The exams are on-site.

	Lausanne			Lugano	Zurich		
Instruction				**X** E 100%			
Documentation				**X** E 100%			
Examination				**X** E 100%			

Module Category

TSM Technical scientific module

Profile Recommendations

This module is recommended for the following profiles:

	Lugano
Profile	ME

Lessons

2 lecture periods and 1 tutorial period per week

Entry level competences

Prerequisites, previous knowledge

Fundamentals of Material Science

Mechanics of Materials

Brief course description of module objectives and content

Materials offer immense opportunities for innovation. However, advance is possible only if a procedure exists for making a rational choice from the materials and a method of identifying ways to shape, join, and finish them.

The objective of this course is to develop a systematic procedure for selecting materials and processes, leading to the subset that best matches the requirements of a design. The structure gives rapid access to data and allows the user great freedom in exploring potential choices. The method is implemented in the GRANTA CES EduPack software to provide greater flexibility: it enhances the learning experience and provides a solid grounding in many of the domains of expertise specified by the various professional engineering accreditation bodies (analysis of components, problem-solving, design and manufacturing , economic, societal and environmental impacts).

Aims, content, methods

Learning objectives and competencies to be acquired

Understand the importance of material property charts

Understand the method for material selection and design

Understand the concept of effective properties and their dependence on phase spatial arrangement in hybrid materials.

Learn the manufacturing techniques of hybrid materials.

Module content with weighting of different components

The course content will be focused on:

- Material property charts
- Material selection and design
- Examples of hybrid materials and their applications
- Hybrid materials processing

Development of an hybrid material

Teaching and learning methods

Teaching: Ex cathedra teaching (theory),

Laboratory exercise with GRANTA ANSYS EduPack.

Learning methods: Self study

Literature

M. F. Ashby, “Materials Selection in Mechanical Design”, Elsevier, 2011.

M. F. Ashby, H. Shercliff, D. Cebon, “Materials: engineering, science, processing and design”, Butterworth-Heinemann, 2018.

Assessment

Additional performance assessment during the semester

The module does not contain an additional performance assessment during the semester

Basic principle for exams

As a rule, all standard final exams are conducted in written form. For resit exams, lecturers will communicate the exam format (written/oral) together with the exam schedule.

Standard final exam for a module and written resit exam

Kind of exam

Written exam

Duration of exam

120 minutes

Permissible aids

No aids permitted

Exception: In case of an electronic Moodle exam, adjustments to the permissible aids may occur. Lecturers will announce the final permissible aids prior to the exam session.

Special case: Resit exam as oral exam

Kind of exam

Oral exam

Duration of exam

30 minutes

Permissible aids

No aids permitted

Module Description, available in: EN, FR

Materials and Surfaces

General Information

Number of ECTS Credits

3

Module code

TSM_MatSurf

Valid for academic year

2026-27

Last modification

2020-12-22

Coordinator of the module

Arnd Jung (ZHAW, arnd.jung@zhaw.ch)

Explanations regarding the language definitions for each location:

- Instruction is given in the language specified for each location and module execution.
- Documentation is available in the language(s) listed for each location and module execution. If the documentation is in multiple languages, the percentage distributed is indicated (100% = all documentation provided).
- The examination, including both questions and answers, is provided entirely (100%) in the language(s) specified for each location and module execution. The exams are on-site.

	Lausanne			Lugano	Zurich		
Instruction		**X** F 100%			**X** E 100%		
Documentation		**X** F 100%	**X** E 100%		**X** E 100%		
Examination		**X** F 100%	**X** E 100%		**X** E 100%		

Module Category

TSM Technical scientific module

Profile Recommendations

This module is recommended for the following profiles:

	Lausanne	Zurich
Profile	ME	ME

Lessons

2 lecture periods and 1 tutorial period per week

Entry level competences

Prerequisites, previous knowledge

The course requires knowledge of general physics, general chemistry and mathematics. Basic knowledge of the materials science and technology of metals, ceramics and organic materials is also necessary.

Brief course description of module objectives and content

The interdisciplinary field of materials science and engineering covers approaches to improving the synthesis of new materials, to understanding their surfaces and main properties and, in particular, to adapting their properties to meet special requirements. The aim of this course is to teach students the fundamental principles necessary to understand the relationships between structure and property in material development.

Aims, content, methods

Learning objectives and competencies to be acquired

Students acquire comprehensive knowledge about the use of modern materials and their properties. Where appropriate, state-of-the-art problems are covered in the form of examples. Students understand the concepts of the structures, from bonding through to the microstructure and then learn to consider the correlations between structure and property. Examples are also presented for discussing how to influence these relationships between structure and property in the development of materials.

The aims of the course are as follows:

- Teaching students the fundamental mechanisms of materials science and materials technology.
- Teaching students the basic concepts regarding the correlations between structure, properties and processing of all the different material classes.
- Teaching students the importance of quantifying and characterising properties and phenomena

Module content with weighting of different components

- Light metals, superalloys: properties and applications, methods for increasing strength, designing with metals
- Ceramics: classes, types, properties and applications, sintering, production technologies, additives
- Inorganic and organic glass types: classes, types and applications, production technologies
- Polymers: structure/property relationships and test methods
- Surface technology, coating and coating methods: functional coatings, thermal spraying processes, CVD, PVD, surface modifications
- Surface engineering: surface characteristics, topography and surface function, surface treatment
- Tribology: friction and wear, wear mechanisms, analysis methods, selection of wear-resistant materials and coatings

Teaching and learning methods

- Frontal teaching
- Presentation and discussion of case studies
- Private study:
    - study of specialist books and texts.
    - analysis of case studies

Literature

- Lecture notes
- Michael F. Ashby, David R. H. Jones: Engineering Materials 1: An Introduction to Properties, Applications and Design, Elsevier Butterworth-Heinemann, Oxford, ISBN 0-7506-6380-4
- Michael F. Ashby, David R. H. Jones: Engineering Materials 2: An Introduction to Microstructures, Processing and Design, Elsevier Butterworth-Heinemann, Oxford, ISBN 0-7506-6381-2

Assessment

Additional performance assessment during the semester

The module does not contain an additional performance assessment during the semester

Basic principle for exams

As a rule, all standard final exams are conducted in written form. For resit exams, lecturers will communicate the exam format (written/oral) together with the exam schedule.

Standard final exam for a module and written resit exam

Kind of exam

Written exam

Duration of exam

120 minutes

Permissible aids

Aids permitted as specified below:

Permissible electronic aids

No electronical aids allowed. AI-tools such as Chat-GPT are not allowed.

Other permissible aids

Lecture notes, personal notes of lessons and exercises, textbooks

Exception: In case of an electronic Moodle exam, adjustments to the permissible aids may occur. Lecturers will announce the final permissible aids prior to the exam session.

Special case: Resit exam as oral exam

Kind of exam

Oral exam

Duration of exam

30 minutes

Permissible aids

No aids permitted

Description du module, disponible en: EN, FR

Matériaux et surfaces

Informations générales

Nombre de crédits ECTS

3

Code du module

TSM_MatSurf

Valable pour l'année académique

2026-27

Dernière modification

2020-12-22

Coordinateur/coordinatrice du module

Arnd Jung (ZHAW, arnd.jung@zhaw.ch)

Explications concernant les langues d'enseignement par site :

- L'enseignement est dispensé dans la langue indiquée ci-dessous pour chaque site et chaque exécution du module.
- Les supports de cours sont disponibles dans les langues indiquées ci-dessous pour chaque site et chaque exécution du module. Lorsque plusieurs langues sont utilisées, la proportion de contenu disponible dans chaque langue est précisée (100 % = ensemble des supports de cours).
- Les examens (questions et réponses) sont entièrement rédigés dans la langue indiquée ci-dessous pour le site et l'exécution du module concernés. Ils se déroulent en présentiel.

	Lausanne			Lugano	Zurich		
Leçons		**X** F 100%			**X** E 100%		
Documentation		**X** F 100%	**X** E 100%		**X** E 100%		
Examen		**X** F 100%	**X** E 100%		**X** E 100%		

Catégorie de module

TSM approfondissement technico-scientifique

Recommandations de profil

Ce module est recommandé pour les profils suivants :

	Lausanne	Zurich
Profil	ME	ME

Leçons

2 leçons et 1 leçon de pratique par semaine

Compétences préalables

Connaissances préalables, compétences initiales

Le cours présuppose des connaissances en physique générale, chimie générale et mathématiques. En outre, des connaissances de base sont prérequises en sciences des matériaux, telles que sur les métaux, les céramiques et les matériaux.

Brève description du contenu et des objectifs

Le champ pluridisciplinaire des sciences et ingénierie des matériaux dresse un aperçu des approches visant à améliorer la synthèse des nouveaux matériaux, comprendre leur surface et leurs principales propriétés, concevoir des caractéristiques spécifiques aux besoins. L'objectif de ce cours est de présenter aux étudiants les principes fondamentaux qui leur permettront de comprendre les relations entre structure et propriété en ingénierie des matériaux.

Objectifs, contenus, méthodes

Objectifs d'apprentissage, compétences à acquérir

Les étudiants se voient dispenser des connaissances approfondies dans le domaine de l'application des matériaux modernes et de leurs propriétés de conception. Le cas échéant, les problématiques de pointe sont abordées sous forme d'exemples. L'étudiant se familiarise avec les concepts de structure, de la mise à la masse à la microstructure, et apprend à considérer les relations d'interdépendance qui existent entre structure et propriété. En outre, des exemples sont présentés pour permettre de discuter de la manipulation des relations entre structure et propriété en termes d'ingénierie des matériaux.
Les objectifs du cours sont:

- Enseigner aux étudiants les mécanismes fondamentaux des sciences et technologie des matériaux.
- Les familiariser avec les concepts de base en termes d'exploitation des relations entre propriété et structure pour toutes les classes de matériaux.
- Sensibiliser les étudiants à l'importance de la quantification et caractérisation des propriétés et phénomènes.

Contenu des modules avec pondération du contenu des cours

- Métaux, superalliages: propriétés et applications, méthodes de renforcement, conception sur métal
- Céramiques: classes, types, propriétés et applications, technologies de production, additifs
- Verres inorganiques et organiques: classes, types et applications, technologies de production
- polymères: structure chimique contre propriétés chimiques et méthodes de test
- technologie de surface, revêtement et méthodes de revêtement: revêtements fonctionnels, vaporisation thermique, dépôt chimique en phase vapeur, depôt physique en phase vapeur, modification de surface
- tribologie: frottement et usure, mécanismes d'usure, méthodes d'analyse, sélection de matériaux et revêtements résistants à l'usure

Méthodes d'enseignement et d'apprentissage

- Enseignement ex cathedra
- Présentation et discussion des études de cas
- Etude autonome:
  - Etude de manuels et publications
  - Analyse des études de cas

Bibliographie

- Documents de cours
- Michael F. Ashby, David R. H. Jones: Engineering Materials 1: An Introduction to Properties, Applications and Design, Elsevier Butterworth-Heinemann, Oxford, ISBN 0-7506-6380-4
- Michael F. Ashby, David R. H. Jones: Engineering Materials 2: An Introduction to Microstructures, Processing and Design, Elsevier Butterworth-Heinemann, Oxford, ISBN 0-7506-6381-2

Evaluation

Évaluation supplémentaire pendant le semestre

Le module ne comprend pas d'évaluation supplémentaire pendant le semestre

Principe pour les examens

En règle générale, tous les examens réguliers de fin de module se déroulent sous forme écrite. Concernant les examens de répétition, leur format (écrit ou oral) sera communiqué par l'enseignant-e en même temps que le calendrier des examens.

Examen de fin de module régulier et examen écrit de répétition

Type de l'examen

Examen écrit

Durée de l'examen

120 minutes

Aides autorisées

Les aides suivantes sont autorisées:

Aides électroniques autorisées

Aucune aide électronique n'est autorisée. Les outils d'IA comme Chat-GPT ne sont pas autorisés.

Autres aides autorisées

Documents de cours, notes personnelles, exercices, manuels

Exception : En cas d'examen électronique sur Moodle, des modifications des aides autorisées peuvent survenir. Dans ce cas, les aides autorisées seront annoncées par les enseignant-e-s avant l'examen.

Cas spécial: examen de répétition oral

Type de l'examen

Examen oral

Durée de l'examen

30 minutes

Aides autorisées

Sans aides

Module Description, available in: EN

Medical Diagnostics & Devices

General Information

Number of ECTS Credits

3

Module code

TSM_MedDD

Valid for academic year

2026-27

Last modification

2019-08-31

Coordinator of the module

Stephan Scheidegger (ZHAW, scst@zhaw.ch)

Explanations regarding the language definitions for each location:

- Instruction is given in the language specified for each location and module execution.
- Documentation is available in the language(s) listed for each location and module execution. If the documentation is in multiple languages, the percentage distributed is indicated (100% = all documentation provided).
- The examination, including both questions and answers, is provided entirely (100%) in the language(s) specified for each location and module execution. The exams are on-site.

	Lausanne			Lugano	Zurich		
Instruction					**X** E 100%		
Documentation					**X** E 100%		
Examination					**X** E 100%		

Module Category

TSM Technical scientific module

Profile Recommendations

This module is recommended for the following profiles:

	Zurich
Profile	Med

Lessons

2 lecture periods and 1 tutorial period per week

Entry level competences

Prerequisites, previous knowledge

Engineering mathematics (algebra, calculus, numerical methods), physics, electricity of BSc engineering programs or similar (including systems and signals, Fourier transform)

Brief course description of module objectives and content

This module gives an introduction to the physical and technical principles and applications of common diagnostic modalities. Starting with an overview about clinically used modalities and their applications, technical requirements and limitations based on the fundamental principles will be discussed. Furthermore, efficient methods for biomedical signal processing and analysis are introduced.

Aims, content, methods

Learning objectives and competencies to be acquired

Upon completition of the module, the student will be able to

- gain knowledge in fundamentals of chemical, biological and physical sensors
- achieve basic knowledge in the design of sensor systems
- apply sensors and systems in medical diagnostics
- apply signal processing methods on biosignals for diagnostic purposes
- achieve basic signal processing skills to perform artifact removal, feature extraction, and classification on biological signals.
- explain fundamental principle of medical imaging modalities (XR, CT, MRI, Ultrasound)
- achieve basic knowledge of the most important clinical application of medical imaging modalities
- describe approaches and methods for image reconstruction and quality assessment

Module content with weighting of different components

Part 1 Imaging Devices: Overview of diagnostic Imaging modalities:

Principles of Ultrasound and MRI

Generation of X-ray, X-ray detectors, technology and application of Fluoroscopy, CT

Image quality, radiation protection and QA for diagnostic devices

Part 2 Signal processing

Chemical, biological, and physical sensors, design requirements for sensors and devices in diagnostics, sensor application in medical diagnostics (ECG, EEG, EMG, optical pulsoxymetrie, (Blood)pressure, flow sensor, otoacoustic emission (OAE), etc.)

Measurement in medical diagnostics, amplifier, signal conversion and quantization

Standard methods for biomedical signal processing and analysis, Imaging processing

- Background on time- and frequency-domain characteristics of particular biosignals and common artifacts
- Techniques for artefact removal, event detection, feature extraction, pattern recognition, classification

Teaching and learning methods

Presentations, Excersises and Labs

Literature

Dance DR, Christofides S, Maidment ADA, McLean ID, Ng KH (Eds): Diagnostic Radiology Physics. Vienna, 2014: IAEA, ISBN 978-92-0-131010-1

Oppelt A (Ed.): Imaging Systems for Medical Diagnostics. Siemens, Publicis Corporate Publishing, Erlangen; ISBN 3-89578-226-2

John D. Enderle, Joseph D. Bronzino, Introduction to Biomedical Engineering, Academic Press

R. A. Wildhaber et al., "Signal detection and discrimination for medical devices using windowed state space filters," 2017 13th IASTED International Conference on Biomedical Engineering (BioMed), Innsbruck, Austria, 2017, pp. 125-133.

R. A. Wildhaber et al., "Windowed State-Space Filters for Signal Detection and Separation," in IEEE Transactions on Signal Processing, vol. 66, no. 14, pp. 3768-3783, 15 July15, 2018.

Assessment

Additional performance assessment during the semester

The module does not contain an additional performance assessment during the semester

Basic principle for exams

As a rule, all standard final exams are conducted in written form. For resit exams, lecturers will communicate the exam format (written/oral) together with the exam schedule.

Standard final exam for a module and written resit exam

Kind of exam

Written exam

Duration of exam

120 minutes

Permissible aids

No aids permitted

Exception: In case of an electronic Moodle exam, adjustments to the permissible aids may occur. Lecturers will announce the final permissible aids prior to the exam session.

Special case: Resit exam as oral exam

Kind of exam

Oral exam

Duration of exam

30 minutes

Permissible aids

No aids permitted

Module Description, available in: EN

Medical Device Market Access

General Information

Number of ECTS Credits

3

Module code

TSM_MedDMA

Valid for academic year

2026-27

Last modification

2023-09-27

Coordinator of the module

Jens Ulmer (OST, jens.ulmer@ost.ch)

Explanations regarding the language definitions for each location:

- Instruction is given in the language specified for each location and module execution.
- Documentation is available in the language(s) listed for each location and module execution. If the documentation is in multiple languages, the percentage distributed is indicated (100% = all documentation provided).
- The examination, including both questions and answers, is provided entirely (100%) in the language(s) specified for each location and module execution. The exams are on-site.

	Lausanne			Lugano	Zurich		
Instruction					**X** E 100%		
Documentation					**X** E 100%		
Examination					**X** E 100%		

Module Category

TSM Technical scientific module

Profile Recommendations

This module is recommended for the following profiles:

	Zurich
Profile	Med

Lessons

2 lecture periods and 1 tutorial period per week

Entry level competences

Prerequisites, previous knowledge

This course requires knowledge about

- technical design methods
- mathematical statistics/data analysis
- basic knowledge about standardization

Brief course description of module objectives and content

The course provides an in-depth overview on necessary aspects for implementing a medical device into the market. You will work on real products and improve the device by reviewing the clinical need and update the concept. For this you will be guided through the first steps of the Stanford biodesign principle. Besides concept improvement you will learn how to go through the mandatory regulatory aspects. In addition, you will get insights into market analysis techniques and fundamentals of the health care system.

Aims, content, methods

Learning objectives and competencies to be acquired

Aims:

The aim of this module is to:

- Know and apply the first steps of the Stanford Biodesign principle to develop a medical device.
- Understand the regulatory aspects within EU (MDR) and US (FDA)
- Know the current standards used for designing and developing medical devices according to MDR
- Understand the basic aspects of the health care system and know the relevant market aspects.

Module content with weighting of different components

- Stage 1: Defining the clinical need
  - From bench to bed side. Understand the clinical need and make use of knowledge about disease fundamentals and observation/clinical problem identification.
  - Understanding the scientific language of medicine, the research culture as well as the ethical aspects in the context of medical devices.
  - Introduction into the medical device regulation.
- Stage 2: Screening and concept improvement
  - Knowledge of the classification of medical devices and the corresponding regulatory pathway within EU-MDR and US-FDA
  - Overview of the legal requirements on the design and construction of medical products. This includes the requirement engineering as well as the general safety and performance requirements.
  - Insights into the quality management system EN ISO 13485:2016 including testing, verification, and validation principles.
- Stage 3: Product concept and business strategy
  - Understanding the basics in usability engineering according EN 62366 and the validation of usability
  - Understanding the risk management according to ISO 14971 and having insights into the risk analysis.
  - Knowledge in market evaluation, current health care systems and developing a reimbursement strategy.
  - Introduction into the clinical testing of medical devices and basic knowledge of "good clinical practice".

Teaching and learning methods

During the course you will directly apply the theoretical aspects of the module by working with your colleagues on real medical devices. The provided documents will help you to navigate through the regulatory approval process.

Literature

- Medical device design: Innovation from concept to market, Peter Ogrodik, Academic Press (2020). ISBN 978-0-12-814962-1
- Biodesign – The Process of Innovating Medical Technologies, Paul Yock, Stefanos Zenios, Josh Makower, Todd Brinton, Uday Kumar, Cambridge Academic (2015). ISBN 978-1-107-08735-4
- EU-MDR, US-FDA
- Various standards

Assessment

Additional performance assessment during the semester

The module contains additional performance assessment(s) during the semester. The achieved mark of the additional performance assessment(s) applies to both the regular and the resit exam.

Description of additional performance assessment during the semester

Practical aspects will be covered by a written and orally presented group work, duration 30 min.

Counting:1/3 of the total grade

Basic principle for exams

As a rule, all standard final exams are conducted in written form. For resit exams, lecturers will communicate the exam format (written/oral) together with the exam schedule.

Standard final exam for a module and written resit exam

Kind of exam

Written exam

Duration of exam

120 minutes

Permissible aids

Aids permitted as specified below:

Permissible electronic aids

Principally none - if required, materials will be handed out

Other permissible aids

2 pages (DIN A4), single sided, handwritten

Exception: In case of an electronic Moodle exam, adjustments to the permissible aids may occur. Lecturers will announce the final permissible aids prior to the exam session.

Special case: Resit exam as oral exam

Kind of exam

Oral exam

Duration of exam

30 minutes

Permissible aids

No aids permitted

Description du module, disponible en: FR

Micromachining and Fabrication Processes in Microengineering

Informations générales

Nombre de crédits ECTS

3

Code du module

TSM_MicroFab

Valable pour l'année académique

2026-27

Dernière modification

2022-01-25

Coordinateur/coordinatrice du module

Florian Serex (HES-SO, florian.serex@he-arc.ch)

Explications concernant les langues d'enseignement par site :

- L'enseignement est dispensé dans la langue indiquée ci-dessous pour chaque site et chaque exécution du module.
- Les supports de cours sont disponibles dans les langues indiquées ci-dessous pour chaque site et chaque exécution du module. Lorsque plusieurs langues sont utilisées, la proportion de contenu disponible dans chaque langue est précisée (100 % = ensemble des supports de cours).
- Les examens (questions et réponses) sont entièrement rédigés dans la langue indiquée ci-dessous pour le site et l'exécution du module concernés. Ils se déroulent en présentiel.

	Lausanne			Lugano	Zurich		
Leçons		**X** F 100%					
Documentation		**X** F 50%	**X** E 50%				
Examen		**X** F 100%					

Catégorie de module

TSM approfondissement technico-scientifique

Recommandations de profil

Ce module est recommandé pour les profils suivants :

	Lausanne
Profil	Mic

Leçons

2 leçons et 1 leçon de pratique par semaine

Compétences préalables

Connaissances préalables, compétences initiales

Physique, Matériaux, Mécanique : bases de l'ingénieur, Processus de fabrication

Brève description du contenu et des objectifs

L'objectif du module est de donner un aperçu des procédés de micro-usinage et de micro-fabrication existants couramment utilisés en microtechnique. Le module couvre les principes de fonctionnement et les aspects techniques des équipements de micro-usinage industriels modernes ainsi que les techniques de micro-fabrication basées sur la photolithographie, la gravure ou les techniques de réplication

Objectifs, contenus, méthodes

Objectifs d'apprentissage, compétences à acquérir

A l'issue du module les participants sont à même de :

- expliquer les principes de fonctionnement des techniques modernes de micro-usinage et de micro-fabrication et discuter d'exemples d'application dans différents secteurs industriels
- discuter des possibilités et des limites de différentes techniques de micro-fabrication pour divers matériaux tels que les métaux, la céramique, les polymères, le silicium
- choisir les techniques de micro-usinage et de fabrication adaptées à des contextes de besoins industriels donnés, en tenant compte de paramètres tels que la précision, la rapidité et les coûts de fabrication du prototypage à la production à petite et grande échelle.

Contenu des modules avec pondération du contenu des cours

- Machines conventionnelles pour la microtechnique, techniques de micro assemblage (14%)
- Usinage par électroérosion (EDM) (14 %)
- Usinage laser (7%)
- Techniques de mesure adaptée au micro-usinage et la micro-fabrication et contrôle de la qualité en ligne ou en cours de fabrication (15 %)
- Autres techniques d'usinage et de fabrication issues du secteur des micro et nanotechnologies (50%)

Méthodes d'enseignement et d'apprentissage

Cours magistraux, études de cas et exercices.

Bibliographie

Evaluation

Évaluation supplémentaire pendant le semestre

Le module comprend une ou des évaluation(s) supplémentaire(s) pendant le semestre. La note obtenue pour la ou les évaluation(s) supplémentaire(s) est valable à la fois pour l'examen final et pour l'examen de répétition.

Description de l'évaluation supplémentaire pendant le semestre

Mode d'évaluation : Exercices et rapports d'études de cas durant le semestre (33,3%), examen final écrit (66,7%).

Principe pour les examens

En règle générale, tous les examens réguliers de fin de module se déroulent sous forme écrite. Concernant les examens de répétition, leur format (écrit ou oral) sera communiqué par l'enseignant-e en même temps que le calendrier des examens.

Examen de fin de module régulier et examen écrit de répétition

Type de l'examen

Examen écrit

Durée de l'examen

120 minutes

Aides autorisées

Les aides suivantes sont autorisées:

Aides électroniques autorisées

- Calculatrice (sans fonction de télécommunication)

Autres aides autorisées

- Résumé et notes personnelles, maximum 2 pages A4

Exception : En cas d'examen électronique sur Moodle, des modifications des aides autorisées peuvent survenir. Dans ce cas, les aides autorisées seront annoncées par les enseignant-e-s avant l'examen.

Cas spécial: examen de répétition oral

Type de l'examen

Examen oral

Durée de l'examen

30 minutes

Aides autorisées

Les aides suivantes sont autorisées:

Aides électroniques autorisées

- Calculatrice (sans fonction de télécommunication)

Autres aides

- Résumé et notes personnelles, maximum 2 pages A4

Module Description, available in: EN

Mobile Computing

General Information

Number of ECTS Credits

3

Module code

TSM_MobCom

Valid for academic year

2026-27

Last modification

2025-10-17

Coordinator of the module

Thomas Amberg (FHNW, thomas.amberg@fhnw.ch)

Explanations regarding the language definitions for each location:

- Instruction is given in the language specified for each location and module execution.
- Documentation is available in the language(s) listed for each location and module execution. If the documentation is in multiple languages, the percentage distributed is indicated (100% = all documentation provided).
- The examination, including both questions and answers, is provided entirely (100%) in the language(s) specified for each location and module execution. The exams are on-site.

	Lausanne			Lugano	Zurich		
Instruction					**X** E 100%		
Documentation					**X** E 100%		
Examination					**X** E 100%		

Module Category

TSM Technical scientific module

Profile Recommendations

This module is recommended for the following profiles:

	Zurich
Profile	CS

Lessons

2 lecture periods and 1 tutorial period per week

Entry level competences

Prerequisites, previous knowledge

Students have working knowledge in:
• Programming in Java or Kotlin
• Software development and frameworks
• Desktop or mobile user interface development
• Internet protocols, HTTP and sending Web requests

• Students bring a laptop to class.
• Students bring an Android phone to class (if available).

Brief course description of module objectives and content

This module enables students to develop advanced, native applications for the Android mobile operating system and get a solid understanding of mobile computing concepts. Building on the basics of mobile application development, this course covers a selection of application programming interfaces for on-board sensors and connectivity options for the integration with backend services, IoT platforms and peripheral devices. Lecturers share their experience and best-practices from recent projects involving mobile computing. Students work with both emulators and real devices.

Aims, content, methods

Learning objectives and competencies to be acquired

Application Development (50%)
• Students know how to design and implement native applications for mobile devices running Android, the most widely used mobile platform.
• Students have basic knowledge of user-interface design guidelines and techniques relevant for mobile application design.
• Students can describe the integration of their application with a cloud backend.

Sensors and Connectivity (50%)
• Students know how to use on-device sensor APIs for motion, position and environment.
• Students have basic knowledge of connectivity options like Near Field Communication (NFC), Bluetooth Low Energy (BLE) and Wi-Fi.
• Students can describe the integration of their application with a peripheral device or IoT platform using request/response or messaging protocols.
• Students have basic knowledge of prototyping a peripheral IoT device with an easy-to-use embedded hardware platform, sensors and actuators.

Module content with weighting of different components

Application Development
• Development of native mobile applications for Android, including user interfaces
• Specific aspects in mobile application programming such as application lifecycle, data storage, data synchronization with a cloud backend, and security of mobile applications.

Sensors and Connectivity
• Development with on-device sensor APIs for motion, position and environment.
• Specific aspects of connecting to peripheral devices with connectivity options like NFC, BLE and Wi-Fi, prototyping an IoT device and integration with IoT platforms.

Teaching and learning methods

• Ex-cathedra teaching
• Team project
• Exercises
• Self-Study

Literature

Android
• IDE https://developer.android.com/studio
• Docs https://developer.android.com/docs
• Source Code https://source.android.com/

Assessment

Additional performance assessment during the semester

The module contains additional performance assessment(s) during the semester. The achieved mark of the additional performance assessment(s) applies to both the regular and the resit exam.

Description of additional performance assessment during the semester

• A graded team project
• Counting 30% (project) and 70% (exam result).
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Basic principle for exams

As a rule, all standard final exams are conducted in written form. For resit exams, lecturers will communicate the exam format (written/oral) together with the exam schedule.

Standard final exam for a module and written resit exam

Kind of exam

Written exam

Duration of exam

120 minutes

Permissible aids

Aids permitted as specified below:

Permissible electronic aids

• Computer with internet, Web search.
• Course repositories, slides and code.
• No communication (phone, chat, AI, …).

Other permissible aids

• Open book examination.

Exception: In case of an electronic Moodle exam, adjustments to the permissible aids may occur. Lecturers will announce the final permissible aids prior to the exam session.

Special case: Resit exam as oral exam

Kind of exam

Oral exam

Duration of exam

30 minutes

Permissible aids

No aids permitted

Module Description, available in: EN

Modelling for aviation infrastructure and future mobility

General Information

Number of ECTS Credits

3

Module code

TSM_ModAvi

Valid for academic year

2026-27

Last modification

2021-01-12

Coordinator of the module

Michael Felux (ZHAW, felu@zhaw.ch)

Explanations regarding the language definitions for each location:

- Instruction is given in the language specified for each location and module execution.
- Documentation is available in the language(s) listed for each location and module execution. If the documentation is in multiple languages, the percentage distributed is indicated (100% = all documentation provided).
- The examination, including both questions and answers, is provided entirely (100%) in the language(s) specified for each location and module execution. The exams are on-site.

	Winterthur			
Instruction	**X** E 100%			
Documentation	**X** E 100%			
Examination	**X** E 100%			

Module Category

TSM Technical scientific module

Profile Recommendations

This module is recommended for the following profiles:

	Zurich
Profile	Avi

Lessons

2 lecture periods and 1 tutorial period per week

Entry level competences

Prerequisites, previous knowledge

The students are expected to have knowledge on a basic level in:

- Descriptive statistic (but not a requirement)
- Aviation in general (but not a requirement)

Brief course description of module objectives and content

The course will focus on operational and infrastructure topics and the optimization of complex systems in terms of delay, capacity issues and future developments in aviation.

Future developments and important upcoming topics in the airline industry will be addressed, such as unmanned aircraft systems, new approaches in business models or passenger operations.

Aims, content, methods

Learning objectives and competencies to be acquired

The students will be able to understand state-of-the-art methods for operations in aviation in general but also new methods e.g. machine learning, deep learning and different approaches in meta-heuristic optimization.

Obtain the ability of modelling and simulation of resources (crews, fleets, passengers) for network planning, data processing and capacity issues.

Improving the presentation competencies to report complex modelling results to the decision makers. Achieving the ability to apply "what has been learnt" to future developments.

The students will learn how to design and plan infrastructures and operation in terms of capacity, delay management, and revenue managements.

Students will be able to assess future developments in the airline industry, classify them and react appropriately.

Module content with weighting of different components

The course starts with a brief introduction in the infrastructural set-up of aviation systems in terms of capacity, demand and operational issues.

Basic concept in operation management will be briefly repeated, which then are used to deepening the knowledge for important topics such as capacity planning, airline transport management, airline revenue management, and overall mathematical optimization methods.

The last part of the course will be dedicated to the future development in the airline industry with a focus on operational methods, upcoming transport techniques and new infrastructure approaches.

Teaching and learning methods

- Lectures
- Self-study
- Run simulations under supervision and in small self-study projects
- Work on weekly exercises (somtimes with oral presentations in front of the class)
- Analysis of case studies
- Scientific paper studies and online research

Literature

- Airline Operations and Management, Gerald N. Cook, Bruce Billig, Verlag Routledge
- Air Transportation A Management Perspective, John G. Wensween, Verlag Routledge

Assessment

Additional performance assessment during the semester

The module does not contain an additional performance assessment during the semester

Basic principle for exams

As a rule, all standard final exams are conducted in written form. For resit exams, lecturers will communicate the exam format (written/oral) together with the exam schedule.

Standard final exam for a module and written resit exam

Kind of exam

Written exam

Duration of exam

120 minutes

Permissible aids

Aids permitted as specified below:

Permissible electronic aids

Calculator (not programmable)

Other permissible aids

Written summary of 5 pages (A4 size, hand written, double sided)

Exception: In case of an electronic Moodle exam, adjustments to the permissible aids may occur. Lecturers will announce the final permissible aids prior to the exam session.

Special case: Resit exam as oral exam

Kind of exam

Oral exam

Duration of exam

30 minutes

Permissible aids

Aids permitted as specified below:

Permissible electronic aids

Calculator (not programmable)

Other permissible aids

Written summary of 5 pages (A4 size, hand written, double sided)

Modulbeschreibung, verfügbar in: DE

Nachhaltigkeit in Planungs- und Entwurfsprozessen

Allgemeine Angaben

Anzahl ECTS-Credits

3

Modulkürzel

TSM_NPlanPro

Gültig für akademisches Jahr

2026-27

Letzte Änderung

2024-10-31

Modul-Koordinator/in

Jasmin Joshi (OST, jasmin.joshi@ost.ch)

Erläuterungen zu den Sprachdefinitionen je Standort:

- Der Unterricht findet in der pro Standort und Durchführung definierten Sprache statt.
- Die Unterlagen sind in den pro Standort und Durchführung definierten Sprachen verfügbar. Bei Mehrsprachigkeit ist die prozentuale Verteilung angegeben (100% = komplette Unterlagen).
- Die Prüfungsfragen und -antworten sind in jeder pro Standort und Durchführung definierten Sprache. Die Prüfung wird vor Ort durchgeführt.

	Lausanne			Lugano	Zurich		
Unterricht						**X** D 100%	
Dokumentation						**X** D 100%	
Prüfung						**X** D 100%	

Modulkategorie

TSM Technisch-wissenschaftliche Vertiefung

Profilempfehlungen

Dieses Modul wird für die folgenden Profile empfohlen:

	Zurich
Profil	ReLa

Lektionen

2 Lektionen und 1 Übungslektion pro Woche

Eintrittskompetenzen

Vorkenntnisse, Eingangskompetenzen

Es werden Grundkenntnisse in Landschaftsarchitektur und Raumplanung sowie in Bezug auf Fragen in der Nachhaltigkeit vorausgesetzt.

Kurzbeschreibung der Inhalte und Ziele

Die Begrenztheit der Ressourcen, katastrophale Auswirkungen des Klimawandels, die Biodiversitätskrise, aber auch soziale Ungleichheiten sind unübersehbare Anzeichen und Vorboten einer fundamentalen weltweiten Krise. Die Transformation hin zu einer anderen Form des Wirtschaftens und (Zusammen-)Lebens wird allseits gefordert. Was können wir auf dem Gebiet der Landschaftsarchitektur, der Raumplanung oder des Städtebaus zu einer nachhaltigen Gesellschaft beitragen? Auf welche neuen Strategien bzw. Techniken im Bereich der Biodiversitätsförderung, des Ressourcenschutzes oder der Hitzeminderung können wir zurückgreifen? Was sind naturbasierte Lösungen? Und wie sähe eine funktionsfähige ökologische Infrastruktur aus? Welche ganzheitlichen Planungstheorien und kollaborativen Raumentwicklungskonzepte stehen uns zur Verfügung? Und was lässt sich aus der Geschichte lernen?
Anhand von Erkenntnissen aus der Grundlagenforschung sowie von Beispielen sowohl aus der Praxis als auch aus der Verwaltung und Politik diskutieren wir über wirksame Ansätze, wie wir Projekte im Bereich der Landschaftsarchitektur und Raumplanung nachhaltiger entwickeln und realisieren können.

Im Rahmen einer Semesterübung sollen mögliche Ansätze für das eigene Berufsfeld reflektiert werden.

Das Thema bietet sich an, über Fächergrenzen hinweg zu denken und zu diskutieren. Studierende aus anderen Fachgebieten und Studiengängen als der Landschaftsarchitektur und der Raumplanung sind ebenfalls willkommen.

Ziele, Inhalte, Methoden

Lernziele und zu erwerbende Kompetenzen

Die Studierenden…

- sind in der Lage, neue und altbewährte Theorien, Methoden und Instrumente zu verstehen, wie Projekte im Bereich der Landschaftsarchitektur bzw. der Raumplanung ganzheitlich und nachhaltig gestaltet und umgesetzt werden können.
- können Erkenntnisse und Massnahmen aus Best-Practice-Beispielen für die eigene Arbeit nutzen.
- sind fähig, unterschiedliche Anforderungen sowie Fachsprachen beteiligter Akteure im Hinblick auf die Nachhaltigkeit einzuordnen und im Planungsprozess zu berücksichtigen.
- sind gewappnet, mit Spezialisten in Teilgebieten der Nachhaltigkeit zu kommunizieren.

Modulinhalt mit Gewichtung der Lehrinhalte

Die einzelnen Themenschwerpunkte sind in etwa gleich gewichtet. Theoretische Blöcke halten sich die Waage mit Unterrichtseinheiten, bei denen die Auseinandersetzung mit praktischen Beispielen und Massnahmen im Vordergrund stehen.

Lehr- und Lernmethoden

- Vorlesungen und Fachvorträge
- nicht bewertete Einzel-, Partner- und Gruppenarbeiten während des Unterrichts
- benotete Semesterübung (Selbststudium sowie Zeit und Betreuungsmöglichkeit im Unterricht)
- Textlektüre
- Analyse von Praxis- und Fallbeispielen
- Diskussionsrunden
- Exkursionen

Bibliografie

Weiterführende Literaturhinweise zu den jeweiligen Themen werden auf Moodle zur Verfügung gestellt.

Bewertung

Zusätzliche Leistungsbewertung während des Semesters

Das Modul beinhaltet eine oder mehrere zusätzliche Leistungsbewertung(en) während des Semesters. Die erzielte Note der zusätzlichen Leistungsbewertung(en) gilt sowohl für die reguläre als auch für die Wiederholungsprüfung.

Beschreibung zusätzliche Leistungsbewertung während des Semesters

Präsentation und Abgabe der während des Semesters erarbeiteten Übung (30 % der Gesamtnote)

Grundsatz Prüfungen

Grundsätzlich werden alle regulären Abschlussprüfungen in schriftlicher Form durchgeführt. Bei den Wiederholungsprüfungen teilen die Dozierenden das Prüfungsformat (schriftlich/mündlich) zusammen mit dem Prüfungsplan mit.

Reguläre Modulschlussprüfung und schriftliche Wiederholungsprüfung

Art der Prüfung

Schriftliche Prüfung

Prüfungsdauer

120 Minuten

Erlaubte Hilfsmittel

Erlaubt sind die aufgeführten Hilfsmittel:

Zulässige elektronische Hilfsmittel

Vorlesungsunterlagen, eigene Notizen (Open-Book-Prüfung)

Weitere erlaubte Hilfsmittel

keine

Ausnahme: Im Falle einer elektronischen Moodle-Prüfung können Änderungen der Hilfsmittel vorkommen. Dozierende werden die endgültig zulässigen Hilfsmittel vor der Prüfung bekanntgeben.

Spezialfall: Wiederholungsprüfung als mündliches Examen

Art der Prüfung

Mündliche Prüfung

Prüfungsdauer

30 Minuten

Erlaubte Hilfsmittel

Ohne Hilfsmittel

Modulbeschreibung, verfügbar in: DE, FR

Naturgefahren

Allgemeine Angaben

Anzahl ECTS-Credits

3

Modulkürzel

TSM_NatHaz

Gültig für akademisches Jahr

2026-27

Letzte Änderung

2020-03-04

Modul-Koordinator/in

Davood Farshi (OST, davood.farshi@ost.ch)

Erläuterungen zu den Sprachdefinitionen je Standort:

- Der Unterricht findet in der pro Standort und Durchführung definierten Sprache statt.
- Die Unterlagen sind in den pro Standort und Durchführung definierten Sprachen verfügbar. Bei Mehrsprachigkeit ist die prozentuale Verteilung angegeben (100% = komplette Unterlagen).
- Die Prüfungsfragen und -antworten sind in jeder pro Standort und Durchführung definierten Sprache. Die Prüfung wird vor Ort durchgeführt.

	Lausanne			Lugano	Zurich		
Unterricht		**X** F 100%				**X** D 100%	
Dokumentation		**X** F 100%				**X** D 100%	
Prüfung		**X** F 100%				**X** D 100%	

Modulkategorie

TSM Technisch-wissenschaftliche Vertiefung

Profilempfehlungen

Dieses Modul wird für die folgenden Profile empfohlen:

	Lausanne	Zurich
Profil	CE	CE

Lektionen

2 Lektionen und 1 Übungslektion pro Woche

Eintrittskompetenzen

Vorkenntnisse, Eingangskompetenzen

- Hydraulik und Hydrologie
- Grundlagen des konstruktiven Wasserbaus
- Bodenmechanik und Geotechnik
- Grundlagen der Baustatik und des konstruktiven Ingenieurbaus

Kurzbeschreibung der Inhalte und Ziele

Das Modul behandelt die wichtigsten meteorologischen-hydrologischen sowie gravitativen Naturgefahren. Neben der Auseinandersetzung mit einzelnen Gefahren (Entstehung, Gefährdungsbilder, Analysen, Massnahmen) werden auch das integrale Risikomanagement sowie rechtliche Aspekte und Haftungsfragen behandelt.

Ziele, Inhalte, Methoden

Lernziele und zu erwerbende Kompetenzen

- Die Studierenden können Ursachen und Entstehung der für die Schweiz wichtigen Naturgefahren in eigenen Worten detailliert beschreiben und analysieren.
- Die Studierenden können selbständig neues Wissen aneignen und ihre Arbeit überzeugend präsentieren.
- Die Studierenden erkennen mögliche Gefahren und daraus resultierende Schadensbilder und können beurteilen, welche Massnahmen geeignet sind, um diese in Zukunft zu vermeiden. Sie können den Kreislauf des integralen Risikomanagements auf ein Fallbeispiel anwenden und die Gefährdung, Verletzlichkeit und den Verlustwert beurteilen.
- Die Studierenden kennen die Gesetze und Verordnungen im Zusammenhang mit Naturgefahren. Sie verstehen den Zusammenhang zwischender Raumplanung und Naturgefahren und wissen, wo die Raumplanung ansetzt.
- Die Studierenden kennen den Aufbau der Gefahrenkarten und können diese an Fallbeispielen umsetzen.

Modulinhalt mit Gewichtung der Lehrinhalte

Übersicht über die wichtigsten Naturgefahren

- Meteorologischen-hydrologische, Gravitative Gefahren

Integrales Risikomanagement (ca. 20 %)

- Kreislauf des integralen Risikomanagements
- Risikoanalyse, Risikobewertung und Risikoreduktion

Rechtliche Aspekte und Haftungsfragen (ca. 10 %)

- Gesetze und Verordnungen

Programmvereinbarung (ca. 10%)

Raumplanung und Schutzzonen (ca. 10 %)

- Gefahrenhinweiskarte, Gefahrenkarte, Differenzierung von Schutzzielen
- Nutzungsplanung, Baubewilligungen

Meteorologischen-hydrologischen Naturgefahren und Gravitative Gefahren (50 %)

- Physikalische Grundlagen, Vorkommen, Entstehung, Gefährdungsbilder, Massnahmen, Modellierungstools für
  - Hochwasser (mit Fokus auf spezielle Themen)
  - Murgänge
  - Stürze
  - Rutschungen
  - Permafrost
  - Lawinen
  - Erdbeben

Lehr- und Lernmethoden

- Frontalunterricht
- Präsentation und Diskussion von Fallbeispielen
- Übungen
- Selbststudium mit dem e-Learning Tool NAHRIS
- Gruppenarbeiten und Feldbegehungen

Bibliografie

- Vorlesungsunterlagen der Dozierenden
- Fachartikel und Bücher
- www.nahris.ch

Bewertung

Zusätzliche Leistungsbewertung während des Semesters

Das Modul beinhaltet keine zusätzliche Leistungsbewertung während des Semesters.

Grundsatz Prüfungen

Grundsätzlich werden alle regulären Abschlussprüfungen in schriftlicher Form durchgeführt. Bei den Wiederholungsprüfungen teilen die

Dozierenden das Prüfungsformat (schriftlich/mündlich) zusammen mit dem Prüfungsplan mit.

Reguläre Modulschlussprüfung und schriftliche Wiederholungsprüfung

Art der Prüfung

Schriftliche Prüfung

Prüfungsdauer

120 Minuten

Erlaubte Hilfsmittel

Erlaubt sind die aufgeführten Hilfsmittel:

Zulässige elektronische Hilfsmittel

- Taschenrechner
- Notebook mit ausgeschaltetem WiFi

Weitere erlaubte Hilfsmittel

- Vorlesungsunterlagen
- Bücher

Ausnahme: Im Falle einer elektronischen Moodle-Prüfung können Änderungen der Hilfsmittel vorkommen. Dozierende werden die endgültig zulässigen Hilfsmittel vor der Prüfung bekanntgeben.

Spezialfall: Wiederholungsprüfung als mündliches Examen

Art der Prüfung

Mündliche Prüfung

Prüfungsdauer

30 Minuten

Erlaubte Hilfsmittel

Ohne Hilfsmittel

Description du module, disponible en: DE, FR

Dangers naturels

Informations générales

Nombre de crédits ECTS

3

Code du module

TSM_NatHaz

Valable pour l'année académique

2026-27

Dernière modification

2020-03-04

Coordinateur/coordinatrice du module

Davood Farshi (OST, davood.farshi@ost.ch)

Explications concernant les langues d'enseignement par site :

- L'enseignement est dispensé dans la langue indiquée ci-dessous pour chaque site et chaque exécution du module.
- Les supports de cours sont disponibles dans les langues indiquées ci-dessous pour chaque site et chaque exécution du module. Lorsque plusieurs langues sont utilisées, la proportion de contenu disponible dans chaque langue est précisée (100 % = ensemble des supports de cours).
- Les examens (questions et réponses) sont entièrement rédigés dans la langue indiquée ci-dessous pour le site et l'exécution du module concernés. Ils se déroulent en présentiel.

	Lausanne			Lugano	Zurich		
Leçons		**X** F 100%				**X** D 100%	
Documentation		**X** F 100%				**X** D 100%	
Examen		**X** F 100%				**X** D 100%	

Catégorie de module

TSM approfondissement technico-scientifique

Recommandations de profil

Ce module est recommandé pour les profils suivants :

	Lausanne	Zurich
Profil	CE	CE

Leçons

2 leçons et 1 leçon de pratique par semaine

Compétences préalables

Connaissances préalables, compétences initiales

- Hydraulique Hydrologie
- Connaissances de base en construction hydraulique
- Mécanique des sols et géotechnique
- Connaissances de base en statique de la construction

Brève description du contenu et des objectifs

Le module traite des principaux dangers naturels gravitationnels et météorologiques. Mis à part la réflexion sur différents dangers naturels (origine, scénarios de risques, analyses, mesures), le cours accorde aussi une importance centrale à la gestion intégrée du risque, aux aspects juridiques et aux questions de responsabilité.

Objectifs, contenus, méthodes

Objectifs d'apprentissage, compétences à acquérir

- Les étudiant-e-s sont en mesure de décrire de manière détaillée la cause et l'origine des principaux dangers naturels en Suisse ;
- Les étudiant-e-s sont en mesure d'acquérir par eux-mêmes de nouvelles connaissances dans le domaine des dangers naturels et de présenter leurs travaux de manière convaincante ;
- Les étudiant-e-s identifient les dangers gravitationnels possibles, ainsi que les dommages qu'ils provoquent, et sont à même d'estimer les mesures indiquées pour les prévenir. Ils/elles appliquent la gestion intégrée du risque dans une étude de cas ; ils/elles évaluent le risque, la vulnérabilité et la valeur de la perte ;
- Les étudiant-e-s connaissent les lois et les ordonnances concernant les dangers naturels. Ils/elles comprennent le lien entre l'aménagement du territoire et les dangers naturels, et connaissent les procédures d'aménagement existantes ;
- Les étudiant-e-s sont capables de concevoir et de réaliser une carte des dangers en partant d'une étude de cas.

Contenu des modules avec pondération du contenu des cours

Aperçu des principaux dangers naturels

- Dangers hydrométéorologiques, dangers gravitationnels

Gestion intégrée du risque (env. 20%)

- Processus de la gestion intégrée du risque
- Analyse, évaluation et réduction de risque

Aspects juridiques et questions de responsabilité (env. 10%)

- Lois et ordonnances

Mise en commun des connaissances (env. 10%)

Aménagement du territoire et zones de protection (env. 10%)

- Carte d'indication des dangers, carte des dangers, différenciation des objectifs de protection
- Plan d'affectation, permis de construire

Dangers hydrométéorologiques, dangers gravitationnels (env. 50%)

- Bases physiques, causes, incidences, scénarios de risques, mesures, outils de modélisation pour :
  - Inondations
  - Coulées de boue
  - Chutes de blocs (instabilités rocheuses)
  - Glissements de terrain
  - Pergélisol
  - Avalanches
  - Tremblements de terre

Méthodes d'enseignement et d'apprentissage

- Cours magistraux
- Présentation et discussion d'études de cas
- Exercices
- Etude autonome avec l'outil e-Learning NAHRIS
- Travaux de groupe et visites in situ

Bibliographie

- Documents de cours
- Articles scientifiques
- www.nahris.ch

Evaluation

Évaluation supplémentaire pendant le semestre

Le module ne comprend pas d'évaluation supplémentaire pendant le semestre

Principe pour les examens

En règle générale, tous les examens réguliers de fin de module se déroulent sous forme écrite. Concernant les examens de répétition, leur format (écrit ou oral) sera communiqué par l'enseignant-e en même temps que le calendrier des examens.

Examen de fin de module régulier et examen écrit de répétition

Type de l'examen

Examen écrit

Durée de l'examen

120 minutes

Aides autorisées

Les aides suivantes sont autorisées:

Aides électroniques autorisées

- Calculatrice
- Notebook (partiellement)

Autres aides autorisées

- Documents de cours
- Livres

Exception : En cas d'examen électronique sur Moodle, des modifications des aides autorisées peuvent survenir. Dans ce cas, les aides autorisées seront annoncées par les enseignant-e-s avant l'examen.

Cas spécial: examen de répétition oral

Type de l'examen

Examen oral

Durée de l'examen

30 minutes

Aides autorisées

Sans aides

Module Description, available in: EN

Numerical methods for building engineering

General Information

Number of ECTS Credits

3

Module code

TSM_NumMeth

Valid for academic year

2026-27

Last modification

2022-01-11

Coordinator of the module

Peter Scheiblechner (HSLU, peter.scheiblechner@hslu.ch)

Explanations regarding the language definitions for each location:

- Instruction is given in the language specified for each location and module execution.
- Documentation is available in the language(s) listed for each location and module execution. If the documentation is in multiple languages, the percentage distributed is indicated (100% = all documentation provided).
- The examination, including both questions and answers, is provided entirely (100%) in the language(s) specified for each location and module execution. The exams are on-site.

	Lausanne			Lugano	Zurich		
Instruction					**X** E 100%		
Documentation					**X** E 100%		
Examination					**X** E 100%		

Module Category

TSM Technical scientific module

Profile Recommendations

This module is recommended for the following profiles:

	Zurich
Profile	BT

Lessons

2 lecture periods and 1 tutorial period per week

Entry level competences

Prerequisites, previous knowledge

Solid knowledge in physics, thermodynamics and mathematics.

Brief course description of module objectives and content

Description of numerical methods and application in building thermodynamics and heat transfer. Modelling complex heat transfer through building construction and for modelling air movement outside and inside the building. Numerical methods for fire simulations. Modeling and solving practical problems in different fields of building engineering.

Aims, content, methods

Learning objectives and competencies to be acquired

1. Introduce the fundamentals of numerical methods used for the solution of engineering problems.
2. Improve the competences in modeling practical engineering problems in different fields of building engineering.
3. Improve the computer skills of the students.

Module content with weighting of different components

Part 1) Numerical methods in building thermodynamics and heat transfer

- Heat conduction in building elements - steady state conditions.
- Heat conduction in building elements - dynamic conditions:

1. Analytical Solution
2. Lumped Capacitance Method
3. Numerical solutions (Finite Differences)
4. Graphical solutions (Binder-Schmidt-Method)

- Models for the thermal balance of a room:

1. Steady state model
2. Non-steady state model
3. Boundary conditions on external surfaces

- Introduction to OCTAVE software, application on test cases in fields of building engineering.
- Introduction to commercial building simulation software, application on test cases in fields of building engineering.

Part 2) Numerical methods for modelling complex heat transfer

- through building construction
- air movement outside and inside the building
- use of Ansys CFX / Ansys Fluent / OpenFOAM

Part 3) Numerical methods for fire simulations

Teaching and learning methods

- 3 lecture periods per week, with integrated exercise sessions.
- Teaching: Frontal teaching and storytelling. Discussion of practical cases. Guided learning using lecture notes and textbooks.
- Exercises: Solving practical problems under the guidance of the tutors (problem solving, modeling and programming in OCTAVE, IDA-ICE, Ansys, OpenFOAM, FDS).

Literature

- Bergman, Theodore L.; Lavine, Adrienne S.: Fundamentals of heat and mass transfer. John Wiley [2017]
- Incropera, F.P., DeWitt, D.P. , Bergman T.L., Lavine, A. S.: Incropera's Principles of Heat and Mass Transfer: Global Edition. Wiley [2017]
- Linge, S., Langtangen, H. P.: Programming for Computations – MATLAB/Octave. Springer [2015]
- Chapra, S. C.: Applied Numerical Methods with MATLAB for Engineers and Scientists, McGraw-Hill [2005]

Assessment

Additional performance assessment during the semester

The module does not contain an additional performance assessment during the semester

Basic principle for exams

As a rule, all standard final exams are conducted in written form. For resit exams, lecturers will communicate the exam format (written/oral) together with the exam schedule.

Standard final exam for a module and written resit exam

Kind of exam

Written exam

Duration of exam

120 minutes

Permissible aids

Aids permitted as specified below:

Permissible electronic aids

Pocket calculator

Other permissible aids

- Lecture notes
- Personal summary
- Course textbooks

Exception: In case of an electronic Moodle exam, adjustments to the permissible aids may occur. Lecturers will announce the final permissible aids prior to the exam session.

Special case: Resit exam as oral exam

Kind of exam

Oral exam

Duration of exam

30 minutes

Permissible aids

No aids permitted

Module Description, available in: EN

Optical engineering and metrology

General Information

Number of ECTS Credits

3

Module code

TSM_OpEngMe

Valid for academic year

2026-27

Last modification

2024-09-24

Coordinator of the module

Bojan Resan (FHNW, bojan.resan@fhnw.ch)

Explanations regarding the language definitions for each location:

- Instruction is given in the language specified for each location and module execution.
- Documentation is available in the language(s) listed for each location and module execution. If the documentation is in multiple languages, the percentage distributed is indicated (100% = all documentation provided).
- The examination, including both questions and answers, is provided entirely (100%) in the language(s) specified for each location and module execution. The exams are on-site.

	Lausanne			Lugano	Zurich		
Instruction					**X** E 100%		
Documentation					**X** E 100%		
Examination					**X** E 100%		

Module Category

TSM Technical scientific module

Profile Recommendations

This module is recommended for the following profiles:

	Zurich
Profile	Pho

Lessons

2 lecture periods and 1 tutorial period per week

Entry level competences

Prerequisites, previous knowledge

Optics: Basics of wave and geometrical optics;

Without optics basics during bachelor studies, the EVA “Fundamentals of light” should be visited before visiting further TSM modules.

Physics: Basics for engineers (bachelor niveau)

Brief course description of module objectives and content

The TSM module "Optical engineering and metrology" will provide the students with knowledge of numerous engineering and practical aspects of optical components, instruments, and metrology systems. Starting from seemingly simple optical components (mirrors, lenses, gratings, filters), the module covers high tech novelties on how to improve those components and bring them to the new level. Building up on those concepts, we will discuss more complex components, including acousto-optic, electro-optic, and liquid crystal modulators, as well as simpler systems like objectives and spectrometers. The module will be completed with methods applied in industry for measuring and diagnostics of various processes, including industrial interferometry, spectroscopy, imaging, and precise distance measurements.

Aims, content, methods

Learning objectives and competencies to be acquired

After successfully completing this module, the students should:

- understand the principles and know engineering aspects of basic optical components,
- be able to choose the appropriate optical element (including appropriate coating) for their tasks,
- know the principles of optical instruments and understand how some simple optical instruments operate,
- understand some optical metrology and microscopy methods, typically used in industry,
- be able to choose the appropriate optical diagnostics method for their process.

Module content with weighting of different components

1) Optical components (total 5 weeks):

- types of mirrors and lenses, incl. different coatings (1 week);
- principles of operation and types of polarization optics (waveplates, polarizer, isolator) (1 week);
- types, characteristics and applications of optical filters: absorption, interference, neutral density, reflective, long-pass, band-pass, notch, spatial, (1 week);
- gratings (1 week);
- light modulators (chopper, LCD, AOM, EOM) (1 week);

2) Optical instruments (total 3 weeks):

- Imaging optics (MTF, aberrations, camera objectives…) (1 week);
- Spectrometers (1 week);
- Colorimetry, color spaces and laser projection and displays (1 week);

3) Optical metrology (total 6 weeks):

- Industrial inspection: interferometry, industrial vision, Moire technique, laser triangulation (1.5 week);
- Spectroscopy: linear absorption, FTIR, luminescence, Raman (1 week);
- Hyperspectral imaging (1 week);
- Microscopy: confocal, two-photon, super-resolution STED, OCT (1.5 week);
- Laser detection: LIDAR, 3D sensing and self-driven cars (1 week);

Teaching and learning methods

Lectures, open discussion with students, self-study, seminar, and practical home work.

Literature

1) Lecturers' references to current literature,

2) Saleh, Tech: Fundamentals of optics

3) Hecht: Optics

Assessment

Additional performance assessment during the semester

The module contains additional performance assessment(s) during the semester. The achieved mark of the additional performance assessment(s) applies to both the regular and the resit exam.

Description of additional performance assessment during the semester

The seminar brings 5% to the final grade. The final grade is calculated as: final grade = 0.05 x seminar grade + 0.95 x final exam grade. Students can participate in the final exam without submitting the seminar.

Basic principle for exams

As a rule, all standard final exams are conducted in written form. For resit exams, lecturers will communicate the exam format (written/oral) together with the exam schedule.

Standard final exam for a module and written resit exam

Kind of exam

Written exam

Duration of exam

120 minutes

Permissible aids

Aids permitted as specified below:

Permissible electronic aids

No electronic aids permitted

Other permissible aids

Personal formula collection: 4 A4 pages allowed.

Exception: In case of an electronic Moodle exam, adjustments to the permissible aids may occur. Lecturers will announce the final permissible aids prior to the exam session.

Special case: Resit exam as oral exam

Kind of exam

Oral exam

Duration of exam

30 minutes

Permissible aids

No aids permitted

Module Description, available in: EN

Service Operations and Management

General Information

Number of ECTS Credits

3

Module code

TSM_OpMgmt

Valid for academic year

2026-27

Last modification

2019-07-17

Coordinator of the module

Christoph Heitz (ZHAW, christoph.heitz@zhaw.ch)

Explanations regarding the language definitions for each location:

- Instruction is given in the language specified for each location and module execution.
- Documentation is available in the language(s) listed for each location and module execution. If the documentation is in multiple languages, the percentage distributed is indicated (100% = all documentation provided).
- The examination, including both questions and answers, is provided entirely (100%) in the language(s) specified for each location and module execution. The exams are on-site.

	Lausanne			Lugano	Zurich		
Instruction					**X** E 100%		
Documentation					**X** E 100%		
Examination					**X** E 100%		

Module Category

TSM Technical scientific module

Profile Recommendations

This module is recommended for the following profiles:

	Zurich
Profile	BE

Lessons

2 lecture periods and 1 tutorial period per week

Entry level competences

Prerequisites, previous knowledge

Bachelor degree, ideally in Business & Engineering

Brief course description of module objectives and content

In all developed economies, the service sector is the dominant economic sector. Its importance is still growing. In particular new services based on new technologies such as mobile and internet-based technologies are changing our world at a breathtaking pace. The goal of this module is to make students familiar with some of the main concepts of modern services.

The module focuses on service science and strategic service management on the one hand, and service operations management (service delivery) on the other hand.

Aims, content, methods

Learning objectives and competencies to be acquired

The students…

- Know the economic importance of services. They know how service delivery differs from manufacturing.
- Know the co-creation of value and the fundamentals of Service Dominant Logic as paradigms for understanding services.
- Are able to describe a service both from the perspective of a customer (value creation, perceived value) as well as from the perspective of a provider (value capture)
- Are familiar with the most important operational challenges of a service provider. They are able to apply important service-specific models of Operations Management.
- Understand the principles of service science and are able to generate and assess new service models

Module content with weighting of different components

Service basics (3 weeks):

- Economic importance of services in developed oconomies
- What is a service? Service systems, coproduction and value co-creation, Service-Dominant Logic.
- Services are an experience: The service encounter
- service quality, the gap model, SERVQUAL

Service Operations Management (7 weeks):

- Managing Capacity and Demand , Capacity planning and queuing
- Managing waiting lines
- Value creation process according to Service Dominant Logic, Value for customers / conjoint analysis.
- Value for providers: Customer lifetime value and Customer Equity
- Yield management as an example of service system optimization

Service Engineering (4 weeks):

- Service optimization: Best Service is no service
- New trends in services, service workshop
- Company Case

Teaching and learning methods

- Theory with exercises
- group assignments
- case work

Literature

[1] James A. Fitzsimmons, Mona J. Fitzsimmons: Service Management: Operations, Strategy, Information Technology

Assessment

Additional performance assessment during the semester

The module does not contain an additional performance assessment during the semester

Basic principle for exams

As a rule, all standard final exams are conducted in written form. For resit exams, lecturers will communicate the exam format (written/oral) together with the exam schedule.

Standard final exam for a module and written resit exam

Kind of exam

Written exam

Duration of exam

120 minutes

Permissible aids

Aids permitted as specified below:

Permissible electronic aids

No electronic aids permitted

Other permissible aids

Open book

Exception: In case of an electronic Moodle exam, adjustments to the permissible aids may occur. Lecturers will announce the final permissible aids prior to the exam session.

Special case: Resit exam as oral exam

Kind of exam

Oral exam

Duration of exam

30 minutes

Permissible aids

No aids permitted

Module Description, available in: EN

Photovoltaic & storage

General Information

Number of ECTS Credits

3

Module code

TSM_PhotoStor

Valid for academic year

2026-27

Last modification

2025-10-10

Coordinator of the module

Hartmut Nussbaumer (ZHAW, nusu@zhaw.ch)

Explanations regarding the language definitions for each location:

- Instruction is given in the language specified for each location and module execution.
- Documentation is available in the language(s) listed for each location and module execution. If the documentation is in multiple languages, the percentage distributed is indicated (100% = all documentation provided).
- The examination, including both questions and answers, is provided entirely (100%) in the language(s) specified for each location and module execution. The exams are on-site.

	Lausanne			Lugano	Zurich		
Instruction					**X** E 100%		
Documentation					**X** E 100%		
Examination					**X** E 100%		

Module Category

TSM Technical scientific module

Profile Recommendations

This module is recommended for the following profiles:

	Zurich
Profile	EnEn

Lessons

2 lecture periods and 1 tutorial period per week

Entry level competences

Prerequisites, previous knowledge

Basics in Physics, Electronics, Basic understanding of I(V) curves

Brief course description of module objectives and content

The objective of the course is to gain the competence to understand the current scientific topics in the field of photovoltaic and battery research and to have the opportunity to familiarise oneself with a special area of research. After a short compact course on the basics of photovoltaics, the current module technology, production of modules and topics from systems engineering will be covered. Another focus of the course is battery technology.

Aims, content, methods

Learning objectives and competencies to be acquired

The aim of the course is to gain an in-depth understanding of photovoltaic and battery technology. Students gain a broad knowledge of the subject area and are able to apply the knowledge they have acquired to assess specific practical issues. After completing the course, students should be able to understand the content of scientific conferences in the field of photovoltaics and battery technology and provide new impulses for the further development of the technology themselves.

Module content with weighting of different components

Chapter 1: Basic photovoltaics 3×3 lectures

Fundamentals of photovoltaic systems: Solar resources, irradiance vs. irradiation, energy yield estimation, components of PV systems, types of PV systems, operating principles of PV inverters, PV market international and in Switzerland, LCOE, energy pay back time

Semiconductor basics, p/n junction, working principle of solar cells, absorption edge, I/V curve, efficiency limit, recombination losses

Chapter 2: Solar modules 1×3 lectures

Production of silicon solar modules: metallurgical silicon, polysilicon, ingot, wafer, solar cell, module, _____

Crystalline silicon solar modules 1: Module construction, encapsulants, solar glass, wafer size, half cells, PERC, TOPCon, HJ, IBC, perovskite silicon tandem

Chapter 3: Solar modules in operation 2×3 lectures

Crystalline silicon solar modules 2: Electrical characteristics. Study of IV curve, partly shading, shading tolerant modules

Crystalline silicon solar modules 3: Reliability, lifetime degradation rates, types (LID, LeTID, PID, UV), Accelerated aging

Chapter 4: System technology 2×3 lectures

PV inverters, hybrid inverter, MPP tracking strategies, power optimisers, inverter behaviour in partial shading conditions

Energy yield and loss calculation of PV systems

Chapter 5: Battery technologies 3×3 lectures

Energy Storage introduction, Battery history, Electrochemistry basics and Li ion battery materials

Battery Performance, System design and lifetime mechanisms

Battery Safety, End of life options, Market overview and Application example

Chapter 6: PV integration 3×3 lectures

PV system design: Matching modules, inverters and power optimisers

Choice of system topologies for specific situations

PV in the power system: Grid integration strategies

Teaching and learning methods

- Lecture, discussion, exercises, case studies
- Exercises using basic mathematics and several public software tools

Literature

Assessment

Additional performance assessment during the semester

The module does not contain an additional performance assessment during the semester

Basic principle for exams

As a rule, all standard final exams are conducted in written form. For resit exams, lecturers will communicate the exam format (written/oral) together with the exam schedule.

Standard final exam for a module and written resit exam

Kind of exam

Written exam

Duration of exam

120 minutes

Permissible aids

No aids permitted

Exception: In case of an electronic Moodle exam, adjustments to the permissible aids may occur. Lecturers will announce the final permissible aids prior to the exam session.

Special case: Resit exam as oral exam

Kind of exam

Oral exam

Duration of exam

30 minutes

Permissible aids

No aids permitted

Module Description, available in: EN

Plastics failure analysis and prevention

General Information

Number of ECTS Credits

3

Module code

TSM_PlaFaAna

Valid for academic year

2026-27

Last modification

2019-08-31

Coordinator of the module

Andrea Castrovinci (SUPSI, andrea.castrovinci@supsi.ch)

Explanations regarding the language definitions for each location:

- Instruction is given in the language specified for each location and module execution.
- Documentation is available in the language(s) listed for each location and module execution. If the documentation is in multiple languages, the percentage distributed is indicated (100% = all documentation provided).
- The examination, including both questions and answers, is provided entirely (100%) in the language(s) specified for each location and module execution. The exams are on-site.

	Lausanne			Lugano	Zurich		
Instruction				**X** E 100%			
Documentation				**X** E 100%			
Examination				**X** E 100%			

Module Category

TSM Technical scientific module

Profile Recommendations

This module is recommended for the following profiles:

	Lugano
Profile	ME

Lessons

2 lecture periods and 1 tutorial period per week

Entry level competences

Prerequisites, previous knowledge

Fundamentals of Inorganic and Organic chemistry.
Fundamental of polymeric materials

Brief course description of module objectives and content

Degradation of polymers is an important driver of plastic and rubber products failures during their service life. Therefore, understanding the mechanisms of polymer degradation is of paramount importance for properly engineering plastic and rubber products, ensuring performances all through their service life. This module discusses the impact of chemical and physical degradating factors on the macromolecules characteristics and performances. It provides fundamentals of macromolecule degradation mechanisms, correlating this know-how with the failure of plastic and rubber products through case study analysis.

Aims, content, methods

Learning objectives and competencies to be acquired

Understand the chemical-physical processes of degradation of polymeric materials.
Master the possible approaches to protect polymeric materials from uncontrolled degradation.

Module content with weighting of different components

The course content are:

- Impact of degradation factors (e.g. oxygen, UV, etc.) on macromolecules
- Impact of macromolecule degradation on mechanical/optical/chemical properties of plastic/rubber products
- Protection of plastic/rubber product against degradation

Teaching and learning methods

Teaching: Ex cathedra teaching (theory) and Presentation of case studies
Learing methods: Self study

Literature

Assessment

Additional performance assessment during the semester

The module does not contain an additional performance assessment during the semester

Basic principle for exams

As a rule, all standard final exams are conducted in written form. For resit exams, lecturers will communicate the exam format (written/oral) together with the exam schedule.

Standard final exam for a module and written resit exam

Kind of exam

Written exam

Duration of exam

120 minutes

Permissible aids

No aids permitted

Exception: In case of an electronic Moodle exam, adjustments to the permissible aids may occur. Lecturers will announce the final permissible aids prior to the exam session.

Special case: Resit exam as oral exam

Kind of exam

Oral exam

Duration of exam

30 minutes

Permissible aids

No aids permitted

Module Description, available in: EN

Power Electronics Systems

General Information

Number of ECTS Credits

3

Module code

TSM_PowElSys

Valid for academic year

2026-27

Last modification

2024-10-15

Coordinator of the module

Adrian Omlin (HSLU, adrian.omlin@hslu.ch)

Explanations regarding the language definitions for each location:

- Instruction is given in the language specified for each location and module execution.
- Documentation is available in the language(s) listed for each location and module execution. If the documentation is in multiple languages, the percentage distributed is indicated (100% = all documentation provided).
- The examination, including both questions and answers, is provided entirely (100%) in the language(s) specified for each location and module execution. The exams are on-site.

	Lausanne			Lugano	Zurich		
Instruction					**X** E 100%		
Documentation					**X** E 100%		
Examination					**X** E 100%		

Module Category

TSM Technical scientific module

Profile Recommendations

This module is recommended for the following profiles:

	Zurich
Profile	EIE, EnEn

Lessons

2 lecture periods and 1 tutorial period per week

Entry level competences

Prerequisites, previous knowledge

To attend the module, a **good fundamental knowledge in electrical engineering** is essential. In addition, a sound basis in power electronics and control technique is needed.

- **Power electronics**: Characteristics, driving and application of power diodes, thyristors, MOS- field effect transistors, IGBT, as well as GTO-thyristors, are known.
- **The basic power electronics circuits**, with and without galvanic isolation, are known and understood. E.g. boost and buck converter, flyback and forward converter, one- and three-phase self-commutated bridges with semiconductors having turn-off capability, line-commutated

rectifiers.
- **System description** with transfer function can be derived and represented in a Bode diagram. Additionally, a basic knowledge of descriptions in state space is useful.
  PI- controller design with help of the Bode diagram (or other methods) can be carried out.

Brief course description of module objectives and content

Building upon the students' fundamental knowledge in power electronics, this module covers current topics in the field of power electronics in greater depth. In the first part, the focus is on modern switched mode power conversion topologies, small signal modelling, control methods and the magnetic components. The second part looks into topologies, modulation schemes and control techniques for medium and high-power converters. One application discussed in greater depth is their application in power grids.

Aims, content, methods

Learning objectives and competencies to be acquired

The students are taught modelling methods, structure and control of power electronics circuits based on selected practical and realistic examples.

Module content with weighting of different components

Switched mode power supplies: 7x3h

- Overview over the most common topologies
- Soft switching in switched mode power converters
- Resonant converter
- Small signal modelling of switched mode power converters
- Control of switched mode power converters
- Magnetic components
- Integrated magnetics

Medium and high-power converters: 7×3h

- Three-phase inverters (topologies, modulation techniques, harmonics)
- Multi-level inverters (topologies, modulation techniques, harmonics)
- Rectifiers and transformers for higher pulse-numbers
- Control methods for converters
- Special features of high-power converters like semiconductors, protection and cooling
- FACTS (Flexible AC Transmission Systems): applications of high-power converters in energy transmission like interties, SVC (Static-Var-Compensation), DVR (Dynamic Voltage Restorer), HVDC (High Voltage DC Transmission)

Teaching and learning methods

- Lecture, interactive instruction and discussion
- Embedded exercises (with Matlab, Simulink and PLECS)

Literature

Documents will be made available in electronic form

Assessment

Additional performance assessment during the semester

The module does not contain an additional performance assessment during the semester

Basic principle for exams

As a rule, all standard final exams are conducted in written form. For resit exams, lecturers will communicate the exam format (written/oral) together with the exam schedule.

Standard final exam for a module and written resit exam

Kind of exam

Written exam

Duration of exam

120 minutes

Permissible aids

Aids permitted as specified below:

Permissible electronic aids

Personal calculator (no PC, no Mobile)

Other permissible aids

Only a self-prepared summary is permitted.

Exception: In case of an electronic Moodle exam, adjustments to the permissible aids may occur. Lecturers will announce the final permissible aids prior to the exam session.

Special case: Resit exam as oral exam

Kind of exam

Oral exam

Duration of exam

30 minutes

Permissible aids

No aids permitted

Module Description, available in: EN, FR

Power Grids: Systems and Devices

General Information

Number of ECTS Credits

3

Module code

TSM_PowGrid

Valid for academic year

2026-27

Last modification

2024-10-03

Coordinator of the module

Adriano Nasciuti (ZHAW, adriano.nasciuti@zhaw.ch)

Explanations regarding the language definitions for each location:

- Instruction is given in the language specified for each location and module execution.
- Documentation is available in the language(s) listed for each location and module execution. If the documentation is in multiple languages, the percentage distributed is indicated (100% = all documentation provided).
- The examination, including both questions and answers, is provided entirely (100%) in the language(s) specified for each location and module execution. The exams are on-site.

	Lausanne			Lugano	Zurich		
Instruction		**X** F 100%			**X** E 100%		
Documentation		**X** F 30%	**X** E 70%		**X** E 100%		
Examination		**X** F 100%			**X** E 100%		

Module Category

TSM Technical scientific module

Profile Recommendations

This module is recommended for the following profiles:

	Lausanne	Zurich
Profile	EnEn	EnEn

Lessons

2 lecture periods and 1 tutorial period per week

Entry level competences

Prerequisites, previous knowledge

Basics of electrical laws, network analysis and its basic components, AC-systems, calculation with complex numbers, three-phase systems.

Brief course description of module objectives and content

In this module, students will increase their knowledge in selected areas of power grids in electricity distribution and transmission:

- High voltage engineering basics and relevant design rules
- Breakdown theory
- Generation of AC testing high voltage and partial discharge testing
- Design, construction and parameters of components in power grids
- Learn the origin of networks failures, consequences, preventing and recovery measures
- Operation principles and challenges of power grids
- Special actual challenges and trends in transmission and distribution systems

Aims, content, methods

Learning objectives and competencies to be acquired

Students

- know the main challenges of today's modern grids
- know the main elements of an electrical grid and the differences of transmission components
- possess a fundamental knowledge of the principles of designing high voltage equipment.
- Know the basic design and technical solutions of the most important high voltage equipment in a power grid
- have become acquainted with the static/dynamic modelling and simulation of high voltage components.
- know the design criteria of power grids and can perform basic grid calculations
- know the behavior of meshed grids in normal operation
- understand the basics of power system stability
- can describe the advantages of smart-grid applications
- learn the basic principles of the management and regulation of electrical grids

Module content with weighting of different components

Course	Designation	Week
0	**Introduction: Evolution of the power grid** History of power grids / technological milestones, DC and AC Systems, components and devices, market and regulations	1
1	**Interconnected Grids** • Design of T&D Grids • Static load flow analysis, fault analysis • Frequency & active power exchange under control of the TSO • Combined voltage and reactive power control in the T&D Grid • **Excursion Swissgrid Control Center, Aarau / W. Sattinger**	2,3,4,5
2	**Special Chapters on T&D (Transmission and Distribution)** • Grid Dynamics and Stability • Optimized Grid use by “Smart Grid” Applications • Energy storage	6,7,8
3	**Fundamentals and devices in high voltage engineering** • Tasks of HVE, Overvoltages origin and control, insulation Coordination (w2) • Properties of insulating materials (w2) • Electric fields and field stress control, (w3) • Break down in gases (homogeneous field – Paschen; inhomogeneous field – Streamer/Leader (w4) • Beakdown in liquids and in solids (w5)	9,10,11,12
4	**PD-Measurement and HV-AC-Generation** • Partial Discharge Measurement and generation of testing high voltages (AC)	13,14

Teaching and learning methods

- ex cathedra teaching
- exercises
- presentation and discussion of case studies

Literature

A. Küchler; «High Voltage Engineering», Springer Vieweg (2018)

Information on additional literature will occasionally be given during the module.

Assessment

Additional performance assessment during the semester

The module does not contain an additional performance assessment during the semester

Basic principle for exams

As a rule, all standard final exams are conducted in written form. For resit exams, lecturers will communicate the exam format (written/oral) together with the exam schedule.

Standard final exam for a module and written resit exam

Kind of exam

Written exam

Duration of exam

120 minutes

Permissible aids

Aids permitted as specified below:

Permissible electronic aids

basic calculator

Other permissible aids

Five double-sided A4 paper sheets (printed and/or handwritten) containing any type of information.

Exception: In case of an electronic Moodle exam, adjustments to the permissible aids may occur. Lecturers will announce the final permissible aids prior to the exam session.

Special case: Resit exam as oral exam

Kind of exam

Oral exam

Duration of exam

30 minutes

Permissible aids

No aids permitted

Description du module, disponible en: EN, FR

Power Grids: Systems and Devices

Informations générales

Nombre de crédits ECTS

3

Code du module

TSM_PowGrid

Valable pour l'année académique

2026-27

Dernière modification

2024-10-03

Coordinateur/coordinatrice du module

Adriano Nasciuti (ZHAW, adriano.nasciuti@zhaw.ch)

Explications concernant les langues d'enseignement par site :

- L'enseignement est dispensé dans la langue indiquée ci-dessous pour chaque site et chaque exécution du module.
- Les supports de cours sont disponibles dans les langues indiquées ci-dessous pour chaque site et chaque exécution du module. Lorsque plusieurs langues sont utilisées, la proportion de contenu disponible dans chaque langue est précisée (100 % = ensemble des supports de cours).
- Les examens (questions et réponses) sont entièrement rédigés dans la langue indiquée ci-dessous pour le site et l'exécution du module concernés. Ils se déroulent en présentiel.

	Lausanne			Lugano	Zurich		
Leçons		**X** F 100%			**X** E 100%		
Documentation		**X** F 30%	**X** E 70%		**X** E 100%		
Examen		**X** F 100%			**X** E 100%		

Catégorie de module

TSM approfondissement technico-scientifique

Recommandations de profil

Ce module est recommandé pour les profils suivants :

	Lausanne	Zurich
Profil	EnEn	EnEn

Leçons

2 leçons et 1 leçon de pratique par semaine

Compétences préalables

Connaissances préalables, compétences initiales

Principes de base des lois électriques, analyse des réseaux et de ses composants de base, systèmes en courant alternatif, calcul avec des nombres complexes, systèmes triphasés.

Brève description du contenu et des objectifs

Dans ce module, les étudiant-e-s approfondiront leurs connaissances dans certains aspects des réseaux électriques de distribution et de transmission d'électricité :

- Ingénierie de la haute tension et règles de design pertinentes
- Outils de test de haute tension
- Conception, construction et paramètres des composants des réseaux électriques
- Connaître l'origine des défaillances des réseaux, leurs conséquences, les mesures de prévention et de rétablissement
- Principes d'exploitation et défis des réseaux électriques
- Défis et tendances actuels spécifiques dans les systèmes de transmission et de distribution

Objectifs, contenus, méthodes

Objectifs d'apprentissage, compétences à acquérir

Les étudiant-e-s

- connaissent les principaux défis des réseaux modernes d'aujourd'hui
- connaissent les principaux éléments d'un réseau électrique et les différences entre les composants de transmission
- possèdent une connaissance fondamentale des principes de conception des équipements à haute tension.
- connaissent la conception de base et les solutions techniques des équipements les plus importants de haute tension d'un réseau électrique
- se familiarisent avec la modélisation et la simulation statique/dynamique des composants à haute tension.
- connaissent les critères de conception des réseaux électriques et peuvent effectuer des calculs de base sur les réseaux
- connaissent le comportement des réseaux maillées en fonctionnement normal
- comprennent les bases de la stabilité du système électrique
- peuvent décrire les avantages des applications de réseaux intelligentes
- connaissent les principes de base de la gestion et de la régulation des réseaux électriques

Contenu des modules avec pondération du contenu des cours

Cours	Designation	Semaine
0	**Introduction: Evolution du réseau éléctrique** Histoire des réseaux électriques / étapes technologiques, systèmes c.a./c.c, composants et dispositifs, marché et réglementation	1
1	**Système et technologies de la haute tension et composants de réseaux** • tâches de haute tension, origine et contrôle des surtensions, coordination de l'isolation (s2) • Matériels isolants • Essai haute tensions • Générateurs haute tensions • Mise en place de tests de hautes tensions (c.c, c.a. et impulsion) • Mesure de la décharge partielle • FACTS, HVDC, et l'influence des onduleurs	2,3,4,5
2	**Calcul de reseaux** • Analyse de charge statique, analyse de défaut • Analyser le problème de flux de puissance optimale dans un réseau	6,7
3	**Reseaux interconnectés** • Conception de réseaux T&D et exploitation coordonné • Frequency & active power exchange under control of the TSO • Combined voltage and reactive power control in the T&D Grid • **Excursion Swissgrid Control Center, Aarau / W. Sattinger**	8,9,10,11
4	**Chapitres spécifiques sur T&D (Transmission et Distribution)** • Planification des réseaux T&D • Réseaux optimisés par des applications “Smart Grid” • Stockage d'énergie	12,13,14

Méthodes d'enseignement et d'apprentissage

- cours magistraux ex cathedra
- exercices

- présentation et discussion des études de cas

Bibliographie

A. Küchler; «High Voltage Engineering», Springer Vieweg (2018)

Des informations sur de la littérature supplémentaire seront données pendant le les cours

Evaluation

Évaluation supplémentaire pendant le semestre

Le module ne comprend pas d'évaluation supplémentaire pendant le semestre

Principe pour les examens

En règle générale, tous les examens réguliers de fin de module se déroulent sous forme écrite. Concernant les examens de répétition, leur format (écrit ou oral) sera communiqué par l'enseignant-e en même temps que le calendrier des examens.

Examen de fin de module régulier et examen écrit de répétition

Type de l'examen

Examen écrit

Durée de l'examen

120 minutes

Aides autorisées

Les aides suivantes sont autorisées:

Aides électroniques autorisées

calculatrice de base

Autres aides autorisées

Cinq feuilles A4 recto verso (imprimées et/ou manuscrites) contenant tout type d'informations

Exception : En cas d'examen électronique sur Moodle, des modifications des aides autorisées peuvent survenir. Dans ce cas, les aides autorisées seront annoncées par les enseignant-e-s avant l'examen.

Cas spécial: examen de répétition oral

Type de l'examen

Examen oral

Durée de l'examen

30 minutes

Aides autorisées

Sans aides

Module Description, available in: EN

Model predictive control

General Information

Number of ECTS Credits

3

Module code

TSM_PredContr

Valid for academic year

2026-27

Last modification

2024-10-08

Coordinator of the module

Konrad Stadler (ZHAW, stdl@zhaw.ch)

Explanations regarding the language definitions for each location:

- Instruction is given in the language specified for each location and module execution.
- Documentation is available in the language(s) listed for each location and module execution. If the documentation is in multiple languages, the percentage distributed is indicated (100% = all documentation provided).
- The examination, including both questions and answers, is provided entirely (100%) in the language(s) specified for each location and module execution. The exams are on-site.

	Lausanne			Lugano	Zurich		
Instruction					**X** E 100%		
Documentation					**X** E 100%		
Examination					**X** E 100%		

Module Category

TSM Technical scientific module

Profile Recommendations

This module is recommended for the following profiles:

	Zurich
Profile	MA

Lessons

2 lecture periods and 1 tutorial period per week

Entry level competences

Prerequisites, previous knowledge

- Linear Algebra
- Differential equations
- Basic feedback control and dynamic systems
- Basic programming skills in Matlab or Python or equivalent
- General affinity to mathematics(!)

Brief course description of module objectives and content

Model Predictive Control (MPC) is an optimisation-based approach to control systems and processes. The general mathematical formulation of MPC allows it to be applied to a broad range of systems and considers system constraints intrinsically. The advances in optimisation methods and available computational power have made MPC a valuable alternative to classical control approaches also for fast dynamic systems. Today, MPC applications can be found from the original chemical process control systems to the control of frequency converters with sampling periods down to a few microseconds.
This module focuses on introducing MPC from the theoretical basics to the use of tool kits to support the implementation and generation of working code. As the classical frequency domain control methods are not considered here, this module does not need in-depth knowledge of control systems. A general affinity to mathematics and programming skills are beneficial.

Aims, content, methods

Learning objectives and competencies to be acquired

The student is able to

- formulate an optimisation problem and solve it with appropriate tool kits
- formulate model predictive control problems
- apply MPC concepts to real world systems and generate executable code which runs on their control systems

Module content with weighting of different components

Basic concepts (3W)

- Introduction to state space models in continuous and discrete time
- Introduction to optimisation (linear quadratic programs) using tool kits like YALMIP
- Introduction to optimisation with constraints

Basic MPC (3W)

- Linear MPC problem formulation
- Receding horizon concepts
- Limits of MPC

MPC Extensions and examples (5W)

- Reference tracking
- Error free tracking
- Nonlinear optimisation and MPC with nonlinear models
- Buck converter control (explicit MPC) -- optional
- Energy management (scheduling) -- optional

Real-time implementation(3W)

- From problem to code using tool kits like ACADO

Teaching and learning methods

Lectures with homework assignments which are a mix of theoretical exercises and programming assignments.

Literature

Comprehensive lecture notes are available.

Assessment

Additional performance assessment during the semester

The module does not contain an additional performance assessment during the semester

Basic principle for exams

As a rule, all standard final exams are conducted in written form. For resit exams, lecturers will communicate the exam format (written/oral) together with the exam schedule.

Standard final exam for a module and written resit exam

Kind of exam

Written exam

Duration of exam

120 minutes

Permissible aids

Aids permitted as specified below:

Permissible electronic aids

Personal PC with Matlab/Simulink

Other permissible aids

Open book

Exception: In case of an electronic Moodle exam, adjustments to the permissible aids may occur. Lecturers will announce the final permissible aids prior to the exam session.

Special case: Resit exam as oral exam

Kind of exam

Oral exam

Duration of exam

30 minutes

Permissible aids

Aids permitted as specified below:

Permissible electronic aids

Personal PC with Matlab/Simulink

Other permissible aids

Open book

Module Description, available in: EN

Process integration and pinch analysis

General Information

Number of ECTS Credits

3

Module code

TSM_ProcInt

Valid for academic year

2026-27

Last modification

2021-01-22

Coordinator of the module

Donald Olsen (HSLU, donald.olsen@hslu.ch)

Explanations regarding the language definitions for each location:

- Instruction is given in the language specified for each location and module execution.
- Documentation is available in the language(s) listed for each location and module execution. If the documentation is in multiple languages, the percentage distributed is indicated (100% = all documentation provided).
- The examination, including both questions and answers, is provided entirely (100%) in the language(s) specified for each location and module execution. The exams are on-site.

	Lausanne			Lugano	Zurich		
Instruction					**X** E 100%		
Documentation					**X** E 100%		
Examination					**X** E 100%		

Module Category

TSM Technical scientific module

Profile Recommendations

This module is recommended for the following profiles:

	Zurich
Profile	EnEn

Lessons

2 lecture periods and 1 tutorial period per week

Entry level competences

Prerequisites, previous knowledge

Students should have a keen interest in process engineering and energy engineering issues. Attendance of the module requires prior knowledge of engineering thermodynamics. This includes, in particular:

- the first law (and ideally also the second law) of thermodynamics and its application to flow processes and energy conversion systems such as heat engines, heat pumps or cooling systems
- a good understanding of the concept of enthalpy for pure substances
- the theory of heat transfer: fundamental laws of heat transfer; mean logarithmic temperature difference of co-current and counter-current heat

exchangers, operating characteristics of heat exchangers (NTU-E)
- **the calculation of mass, component and energy balances for common industrial unit operations, processes and energy conversion systems**

Prior knowledge of thermal process engineering and the energy integration of processes is desirable but not absolutely essential for attending the module.

Brief course description of module objectives and content

Against the background of rising energy prices, incentive taxes and ecological requirements, increasing importance is being attached to reducing the energy requirements of industry. The key to higher energy efficiency and cost-efficiency in thermal processes is the energy integration of processes with the aid of pinch analysis. This is characterized by a systematic approach which can be applied to establish the best system design and the optimum energy input from the economic viewpoint. From the results of the analysis, it is possible to derive measures for heat recovery and an improved energy supply in the context of strategic planning.
In this module, students learn the fundamental methods of the energy integration of processes with the aid of pinch analysis. After completing the module, they are in a position to conduct pinch analyses by themselves for "straightforward" industrial processes and to answer the following questions: how large is the energy requirement if an existing plant were to be fully-optimized? Where is the economic optimum for the investment and energy costs? How can this optimum state be achieved? They can then support industrial companies in sustainable development and in the reduction of CO2 emissions, since reducing energy requirements goes hand in hand with increasing profitability.

Aims, content, methods

Learning objectives and competencies to be acquired

The student
- understands the "nature/philosophy" of process design as well as the energy integration of processes and pinch analysis (onion model, targets before design).
- can complete the mass, component and energy balance for industrial processes with several components and phases and masters the fundamental laws of the thermodynamics for ideal two-component systems (e.g. humid air).
- masters the thermodynamically correct assessment of energy conversion systems and the fundamentals of heat transfer with regard to the energy integration of processes and pinch analysis.
- is in a position to determine the energy targets, heat transfer area targets and cost targets of processes (continuous and non-continuous) using the fundamental methods of pinch analysis (problem table algorithm, composite curves, grand composite curve and cost curves, etc.).
- is familiar with and understands the "golden rules" of pinch analysis plus the rules for the design of heat exchanger networks, and is able to apply these for practical cases. He/she can, additionally, optimize heat exchanger networks.
- is able to correctly place utilities such as steam and cooling water systems and also energy conversion systems like heat pumps, combined heat and power generation systems, etc. in a process.
- can also optimize non-continuous processes (e.g. multiple operating cases and batch processes) using indirect heat recovery through the integration of thermal energy storages.
- after completing the module, is in a position to correctly perform the energy modeling of a process and conduct the pinch analysis independently with the aid of software, and to work out measures for increasing efficiency.

Module content with weighting of different components

The module contents are divided up as follows (14 semester weeks):

1. *Introduction*: Energy and Resource Requirements of Industrial Processes, Nature of Process Design and Integration, Mass, Component and Energy Balances
2. *Refresher Energy Conversion Units (ECUs)*: 1st and 2nd Law of Thermodynamics Analysis in Relation to Pinch Analysis, Heat Engines, Heat Pumps (HP), Mechanical and Thermal Vapour Recompression (MVR/TVR), Combined Heat and Power (CHP) Generation Systems, Utility Systems
3. *Heat Transfer and Heat Transfer Equipment*: Overall Heat Transfer Coefficients, Temperature Differences in Heat Exchangers (HEXs), Different Types of HEXs, Operating Characteristics of HEXs (NTU-E Method)
4. *Energy and Cost Targets*: Composite Curves (CC), Heat Recovery Pinch, “Golden Rules” of Pinch Analysis, Energy Targets
5. *Energy and Cost Targets*: Process Economics, HEX Area Targets, Number of HEX Units, Cost Targets, Trade-off Between Annualized Capital and Operating Costs (Supertargeting), Introduction to Process Analysis and Design Tool PinCH
6. *Heat Exchanger Network (HEN) Design*: Design of Minimum Energy Requirement or Maximum Energy Recovery (MER) HEN, The Pinch Design Method, HEN Design Grid, Heuristic HEN Design Rules
7. *Stream Data*: Basic Principles of Data Extraction for Pinch Analysis, Definition of Process Requirements
8. *Optimization of Energy Supply Systems*: Shifted Composite Curves, Grand Composite Curve (GCC), Utility Selection and Placement (Steam Systems, Furnaces, Cooling Water Systems), Problem Table Algorithm
9. *Integration of ECUs*: Integration of Heat Pumps and Refrigeration Systems, MVR, TVR
10. *Integration of ECUs*: Integration of CHP Systems: Internal Combustion Engines, Steam Turbines, Gas Turbines, Reciprocating Engines
11. *Optimization of HEN Design*: Design for Threshold Problems, Design for Multiple Pinches, Network Optimization (relaxed HEN, Loops, Paths)
12. *Multiple Operating Case (MOC) Analysis*: Challenges and Approach for MOC-Problems, Conventional Design Type, Resequence Design Type, Split Grand Composite Curve (Split GCC) and Indirect Heat Recovery (IHR)
13. *Batch Process Analysis*: Time Averaged Models (TAM) and Time Slice Models (TSM), Supertargeting Optimization, Scheduling, Indirect Source and Sink Profile (ISSP)
14. *Batch Process Analysis*: Approach for Batch Process Analysis, Types of Thermal Energy Storage (TES) and Integration

Teaching and learning methods

- Classroom Instruction (2 lecture periods per week)
- Exercises/tutorials (1 period per week)
- Individual study from the course script and papers
- Homework (weekly) with subsequent discussion
- Solving case studies with the PinCH software (see www.pinch.ch)

Literature

A script and additional documents will be made available to students. The following books are recommended for reading:

- Robin Smith: Chemical Process Design and Integration, Wiley, 2007, ISBN 978-0-471-48681-7
- Ian C. Kemp: Pinch Analysis and Process Integration: a User Guide on Process Integration for the efficient Use of Energy, Elsevier Butterworth-Heinemann, 2007, ISBN 978-0-7506-8260-2
- Florian Brunner, Pierre Krummenacher: Einführung in die Prozessintegration mit der Pinch-Methode – Handbuch für die Analyse von kontinuierlichen Prozessen und Batch-Prozessen. Swiss Federal Office of Energy SFOE, 2017 (available from www.pinch.ch)

Assessment

Additional performance assessment during the semester

The module does not contain an additional performance assessment during the semester

Basic principle for exams

As a rule, all standard final exams are conducted in written form. For resit exams, lecturers will communicate the exam format (written/oral) together with the exam schedule.

Standard final exam for a module and written resit exam

Kind of exam

Written exam

Duration of exam

120 minutes

Permissible aids

Aids permitted as specified below:

Permissible electronic aids

Theory Part: None

Application Part: Calculator

Other permissible aids

Theory Part: None

Application Part: Hardcopy form: Lecture Material, script (including personal notes)

Exception: In case of an electronic Moodle exam, adjustments to the permissible aids may occur. Lecturers will announce the final permissible aids prior to the exam session.

Special case: Resit exam as oral exam

Kind of exam

Oral exam

Duration of exam

30 minutes

Permissible aids

No aids permitted

Module Description, available in: EN

Product Innovation and Product Lifecycle Management

General Information

Number of ECTS Credits

3

Module code

TSM_Product

Valid for academic year

2026-27

Last modification

2021-01-03

Coordinator of the module

Felix Nyffenegger (OST, felix.nyffenegger@ost.ch)

Explanations regarding the language definitions for each location:

- Instruction is given in the language specified for each location and module execution.
- Documentation is available in the language(s) listed for each location and module execution. If the documentation is in multiple languages, the percentage distributed is indicated (100% = all documentation provided).
- The examination, including both questions and answers, is provided entirely (100%) in the language(s) specified for each location and module execution. The exams are on-site.

	Lausanne			Lugano	Zurich		
Instruction					**X** E 100%		
Documentation					**X** E 100%		
Examination					**X** E 100%		

Module Category

TSM Technical scientific module

Profile Recommendations

This module is recommended for the following profiles:

	Zurich
Profile	BE

Lessons

2 lecture periods and 1 tutorial period per week

Entry level competences

Prerequisites, previous knowledge

To attend this module, students must have a Bachelor's degree in Engineering (mechanical, electrical, industrial, ...)

Students should have the following experience:

- know the purpose and content of project specifications and requirements with respect to user needs,
- know the evaluation methods (value benefit analysis, SWOT analysis, etc.)
- know the basic steps of a product development process (in the consumption and/or investment goods sectors)

- have experience in the application of CAD system (mechanical or electrical)
- have worked in a team on at least one small development project

Brief course description of module objectives and content

Students become acquainted with the product innovation process and its strategic importance for enterprises. The will learn different processes, methods and tools to develop new products and further optimize them along its full lifecycle. A special focus is on the development of complex systems, an interdisciplinary environment. Current approaches and new tools are discussed in addition to established processes such as Systems-Engineering or VDI2206. To further explain the impact of product development outcome on an enterprise level, course will focus on the information flow across an industrial enterprise. Both, the process level (engineering, sales, manufacturing, purchasing, service) as well as the data level (CAX, PLM, ERP, IoT)

The module will be accompanied by a product development project, where students apply the theory "hands-on" on a realistic example throughout the semester

Aims, content, methods

Learning objectives and competencies to be acquired

Students

- know the importance of innovation for enterprises,
- understand the integration of technological product innovation and product development in business processes within enterprises,
- possess an in-depth knowledge of the product innovation process (processes, methods, and tools),
- can correctly apply methods and tools in the innovation process according to the situation,
- know the importance of PLM in enterprises,
- possess an in-depth knowledge of the product conception process,
- possess an in-depth knowledge concerning product structure and product variants (serial and plant production) and can apply these in concrete examples,
- know the relationship between the most important data generation systems and management systems of technological product data,
- know the impact of design decisions and design data for all subsequent processes in an enterprise

Module content with weighting of different components

The module comprises the two main subject areas: “Development methods and product innovation” and “Product lifecycle management”.

- Product innovation process
- Classical methods such as VDI 2221, 2222, 2206
- Systems Engineering (cross disciplinary approaches)
- Creativity methods
- Alternative product development processes
- Tools for product development and lifeycle management (CAx, PLM, ERP, IoT)
- Product lifecycle management
- Product structure management: Variant management, product configuration, material master data, product description data
- Release processes and change management

Teaching and learning methods

- Theoretical instructions in classroom
- Theoretical instructions based on guided self-teaching
- Project-oriented work in the form of group work in present and as self-study hours (students will be assisted through)
- Presentation and discussion in peer and expert groups

Literature

Development methods and product innovation

- **German**: Pahl, G.; Beitz, W.; Feldhusen, J.; Grote, K.-H.: „Pahl/Beitz. Konstruktionslehre. Grundlagen erfolgreicher Produktentwicklung. Methoden und Anwendung“. Berlin: Springer-Verlag. 2007. – ISBN-10 3-540-34060-2, ISBN-13 978-3-540-34060-7
- **French**: Tassinari Robert, Pratique de l’analyse fonctionnelle, L’Usine Nouvelle, France, 2003, ISBN : 2-10-005338-8
- **English**: Pahl, G., Beitz, W., Feldhusen, J., Grote, K.-H.: Engineering Design, A Systematic Approach, 3rd ed., 2007, XXI, 617 p., Hardcover, ISBN 978-1-84628-318-5
- **English**: Ulrich, T. U., Eppinger, S.D., Product Design and Development, 3rd ed., 366p, Hardcover, ISBN 007-123273-7

Product Lifecycle Management

- **German**: Eigner Martin / Stelzer Ralph: Produktdatenmanagement-Systeme, Springer, ISBN-10: 3-540-66870-5
- **French**: Debaecker Denis: PLM : La gestion collaborative du cycle de vie des produits, Hermes, France, 2004, ISBN : 2-7462-0884-9
- **English**: Stark John, Product Lifecycle Management : 21st century paradigm for product realisation, Springer, London, 2005
- **English**: Saaksvuori Antti / Immonen Anselmie, Product Lifecycle Management, Springer, ISBN-10: 3-540-25731-4

Assessment

Additional performance assessment during the semester

The module contains additional performance assessment(s) during the semester. The achieved mark of the additional performance assessment(s) applies to both the regular and the resit exam.

Description of additional performance assessment during the semester

1/3 Project work

2/3 Written exam

Basic principle for exams

As a rule, all standard final exams are conducted in written form. For resit exams, lecturers will communicate the exam format (written/oral) together with the exam schedule.

Standard final exam for a module and written resit exam

Kind of exam

Written exam

Duration of exam

120 minutes

Permissible aids

Aids permitted as specified below:

Permissible electronic aids

Open Book,
Devices must be in offline mode.

Other permissible aids

Any auxiliary materials or other documents required for the examination will be provided only by the lecturers.
Exception: In case of an electronic Moodle exam, adjustments to the permissible aids may occur. Lecturers will announce the final permissible aids prior to the exam session.

Special case: Resit exam as oral exam

Kind of exam

Oral exam

Duration of exam

30 minutes

Permissible aids

Aids permitted as specified below:

Permissible electronic aids

Open Book,
Devices must be in offline mode.

Other permissible aids

Any auxiliary materials or other documents required for the examination will be provided only by the lecturers.

Module Description, available in: EN

Parallel and distributed computing

General Information

Number of ECTS Credits

3

Module code

TSM_ProgAlg

Valid for academic year

2026-27

Last modification

2024-09-27

Coordinator of the module

Christoph Stamm (FHNW, christoph.stamm@fhnw.ch)

Explanations regarding the language definitions for each location:

- Instruction is given in the language specified for each location and module execution.
- Documentation is available in the language(s) listed for each location and module execution. If the documentation is in multiple languages, the percentage distributed is indicated (100% = all documentation provided).
- The examination, including both questions and answers, is provided entirely (100%) in the language(s) specified for each location and module execution. The exams are on-site.

	Lausanne			Lugano	Zurich		
Instruction					**X** E 100%		
Documentation					**X** E 100%		
Examination					**X** E 100%		

Module Category

TSM Technical scientific module

Profile Recommendations

This module is recommended for the following profiles:

	Zurich
Profile	CS

Lessons

2 lecture periods and 1 tutorial period per week

Entry level competences

Prerequisites, previous knowledge

- Procedural programming (C/C++ knowledge is helpful)
- Algorithms and data structures
- Basic notion of complexity analysis and big-O notation
- Basic notions of concurrent programming (Threads)

Brief course description of module objectives and content

The objective of this module is to provide the student with an introduction to parallel computing and algorithms. Students learn to parallelize systems at three different levels: Shared memory systems, distributed memory systems, and heterogeneous shared memory systems. For all three systems, which can be part of a high-performance cluster, students learn the necessary parallelization techniques and a few classical parallel algorithms.

This course includes hands-on work to train students in the application of parallel programming techniques and the programming and analysis of parallel algorithms.

Aims, content, methods

Learning objectives and competencies to be acquired

By the end of the course, students will know:

- the most common heterogeneous parallel hardware infrastructures
- different ways to model and efficiently program these architectures
- how to assess the performance of parallel algorithms
- how to efficiently implement parallel algorithms
- how to choose the right parallel algorithm to solve a specific problem on a specific parallel architecture

Module content with weighting of different components

Introduction (30%)

- Motivation and high-performance cluster model
- Basic concepts in parallel programming in C++
- Asymptotic analysis of parallel programs
- Performance metrics for parallel systems
- Decomposition and mapping techniques for load balancing
- Scalability of parallel systems

Shared memory systems (20%)

- Architectures of widely used multi-core systems
- Cache coherence in multiprocessor systems
- Parallel programming models (OpenMP)
- Parallel algorithms (numerical, sorting, graphs)

Distributed memory systems (30%)

- Architectures of distributed memory systems
- Communications models and communication costs
- Message passing paradigm (MPI)
- Collective operations and their costs
- Distributed algorithms (numerical, sorting)

Heterogeneous shared memory systems (20%)

- GPU architectures
- SIMD programming models (vectorization, SYCL)
- Matrix-vector and matrix-matrix multiplication
- GPU algorithms (numerical, image processing)

Teaching and learning methods

The most important basics are taught in theory lessons in face-to-face classes. In between, students work on the practical exercises at home and exchange information via online channels.

Literature

A. Introduction to Parallel Computing, Trobec, R. et al., Springer, 2018
B. SYCL. Data Parallel C++, Reinders, J., Ashbaugh, B., et al., Apress, 2nd Edt., 2023.

Assessment

Additional performance assessment during the semester

The module does not contain an additional performance assessment during the semester

Basic principle for exams

As a rule, all standard final exams are conducted in written form. For resit exams, lecturers will communicate the exam format (written/oral) together with the exam schedule.

Standard final exam for a module and written resit exam

Kind of exam

Written exam

Duration of exam

120 minutes

Permissible aids

Aids permitted as specified below:

Permissible electronic aids

No electronic aids permitted

Other permissible aids

A handwritten summary of a fixed number of pages given by the lecturer.
Exception: In case of an electronic Moodle exam, adjustments to the permissible aids may occur. Lecturers will announce the final permissible aids prior to the exam session.

Special case: Resit exam as oral exam

Kind of exam

Oral exam

Duration of exam

30 minutes

Permissible aids

No aids permitted

Module Description, available in: EN

Quality Control

General Information

Number of ECTS Credits

3

Module code

TSM_QCheck

Valid for academic year

2026-27

Last modification

2022-01-05

Coordinator of the module

Yuri Lopez De Meneses (HES-SO, yuri.lopezdemeneses@he-arc.ch)

Explanations regarding the language definitions for each location:

- Instruction is given in the language specified for each location and module execution.
- Documentation is available in the language(s) listed for each location and module execution. If the documentation is in multiple languages, the percentage distributed is indicated (100% = all documentation provided).
- The examination, including both questions and answers, is provided entirely (100%) in the language(s) specified for each location and module execution. The exams are on-site.

	Lausanne			Lugano	Zurich		
Instruction	**X** E 100%						
Documentation	**X** E 100%						
Examination	**X** E 100%	**X** F 100%					

Module Category

TSM Technical scientific module

Profile Recommendations

This module is recommended for the following profiles:

	Lausanne
Profile	Mic

Lessons

2 lecture periods and 1 tutorial period per week

Entry level competences

Prerequisites, previous knowledge

Prior to joining the module, the students should be familiar with the basics of statistics (variance, standard deviation, probability density). The student should also understand the concepts of measurement uncertainty, repeatability and reproducibility. Knowledge of design/mechanical drawing reading/tolerancing

Brief course description of module objectives and content

Introduction:

- Introduction to Quality Control
- Statistics refresher: Probability distributions, sampling distributions, inference
- Overview of the most commonly used problem-solving tools: histogram, plots, Pareto chart

Problem-solving methodology:

- Quality management approaches: QRQC, A3, 8D, DMAIC, etc.
- Statistical analysis: t-tests, confidence intervals

Introduction to Statistical Process Control :

- Customer and supplier risk
- Acceptable Quality Level
- Acceptance Sampling plans
- Control charts: variable, attribute, multivariate
- Analysis of Variance (ANOVA)
- Process and Measurement System Capabilities
- Gage repeatability and reproducibility, GR&R studies

Design of experiments:

- Process optimization with designed experiments
- Factorial and fractional experimental designs
- Surface response methodology

Aims, content, methods

Learning objectives and competencies to be acquired

At the end of the module, the students should

- Understand the quality management approach
- Understand the functioning and apply the principles of statistical process control
- Be able to estimate the capability of a measuring device for the quality control
- Be able to make a conformity decision
- Be able to evaluate the resulting customer/supplier risks
- Be able to set up a sampling plan for a given Acceptable Quality Level
- Know the most commonly used SPC methods and understand their main limitations.
- Understand the different methods for problem solving
- Be able to setup and analyze a designed experiment for process improvement.
- Understand the main quality wordings.

Module content with weighting of different components

- Introduction to quality management: 10%
- Problem solving methodology: 20%
- Introduction to Statistical Process Control: 20%
- Incoming quality control: 10%
- Metrologic performance and measurement capability: 10%
- Design of Experiments: 20%
- Examples and case studies: 10%

Teaching and learning methods

- Lectures
- Exercises
- Case studies

- Self-study of SPC methodologies

Literature

D. Montgomery, "Introduction to Statistical Quality Control", 8th ed., Wiley & Sons (2020)
D. Montgomery, "Design and Analysis of Experiments", 10th ed., Wiley & Sons (2019)
Quality Trainer, http://qualitytrainer.minitab.com, Minitab
E.L. Cano, J.M. Moguerza and A. Redchuk. "Six Sigma with R. Statistical Engineering for Process Improvement", UseR ! series. Springer, (2012)

M. Pillet, « Six Sigma: Comment l'appliquer » , Ed. Eyrolles (2013)

Assessment

Additional performance assessment during the semester

The module contains additional performance assessment(s) during the semester. The achieved mark of the additional performance assessment(s) applies to both the regular and the resit exam.

Description of additional performance assessment during the semester

Evaluation mode: 33% exercises during the semester, 67% written examination

Basic principle for exams

As a rule, all standard final exams are conducted in written form. For resit exams, lecturers will communicate the exam format (written/oral) together with the exam schedule.

Standard final exam for a module and written resit exam

Kind of exam

Written exam

Duration of exam

120 minutes

Permissible aids

Aids permitted as specified below:

Permissible electronic aids

- Calculator (without telecommunication functionality)
- Open book

Other permissible aids

Pocket language dictionary for non-native English or French speakers

Exception: In case of an electronic Moodle exam, adjustments to the permissible aids may occur. Lecturers will announce the final permissible aids prior to the exam session.

Special case: Resit exam as oral exam

Kind of exam

Oral exam

Duration of exam

30 minutes

Permissible aids

Aids permitted as specified below:

Permissible electronic aids

- Calculator (without telecommunication functionality)
- Open Book

Other permissible aids

Pocket language dictionary for non-native English or French speakers

Module Description, available in: EN

Quantitative Methods in Industrial Operations Management

General Information

Number of ECTS Credits

3

Module code

TSM_QInOpMgmt

Valid for academic year

2026-27

Last modification

2018-11-06

Coordinator of the module

Stephan Bütikofer (ZHAW, buts@zhaw.ch)

Explanations regarding the language definitions for each location:

- Instruction is given in the language specified for each location and module execution.
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- The examination, including both questions and answers, is provided entirely (100%) in the language(s) specified for each location and module execution. The exams are on-site.

	Lausanne			Lugano	Zurich		
Instruction					**X** E 100%		
Documentation					**X** E 100%		
Examination					**X** E 100%		

Module Category

TSM Technical scientific module

Profile Recommendations

This module is recommended for the following profiles:

	Zurich
Profile	BE

Lessons

2 lecture periods and 1 tutorial period per week

Entry level competences

Prerequisites, previous knowledge

Linear Algebra:

- Solving systems of linear equations with Gaussian elimination
- Vector and matrix calculus

Analysis:

- Differential calculus of one variable

Statistics:
- Fundamentals of probability theory
- discrete and continuous density functions

Brief course description of module objectives and content

Operations management is concerned with the design, operation and optimization of the value-adding areas of a company. At the strategic level it includes in particular the design of infrastructure and resources, the dimensioning of capacity and the definition of business processes. At an operational level, it includes ongoing planning and control of operational activities. The aim is to achieve high business performance through clever organization and efficient use of resources.
In a first part an overview of the classical themes of Operations Management is given. In a second part selected methods of quantitative Operations Management (see Operations Research) are applied to tasks of important areas (see. contents below) of Operations Management. These tasks will be analyzed and optimized with the help of mathematical models.

Aims, content, methods

Learning objectives and competencies to be acquired

- The students have an overview of the various areas of Operations Management.
- The students can classify operational issues in the tasks of the Operations Management (i.e. design or operations).
- The students know selected quantitative methods and models of Operations Management.
- The students can make use of the learned methods and are aware of the assumptions and restrictions of these.
- The students can formulate practical questions from Operations Management as mathematical models.

Module content with weighting of different components

Part 1 (2 weeks):
- Overview of the areas of Operations Management (design and operations)
- Focus on operations
  - Overview production planning and control
  - Aggregate planning: Sales & operations planning and master production scheduling

Part 2: From the areas below selected methods of quantitative Operations Management are taught.
- Capacity planning and lead times (1 week)
- MRP concepts, mathematical foundation of MRP planning calculations (2 weeks)
- Lotsizing and inventory control (3-4 weeks)
- Scheduling (5-6 Wochen)

Teaching and learning methods

Lecture with exercises

Literature

Will be announced at the beginning of the semester

Assessment

Additional performance assessment during the semester

The module does not contain an additional performance assessment during the semester

Basic principle for exams

As a rule, all standard final exams are conducted in written form. For resit exams, lecturers will communicate the exam format (written/oral) together with the exam schedule.

Standard final exam for a module and written resit exam

Kind of exam

Written exam

Duration of exam

120 minutes

Permissible aids

Aids permitted as specified below:

Permissible electronic aids

A hand calculator is permitted. No laptop!

Other permissible aids

All the material of the course is permitted. Open book exam.

Exception: In case of an electronic Moodle exam, adjustments to the permissible aids may occur. Lecturers will announce the final

permissible aids prior to the exam session.

Special case: Resit exam as oral exam

Kind of exam

Oral exam

Duration of exam

30 minutes

Permissible aids

Aids permitted as specified below:

Permissible electronic aids

A hand calculator is permitted. No laptop!

Other permissible aids

All the material of the course is permitted. Open book exam.

Modulbeschreibung, verfügbar in: DE

Regionalentwicklung, Regionalökonomie und Politik

Allgemeine Angaben

Anzahl ECTS-Credits

3

Modulkürzel

TSM_RegDev

Gültig für akademisches Jahr

2026-27

Letzte Änderung

2024-10-08

Modul-Koordinator/in

Stefan Lüthi (HSLU, stefan.luethi@hslu.ch)

Erläuterungen zu den Sprachdefinitionen je Standort:

- Der Unterricht findet in der pro Standort und Durchführung definierten Sprache statt.
- Die Unterlagen sind in den pro Standort und Durchführung definierten Sprachen verfügbar. Bei Mehrsprachigkeit ist die prozentuale Verteilung angegeben (100% = komplette Unterlagen).
- Die Prüfungsfragen und -antworten sind in jeder pro Standort und Durchführung definierten Sprache. Die Prüfung wird vor Ort durchgeführt.

	Lausanne			Lugano	Zurich		
Unterricht						**X** D 100%	
Dokumentation						**X** D 100%	
Prüfung						**X** D 100%	

Modulkategorie

TSM Technisch-wissenschaftliche Vertiefung

Profilempfehlungen

Dieses Modul wird für die folgenden Profile empfohlen:

	Zurich
Profil	ReLa

Lektionen

2 Lektionen und 1 Übungslektion pro Woche

Eintrittskompetenzen

Vorkenntnisse, Eingangskompetenzen

Die Kursteile zur Regionalentwicklung und Regionalpolitik beziehen sich auf das politische Umfeld der Schweiz. Es ist deshalb erforderlich, die Strukturen und Abläufe des politischen Systems Schweiz zu kennen.

Kurzbeschreibung der Inhalte und Ziele

Lernziel des Moduls ist, dass die Studierenden die Argumentationen, Strukturen und Instrumente kennen, mit welchen auf Ebene unterschiedlicher Gebietskörperschaften Entwicklungsstrategien erarbeitet und umgesetzt werden. Raumplanung und weitere konzeptionelle und planerische Arbeiten sind in dieses Umfeld eingebettet. Deren Dynamiken resp. die Handlungsweise der beteiligten Akteure lassen sich aus diesem Umfeld heraus verstehen und werden damit – aus Sicht der Planung gesprochen – kalkulierbar. Nach Abschluss des Moduls sollen die Studierenden in der Lage sein, Fragestellungen ihrer spezifischen Studien- und Berufsrichtung auf zielführende Weise in den Kontext von Regionalentwicklung und Regionalpolitik einzubetten.

Ziele, Inhalte, Methoden

Lernziele und zu erwerbende Kompetenzen

Übergeordnetes Lernziel: Die Studierenden sind in der Lage, auf Basis regionalwissenschaftlicher Analysen und Theorien ein Managementkonzept für eine Region zu entwickeln.

Modulinhalt mit Gewichtung der Lehrinhalte

Dem Modul liegt eine funktionalräumliche Sichtweise zugrunde. Städtische und ländliche Räume stehen sowohl unter- als auch zwischen einander in funktionalen Beziehungen. Durch diese Verflechtungen ergeben sich je nach Region unterschiedliche Potentiale, Herausforderungen und Entwicklungsmöglichkeiten. Im Kurs werden zentrale Themen und Herausforderungen vorgestellt und diskutiert, die sich aus den aktuellen funktionalräumlichen Verflechtungen ergeben. Weiter wird aufgezeigt, mit welchen Instrumenten in der Schweiz ein Interessens- und Disparitäten-Ausgleich stattfindet. Der Kurs widmet sich auch regionalökonomischen Fragestellungen. Entwicklung schliesst weit mehr ein als ökonomische Entwicklung. Gleichwohl werden die ökonomischen Argumente in der (politischen) Diskussion um Regionalentwicklung stark gewichtet, woraus sich die Notwendigkeit ergibt, die diesen Argumentationen zu Grunde liegenden Modelle und Theorien zu kennen. Schliesslich beschäftigt sich der Kurs auch mit der Frage der politischen Steuerung auf regionaler Ebene, wobei dem „Raumkonzept Schweiz“ besondere Beachtung geschenkt werden.

Lehr- und Lernmethoden

Vorwiegend Lehrgespräche und Aufarbeitung / Diskussion aktueller Beispiele im Unterricht / Entwicklung eigener regionaler Strategien.

Bibliografie

Unterlagen werden im Unterricht abgegeben resp. auf moodle gestellt.

Bewertung

Zusätzliche Leistungsbewertung während des Semesters

Das Modul beinhaltet keine zusätzliche Leistungsbewertung während des Semesters.

Grundsatz Prüfungen

Grundsätzlich werden alle regulären Abschlussprüfungen in schriftlicher Form durchgeführt. Bei den Wiederholungsprüfungen teilen die Dozierenden das Prüfungsformat (schriftlich/mündlich) zusammen mit dem Prüfungsplan mit.

Reguläre Modulschlussprüfung und schriftliche Wiederholungsprüfung

Art der Prüfung

Schriftliche Prüfung

Prüfungsdauer

120 Minuten

Erlaubte Hilfsmittel

Ohne Hilfsmittel

Ausnahme: Im Falle einer elektronischen Moodle-Prüfung können Änderungen der Hilfsmittel vorkommen. Dozierende werden die endgültig zulässigen Hilfsmittel vor der Prüfung bekanntgeben.

Spezialfall: Wiederholungsprüfung als mündliches Examen

Art der Prüfung

Mündliche Prüfung

Prüfungsdauer

30 Minuten

Erlaubte Hilfsmittel

Ohne Hilfsmittel

Module Description, available in: EN

Engineering of safety critical systems

General Information

Number of ECTS Credits

3

Module code

TSM_SafeSys

Valid for academic year

2026-27

Last modification

2019-08-31

Coordinator of the module

Pierluigi Capone (ZHAW, capo@zhaw.ch)

Explanations regarding the language definitions for each location:

- Instruction is given in the language specified for each location and module execution.
- Documentation is available in the language(s) listed for each location and module execution. If the documentation is in multiple languages, the percentage distributed is indicated (100% = all documentation provided).
- The examination, including both questions and answers, is provided entirely (100%) in the language(s) specified for each location and module execution. The exams are on-site.

	Winterthur			
Instruction	**X** E 100%			
Documentation	**X** E 100%			
Examination	**X** E 100%			

Module Category

TSM Technical scientific module

Profile Recommendations

This module is recommended for the following profiles:

	Zurich
Profile	Avi

Lessons

2 lecture periods and 1 tutorial period per week

Entry level competences

Prerequisites, previous knowledge

The students are expcted to have basic knowledge of aircraft engineering such as:

- Aerodynamics
- Aircaft Structures
- Understanding of Aircraft Systems
- Understanding of Aircraft Propulsion
- Basic concepts of Maintenance

- Safety:
    - System Safety
    - Safety Process

Brief course description of module objectives and content

Safety-critical systems are those systems whose failure could result in loss of life. An aircraft such as an airliner has more than one safety critical systems.

The engineering activities required to design and manage these complex systems over their life cycles require a deep understanding of several disciplines and a systematic approach to problems such as:

- Requirements engineering
- Requirement based testing
- Validation and verification of complex function
- Managing human factors and teams

In this module the students will have an overview of Safety Critical Systems and related engineering activities and how these actitivties must be planned and executed in order to lead to successful certification and continued airworthiness.

Aims, content, methods

Learning objectives and competencies to be acquired

Understand core engineering and human-centered disciplines necessary to successful design, development and continued airworthiness of Safety Critical Systems (SCS).

The student are expected to acquire the following competencies:

- Understanding of safety critical system
- Be able to apply system engineering principles
- Understanding of system components qualification
- Understanding of aircraft certification process
- Logic of human behaviour

Module content with weighting of different components

Syllabus:

1. Introduction to Safety Critical Systems (SCS): General Concepts, Examples of SCS
2. Review of System Engineering Principles
3. Requirements: Writing, Verification and Validation, Testing
4. Safety Process: SAE-ARP-4761
5. Development Assurance Level: SAE-ARP-4754A
6. Unmanned Aircraft: Concept of Operations, Holistic Approach/SORA, Integration with Manned Aviation
7. Robustness, Redundancy, Dissimilarity and Integrity
8. Modeling and Simulation: Introduction
9. Modeling and Simulation of SCS
10. Testing of SCS
11. Human Reliability
12. Personality Motivation / Interpersonal Skills
13. Stress & Resilience
14. Safety Culture & Team Performance

Teaching and learning methods

- All lectures are strictly connected to current aviation practice and, where feasible, practical examples will be provided
- Real world examples with lessons learned will be provided for self study

Literature

- SAE-ARP-4754B - *Guidelines For Development Of Civil Aircraft and Systems*
- Aircraft Design - A Systems Engineering Approach M. H. Sadraey, Wiley Aerospace Engineering
- SAE-ARP4761A - Guidelines And Methods For Conducting The Safety Assessment Process On Civil Airborne Systems And Equipment
- DO-178C, Software Considerations in Airborne Systems and Equipment Certification

Assessment

Additional performance assessment during the semester

The module does not contain an additional performance assessment during the semester

Basic principle for exams

As a rule, all standard final exams are conducted in written form. For resit exams, lecturers will communicate the exam format (written/oral) together with the exam schedule.

Standard final exam for a module and written resit exam

Kind of exam

Written exam

Duration of exam

120 minutes

Permissible aids

Aids permitted as specified below:

Permissible electronic aids

- A non programmable calculator

Other permissible aids

- Closed Book
- Formulary will be distributed

Exception: In case of an electronic Moodle exam, adjustments to the permissible aids may occur. Lecturers will announce the final permissible aids prior to the exam session.

Special case: Resit exam as oral exam

Kind of exam

Oral exam

Duration of exam

30 minutes

Permissible aids

No aids permitted

Module Description, available in: EN

Security of Industrial Operational Technology

General Information

Number of ECTS Credits

3

Module code

TSM_SecIndOpT

Valid for academic year

2026-27

Last modification

2023-07-25

Coordinator of the module

Luca Haab (HES-SO, luca.haab@hefr.ch)

Explanations regarding the language definitions for each location:

- Instruction is given in the language specified for each location and module execution.
- Documentation is available in the language(s) listed for each location and module execution. If the documentation is in multiple languages, the percentage distributed is indicated (100% = all documentation provided).
- The examination, including both questions and answers, is provided entirely (100%) in the language(s) specified for each location and module execution. The exams are on-site.

	Lausanne			Lugano	Zurich		
Instruction					**X** E 100%		
Documentation					**X** E 100%		
Examination					**X** E 100%		

Module Category

TSM Technical scientific module

Profile Recommendations

This module is recommended for the following profiles:

	Zurich
Profile	ICS

Lessons

2 lecture periods and 1 tutorial period per week

Entry level competences

Prerequisites, previous knowledge

Students should have a basic understanding of computer networks and security concepts. It is recommended that students have completed introductory courses in computer networking and security before taking this module.

Pre-reading material required for specific labs may be provided.

Brief course description of module objectives and content

This module provides an understanding of the fundamental principles of the security of Operational Technology (OT) in an industrial context. The module will cover the standards, key concepts and methodologies involved in securing OT systems commonly used in industrial environments, such as factories, power plants, and other critical infrastructure.

The module will begin by exploring particularities of OT systems and the unique security challenges associated with OT environments. Different aspects of OT systems and their implication for security are studied, such as network technology and network architecture. Challenges related to product lifecycle and key management as well as existing solutions to those problems are explored. A specific focus is put on the implementation of standard IEC 62443.

Aims, content, methods

Learning objectives and competencies to be acquired

Upon completion of the module, students should be able to

- Understand the unique security challenges associated with OT environments
- Comprehend the main cybersecurity standards related to OT environments
- Identify and assess the risks and threats associated with OT systems
- Understand which security measures are suitable to protect OT systems and how to respond to incidents

Module content with weighting of different components

The module will address the following topics:

- An introduction to the particularities of OT systems in comparison to IT systems and Sensor Technology
- Securing OT-relevant aspects of SCADA, DCS & ICS
- Communication technology relevant to OT environment as well as the implications of air-gapped and connected systems
- Threat models for OT systems
- Product lifecycle, in particular issues related to key generation and key management
- Incident Response in an OT context
- The application of Standard IEC 62443, in particular weakness analysis, post-incidence analysis and auditing

Teaching and learning methods

In addition to lectures, the module is completed by exercises on simulated OT environments corresponding to industry standards. The exercises will apply the content from the lectures to specific situations inspired by the challenges of real world environments.

Literature

Assessment

Additional performance assessment during the semester

The module does not contain an additional performance assessment during the semester

Basic principle for exams

As a rule, all standard final exams are conducted in written form. For resit exams, lecturers will communicate the exam format (written/oral) together with the exam schedule.

Standard final exam for a module and written resit exam

Kind of exam

Written exam

Duration of exam

120 minutes

Permissible aids

Aids permitted as specified below:

Permissible electronic aids

None

Other permissible aids

A written summary, up to 4 double-sided A4 pages long, can be utilized during the exam. It can be handwritten or digital, though the font used must be size 9 or larger. The summary is to be handed in at the end of the exam.

Exception: In case of an electronic Moodle exam, adjustments to the permissible aids may occur. Lecturers will announce the final

permissible aids prior to the exam session.

Special case: Resit exam as oral exam

Kind of exam

Oral exam

Duration of exam

30 minutes

Permissible aids

No aids permitted

Module Description, available in: EN

Servitization of Manufacturing

General Information

Number of ECTS Credits

3

Module code

TSM_ServMan

Valid for academic year

2026-27

Last modification

2024-09-24

Coordinator of the module

Shaun West (HSLU, shaun.west@hslu.ch)

Explanations regarding the language definitions for each location:

- Instruction is given in the language specified for each location and module execution.
- Documentation is available in the language(s) listed for each location and module execution. If the documentation is in multiple languages, the percentage distributed is indicated (100% = all documentation provided).
- The examination, including both questions and answers, is provided entirely (100%) in the language(s) specified for each location and module execution. The exams are on-site.

	Lausanne			Lugano	Zurich		
Instruction					**X** E 100%		
Documentation					**X** E 100%		
Examination					**X** E 100%		

Module Category

TSM Technical scientific module

Profile Recommendations

This module is recommended for the following profiles:

	Zurich
Profile	BE

Lessons

2 lecture periods and 1 tutorial period per week

Entry level competences

Prerequisites, previous knowledge

Please read the following books before joining the class:
Chrisitan Kowalkowski & Wolfgang Ulaga. Service Strategy in Action: A Practical Guide for Growing Your B2B Service and Solution Business. March 2017. ISBN: 9780692819104.
http://servicestrategyinaction.com

Editors: **Kohtamäki**, M., **Baines**, T., **Rabetino**, R., **Bigdeli**, A.Z. (Eds.). (2018). Practices and Tools for Servitization -Managing Service Transition. Palgrave.

https://www.palgrave.com/us/book/9783319765167

Brief course description of module objectives and content

This module will help students to understand how a manufacturer changes its business model to provide a holistic solution to the customer, helping the customer to improve its competitiveness, rather than just engaging the sale of product. Much of the course is based around the transition from pure products to provide product service systems in basic and advanced forms.

Aims, content, methods

Learning objectives and competencies to be acquired

- To gain an appreciation of the role of servitization in the competitive landscape
- To create innovative value propositions by designing new service offerings and by drawing the customer journey
- To design an integrated ecosystem for services and products
- To understand the move towards a service mind-set
- To develop price strategies for services
- To manage the core processes for successful service delivery
- To manage risks and business benchmarking to identify improvement areas

Module content with weighting of different components

Lecture 1 Part 1 Introduction to the services for product firms

Based on chapter 1 of the book "Modern Industrial Services".

- Why services are important for a product firm
- Product service systems and servitization
- The journey to services
- Learning to understand complex systems
- Seven barriers stopping firms from moving to services

Lectures 2-9 Part 2 - Service delivery for value capture, Shaun West

Based on Chapter 2 of the book "Modern Industrial services".

- Customers
- Organizational structure and culture
- Knowledge and information
- Products and activities
- Competitors, suppliers and partners
- Economics and finance
- Society and the environment.
- Building your own servitization roadmap (Ch3)

Lectures 9-14 Part 3 - Service design for value creation

- Customer value proposition in services
- Customer ecosystems and market segmentation
- Customer journey mapping and blueprinting
- Service selling and pricing
- Modularity in services
- Customer business processes
- Integration of IoT into customer value propositions

Teaching and learning methods

- Lectures, book and videos
- Group work, presentation and discussion of case studies
- Self-study of papers and analysis of business case studies

Note: individual and group work will contribute 30% to the final exam grade.

Literature

- West S., Gaiardelli, P., & Saccani, N. (2022). Managing Industrial Services: A Cookbook for Design and Delivery. Springer. Cham.

https://link.springer.com/book/10.1007/978-3-030-80511-1
- Annarelli, A., Battistella, C., & Nonino, F. (2019). The Road to Servitization. https://doi.org/10.1007/978-3-030-12251-5
- Timothy Baines, Howard Lightfoot. Made to Serve: How Manufacturers can Compete Through Servitization and Product Service Systems. April 2013. ISBN: 978-1-118-58531-3 http://www.aston-servitization.com/news/details/19/made-to-serve-how-manufacturers-can-compete-through-servitization
- Thomas Fischer, Heiko Gebauer, Elgar Fleisch Service Business Development: Strategies for Value Creation in Manufacturing Firms. March 2014. ISBN: 9781107652071 http://www.cambridge.org/ch/academic/subjects/management/strategic-management/service-business-development-strategies-value-creation-manufacturing-firms.
- Chrisitan Kowalkowski & Wolfgang Ulaga. Service Strategy in Action: A Practical Guide for Growing Your B2B Service and Solution Business. March 2017. ISBN: 9780692819104. http://servicestrategyinaction.com

Assessment

Additional performance assessment during the semester

The module contains additional performance assessment(s) during the semester. The achieved mark of the additional performance assessment(s) applies to both the regular and the resit exam.

Description of additional performance assessment during the semester

Individual and group work will contribute 30% to the final exam grade.

Basic principle for exams

As a rule, all standard final exams are conducted in written form. For resit exams, lecturers will communicate the exam format (written/oral) together with the exam schedule.

Standard final exam for a module and written resit exam

Kind of exam

Written exam

Duration of exam

120 minutes

Permissible aids

Aids permitted as specified below:

Permissible electronic aids

Open book exam

- Calculator
- Class notes
- Dictionary
- Case study provided for the exam

Other permissible aids

No other aids permitted

Exception: In case of an electronic Moodle exam, adjustments to the permissible aids may occur. Lecturers will announce the final permissible aids prior to the exam session.

Special case: Resit exam as oral exam

Kind of exam

Oral exam

Duration of exam

30 minutes

Permissible aids

Aids permitted as specified below:

Permissible electronic aids

Calculator

Class notes

Dictionary

Case study provided for the exam

Other permissible aids

No other aids permitted

Module Description, available in: EN, FR

Signal Processing and Transmission

General Information

Number of ECTS Credits

3

Module code

TSM_SignProc

Valid for academic year

2026-27

Last modification

2021-02-10

Coordinator of the module

Heinz Mathis (OST, heinz.mathis@ost.ch)

Explanations regarding the language definitions for each location:

- Instruction is given in the language specified for each location and module execution.
- Documentation is available in the language(s) listed for each location and module execution. If the documentation is in multiple languages, the percentage distributed is indicated (100% = all documentation provided).
- The examination, including both questions and answers, is provided entirely (100%) in the language(s) specified for each location and module execution. The exams are on-site.

	Lausanne			Lugano	Zurich		
Instruction		**X** F 100%			**X** E 100%		
Documentation		**X** F 70%	**X** E 30%		**X** E 100%		
Examination		**X** F 100%			**X** E 100%		

Module Category

TSM Technical scientific module

Profile Recommendations

This module is recommended for the following profiles:

	Lausanne	Zurich
Profile	EIE	EIE

Lessons

2 lecture periods and 1 tutorial period per week

Entry level competences

Prerequisites, previous knowledge

- Basics in probability theory
- Basics of information theory: entropy, basic source coding, linear block codes (e.g., CRC, Hamming)
- Basics in free-space propagation
- Basic modulation techniques: AM/FM, digital modulations
- Knowledge of the Fourier transform (theory and applications)

- Matlab user knowledge

Brief course description of module objectives and content

The aim of this module is to provide insight into state-of-the-art methods of how to make a signal fit for transmission over a cable or over the air. It starts with some information-theoretic aspects, covers modern modulation formats, hardware used, and closes with an excursion into propagation mechanisms.

Aims, content, methods

Learning objectives and competencies to be acquired

The students:

- understand the basic descriptions of a communication chain from a signal processing point of view,
- can describe the complete transmission chain, for several state-of-the-art communication systems,
- know the main characteristics, advantages and disadvantages of the presented techniques,
- are aware of the current research directions in advanced transmission technologies.

Module content with weighting of different components

- Complex base-band representation, CIC filters
- Detection theory
- Adaptive filters (LMS, RLS, Kalman Filter)
- Code-Division Multiple Access (CDMA), Ultrawideband (UWB)
- Orthogonal Frequency Division Multiplex (OFDM)
- Trellis-Coded Modulation (TCM)
- Architectures of optimal receivers
- Zero-IF, low-IF, bandpass architecture
- Wave propagation models for wireless communications
- Digital signal transmission over multipath channels
- Smart antenna systems

Teaching and learning methods

Lectures with problem-solving sessions

Literature

Lecture notes and slides in English

Assessment

Additional performance assessment during the semester

The module does not contain an additional performance assessment during the semester

Basic principle for exams

As a rule, all standard final exams are conducted in written form. For resit exams, lecturers will communicate the exam format (written/oral) together with the exam schedule.

Standard final exam for a module and written resit exam

Kind of exam

Written exam

Duration of exam

120 minutes

Permissible aids

Aids permitted as specified below:

Permissible electronic aids

Open-book exam: Lecture notes (no old exams) may be accessed using a pdf reader on a tablet or notebook pc in "airplane" mode with WiFi/BT switched off. Stand-alone calculator may be used.

Other permissible aids

Open-book exam: Lecture notes (no old exams) and books may be accessed in paper-copy form.

Exception: In case of an electronic Moodle exam, adjustments to the permissible aids may occur. Lecturers will announce the final permissible aids prior to the exam session.

Special case: Resit exam as oral exam

Kind of exam

Oral exam

Duration of exam

30 minutes

Permissible aids

No aids permitted

Description du module, disponible en: EN, FR

Traitement du signal et transmission

Informations générales

Nombre de crédits ECTS

3

Code du module

TSM_SignProc

Valable pour l'année académique

2026-27

Dernière modification

2021-02-10

Coordinateur/coordinatrice du module

Heinz Mathis (OST, heinz.mathis@ost.ch)

Explications concernant les langues d'enseignement par site :

- L'enseignement est dispensé dans la langue indiquée ci-dessous pour chaque site et chaque exécution du module.
- Les supports de cours sont disponibles dans les langues indiquées ci-dessous pour chaque site et chaque exécution du module. Lorsque plusieurs langues sont utilisées, la proportion de contenu disponible dans chaque langue est précisée (100 % = ensemble des supports de cours).
- Les examens (questions et réponses) sont entièrement rédigés dans la langue indiquée ci-dessous pour le site et l'exécution du module concernés. Ils se déroulent en présentiel.

	Lausanne			Lugano	Zurich		
Leçons		**X** F 100%			**X** E 100%		
Documentation		**X** F 70%	**X** E 30%		**X** E 100%		
Examen		**X** F 100%			**X** E 100%		

Catégorie de module

TSM approfondissement technico-scientifique

Recommandations de profil

Ce module est recommandé pour les profils suivants :

	Lausanne	Zurich
Profil	EIE	EIE

Leçons

2 leçons et 1 leçon de pratique par semaine

Compétences préalables

Connaissances préalables, compétences initiales

- Bases de la théorie des probabilités
- Bases de la théorie de l'information : entropie, codage de base des sources, codes de blocs linéaires (par exemple, CRC, Hamming)
- Notions de base sur la propagation en espace libre
- Techniques de modulation de base : AM/FM, modulations numériques

- Connaissance de la transformée de Fourier (théorie et applications)
- Connaissance des utilisateurs de Matlab

Brève description du contenu et des objectifs

L'objectif de ce module est de donner un aperçu des méthodes de pointe permettant de rendre un signal transmissible par câble ou par voie aérienne. Il commence par quelques aspects de la théorie de l'information, couvre les formats de modulation modernes, le matériel utilisé, et se termine par une excursion dans les mécanismes de propagation.

Objectifs, contenus, méthodes

Objectifs d'apprentissage, compétences à acquérir

Les étudiant-e-s :

- comprennnent les descriptions de base d'une chaîne de communication du point de vue du traitement du signal,
- peuvent décrire la chaîne de transmission complète, pour plusieurs systèmes de communication de pointe,
- connaissent les principales caractéristiques, avantages et inconvénients des techniques présentées,
- connaissent les orientations actuelles de la recherche dans le domaine des technologies de transmission avancées.

Contenu des modules avec pondération du contenu des cours

- Représentation complexe en bande de base, filtres CIC
- La théorie de la détection
- Filtres adaptatifs (LMS, RLS, filtre de Kalman)
- Accès multiple par répartition en code (AMRC), bande ultralarge (UWB)
- Multiplexage par répartition en fréquences orthogonales (OFDM)
- Modulation codée en treillis (TCM)
- Architectures des récepteurs optimaux
- Zero-IF, low-IF, architecture de bande passante
- Modèles de propagation des ondes pour les communications sans fil
- Transmission de signaux numériques sur des canaux à trajets multiples
- Systèmes d'antennes intelligentes

Méthodes d'enseignement et d'apprentissage

Cours magistral et séances de résolution de problèmes

Bibliographie

Notes de cours et slides

Evaluation

Évaluation supplémentaire pendant le semestre

Le module ne comprend pas d'évaluation supplémentaire pendant le semestre

Principe pour les examens

En règle générale, tous les examens réguliers de fin de module se déroulent sous forme écrite. Concernant les examens de répétition, leur format (écrit ou oral) sera communiqué par l'enseignant-e en même temps que le calendrier des examens.

Examen de fin de module régulier et examen écrit de répétition

Type de l'examen

Examen écrit

Durée de l'examen

120 minutes

Aides autorisées

Les aides suivantes sont autorisées:

Aides électroniques autorisées

Examen à livre ouvert : Les notes de cours (pas d'anciens examens) peuvent être consultées à l'aide d'un lecteur de pdf sur une tablette ou un ordinateur portable en mode "avion" avec WiFi/BT désactivé. Une calculatrice autonome peut être utilisée.

Autres aides autorisées

Examen à livre ouvert : Les notes de cours (pas d'anciens examens) et les livres peuvent être consultés sous forme de copies papier.

Exception : En cas d'examen électronique sur Moodle, des modifications des aides autorisées peuvent survenir. Dans ce cas, les aides autorisées seront annoncées par les enseignant-e-s avant l'examen.

Cas spécial: examen de répétition oral

Type de l'examen

Examen oral

Durée de l'examen

30 minutes

Aides autorisées

Sans aides

Description du module, disponible en: FR

Smart Sensing

Informations générales

Nombre de crédits ECTS

3

Code du module

TSM_SmartSens

Valable pour l'année académique

2026-27

Dernière modification

2022-10-31

Coordinateur/coordinatrice du module

Joseph Moerschell (HES-SO, joseph.moerschell@hevs.ch)

Explications concernant les langues d'enseignement par site :

- L'enseignement est dispensé dans la langue indiquée ci-dessous pour chaque site et chaque exécution du module.
- Les supports de cours sont disponibles dans les langues indiquées ci-dessous pour chaque site et chaque exécution du module. Lorsque plusieurs langues sont utilisées, la proportion de contenu disponible dans chaque langue est précisée (100 % = ensemble des supports de cours).
- Les examens (questions et réponses) sont entièrement rédigés dans la langue indiquée ci-dessous pour le site et l'exécution du module concernés. Ils se déroulent en présentiel.

	Lausanne			Lugano	Zurich		
Leçons		**X** F 100%					
Documentation			**X** E 100%				
Examen			**X** E 100%				

Catégorie de module

TSM approfondissement technico-scientifique

Recommandations de profil

Ce module est recommandé pour les profils suivants :

	Lausanne
Profil	Mic

Leçons

2 leçons et 1 leçon de pratique par semaine

Compétences préalables

Connaissances préalables, compétences initiales

This module is aimed for students having already acquired fundamentals knowledge and experience in measuring systems, in sensors with basic physical working principles, including as well basic electronic circuits (Wheatstone bridge, differential operational amplifier, oscillators, analog filters). Notions of MEMS are welcome.

Brève description du contenu et des objectifs

Sensors can be defined as smart sensors in three different manners: (a) the use of a smart design to obtain immunity from various parameters of influences in the targeted application, (b) the integration or embedding of a readout circuit and possibly also of a microcontroler in the same package or on the same substrate, (c) smart regarding its configuration and data analysis method allowing the observation of complex phenomenon (e.g. sensor fusion, sensor network).

The objective of this module is to complement the student with knowledge on modern sensor solutions that do already allow their integration in numerous key application, with its miniaturization, its reduction of costs and the improvement of its performances.

Objectifs, contenus, méthodes

Objectifs d'apprentissage, compétences à acquérir

At the end of this module, the student will be able :

- To explain basic design principles allowing the enhancement of the performances (noise reduction, increased sensitivity, linearization,...)
- To analyse the various stages of smart sensing systems, comprising the analog blocks, the mixed signal blocks, the digital blocks, and to explain the main types of digital signals used as well as to identify basic signal havesting and conditioning methods for its data transmission.
- To identify and explain differences between “analog” and “digital” design and the implications of “mixed-signal” design on the same substrate
- To design solution involving autonomous smart sensors
- To explain the interest of advanced sensor signal or data processing methods for sensing performance optimization

Contenu des modules avec pondération du contenu des cours

As red thread for this modules, the examples of sensors in smartphone and smart watched will be used.

The content of this module will include:

- Important principles for smart sensors for reduction of parasitic effects (2/14)
- Electronic building blocks and Signal processing chain (4/14)
- Calibration principles (1/14)
- Examples of MEMS and CMOS sensors (for example: Accelerometers, Gyroscope, Compass, TOF,…) (4/14)
- Micropower generation (1/14)
- Sensors fusion and networks (2/14)

Méthodes d'enseignement et d'apprentissage

This course involves theoretical presentations and practical exercises

Bibliographie

Lecture slides, references to internet resources and books (e.g. Smart Sensor Systems: Emerging Technologies and Applications Wiley Gerard Meijer, Michiel Pertijs, Kofi Makinwa)

Evaluation

Évaluation supplémentaire pendant le semestre

Le module ne comprend pas d'évaluation supplémentaire pendant le semestre

Principe pour les examens

En règle générale, tous les examens réguliers de fin de module se déroulent sous forme écrite. Concernant les examens de répétition, leur format (écrit ou oral) sera communiqué par l’enseignant-e en même temps que le calendrier des examens.

Examen de fin de module régulier et examen écrit de répétition

Type de l'examen

Examen écrit

Durée de l'examen

120 minutes

Aides autorisées

Les aides suivantes sont autorisées:

Aides électroniques autorisées

Calculator, computer offline; neither smartphone nor smartwatch, no social network or other means of electronic communication.

Autres aides autorisées

Open books.

Exception : En cas d'examen électronique sur Moodle, des modifications des aides autorisées peuvent survenir. Dans ce cas, les aides autorisées seront annoncées par les enseignant-e-s avant l'examen.

Cas spécial: examen de répétition oral

Type de l'examen

Examen oral

Durée de l'examen

30 minutes

Aides autorisées

Sans aides

Module Description, available in: EN

Smart systems for buildings

General Information

Number of ECTS Credits

3

Module code

TSM_SmartSys

Valid for academic year

2026-27

Last modification

2025-12-17

Coordinator of the module

Olivier Steiger (HSLU, olivier.steiger@hslu.ch)

Explanations regarding the language definitions for each location:

- Instruction is given in the language specified for each location and module execution.
- Documentation is available in the language(s) listed for each location and module execution. If the documentation is in multiple languages, the percentage distributed is indicated (100% = all documentation provided).
- The examination, including both questions and answers, is provided entirely (100%) in the language(s) specified for each location and module execution. The exams are on-site.

	Lausanne			Lugano	Zurich		
Instruction					**X** E 100%		
Documentation					**X** E 100%		
Examination					**X** E 100%		

Module Category

TSM Technical scientific module

Profile Recommendations

This module is recommended for the following profiles:

	Zurich
Profile	BT

Lessons

2 lecture periods and 1 tutorial period per week

Entry level competences

Prerequisites, previous knowledge

Basic knowledge of building technologies is desirable, but not mandatory

Brief course description of module objectives and content

This module aims to familiarise students with smart systems that are already, or will soon be, present in buildings. These include building automation and control systems (BACS), smart homes, IoT solutions, energy management and building security systems. Students will learn about the purpose, functionality and applications of these systems. They will also cover the necessary fundamentals such as components and system architecture, communication technologies and protocols.

Aims, content, methods

Learning objectives and competencies to be acquired

Learning objectives. The students should

- Understand the purpose, functionality and applications of smart systems for building
- Learn the necessary fundamentals. E.g. components and system architecture, communication technologies, protocols

Competences acquired. Students will be able to

- Understand, select and design smart systems for buildings

Module content with weighting of different components

1. **Introduction** History of smart buildings, definition and benefits, applications
2. **Fundamentals** Automation of buildings, communication technologies, protocols (wired and wireless)
3. **Applications**. Building automation and control systems BACS, smart home, internet of things IoT, energy management systems EMS, building security
4. **Future trends**
5. **Lab work**

Teaching and learning methods

- Three lecture periods per week, mixed with practical sessions and exercises.
- Teaching: Frontal teaching and storytelling. Discussion of practical examples. Guided study using lecture notes and textbooks.
- Exercises: Solving practical problems under the guidance of tutors (coaching).

Literature

Assessment

Additional performance assessment during the semester

The module does not contain an additional performance assessment during the semester

Basic principle for exams

As a rule, all standard final exams are conducted in written form. For resit exams, lecturers will communicate the exam format (written/oral) together with the exam schedule.

Standard final exam for a module and written resit exam

Kind of exam

Written exam

Duration of exam

120 minutes

Permissible aids

Aids permitted as specified below:

Permissible electronic aids

No electronic aids are permitted

Other permissible aids

Closed book: You may only use one two-sided A4 sheet containing a summary of the course material.

Exception: In case of an electronic Moodle exam, adjustments to the permissible aids may occur. Lecturers will announce the final permissible aids prior to the exam session.

Special case: Resit exam as oral exam

Kind of exam

Oral exam

Duration of exam

30 minutes

Permissible aids

Aids permitted as specified below:

Permissible electronic aids

No permissible electronic aids.

Other permissible aids

Closed book: You may only use one two-sided A4 sheet containing a summary of the course material.

Module Description, available in: EN

Software Assurance

General Information

Number of ECTS Credits

3

Module code

TSM_SoftwAs

Valid for academic year

2026-27

Last modification

2025-04-17

Coordinator of the module

Stephan Neuhaus (ZHAW, stephan.neuhaus@zhaw.ch)

Explanations regarding the language definitions for each location:

- Instruction is given in the language specified for each location and module execution.
- Documentation is available in the language(s) listed for each location and module execution. If the documentation is in multiple languages, the percentage distributed is indicated (100% = all documentation provided).
- The examination, including both questions and answers, is provided entirely (100%) in the language(s) specified for each location and module execution. The exams are on-site.

	Lausanne			Lugano	Zurich		
Instruction					**X** E 100%		
Documentation					**X** E 100%		
Examination					**X** E 100%		

Module Category

TSM Technical scientific module

Profile Recommendations

This module is recommended for the following profiles:

	Zurich
Profile	ICS

Lessons

2 lecture periods and 1 tutorial period per week

Entry level competences

Prerequisites, previous knowledge

Students will need knowledge in software engineering, specifically testing. Students will need to be reasonably fluent in a variety of languages including but not limited to C and Python. Knowledge of some assembly (e.g., x86, x86-64, or ARM) will be advantageous.

Brief course description of module objectives and content

Students shall gain an overview over current methods for software assurance. This may include, but is not limited to,

* advanced techniques for automated debugging; and

* advanced techniques for formal correctness of programs.

Aims, content, methods

Learning objectives and competencies to be acquired

- Students get an overview of advanced techniques for software assurance that are related to automated debugging. This may include, but is not limited to, delta debugging, automated fault repair, and mining function specifications.
- Students know techniques and tools for automated test case generation, such as fuzzing, how they work, to what class of faults they apply, how to interpret their outputs, and how to use them in their own projects.
- Students receive an in-depth introduction to techniques of formal correctness, such as symbolic execution or automated correctness proofs

Module content with weighting of different components

- Automated debugging
- Formal methods

Teaching and learning methods

Lectures will be part ex-cathedra lectures, part in-class exercises.

These exercises are designed to be done either individually or in groups and can be done remotely. There may also be guest lectures.

Literature

Andreas Zeller, Why Programs Fail. Morgan Kaufman. Second Edition, 1770. (Yes, that's the date that Amazon has for the book. In reality, the second edition is from 2008.)

Ari Takanen, Fuzzing for Software Security Testing and Quality Assurance. Artech House Publishers. Second Edition, 2018. Seokhie Hong (Ed.), Side Channel Attacks. MDPI. 2019.

David J. Smith and Kenneth G. L. Simpson, The Safety Critical Systems Handbook: A Straightforward Guide to Functional Safety: IEC 61508 (2010 Edition), IEC 61511 (2015 Edition) and Related Guidance. Butterworth-Heisman. Fifth edition, 2020.

Assessment

Additional performance assessment during the semester

The module does not contain an additional performance assessment during the semester

Basic principle for exams

As a rule, all standard final exams are conducted in written form. For resit exams, lecturers will communicate the exam format (written/oral) together with the exam schedule.

Standard final exam for a module and written resit exam

Kind of exam

Written exam

Duration of exam

120 minutes

Permissible aids

Aids permitted as specified below:

Permissible electronic aids

None

Other permissible aids

hand-written summary of no more than 4 sheets of A4 paper

Exception: In case of an electronic Moodle exam, adjustments to the permissible aids may occur. Lecturers will announce the final permissible aids prior to the exam session.

Special case: Resit exam as oral exam

Kind of exam

Oral exam

Duration of exam

30 minutes

Permissible aids

Aids permitted as specified below:

Permissible electronic aids

None

Other permissible aids

hand-written summary of no more than 4 sheets of A4 paper

Module Description, available in: EN

Software Engineering and Architectures

General Information

Number of ECTS Credits

3

Module code

TSM_SoftwEng

Valid for academic year

2026-27

Last modification

2023-11-13

Coordinator of the module

Sandy Ingram (HES-SO, sandy.ingram@hefr.ch)

Explanations regarding the language definitions for each location:

- Instruction is given in the language specified for each location and module execution.
- Documentation is available in the language(s) listed for each location and module execution. If the documentation is in multiple languages, the percentage distributed is indicated (100% = all documentation provided).
- The examination, including both questions and answers, is provided entirely (100%) in the language(s) specified for each location and module execution. The exams are on-site.

	Lausanne			Lugano	Zurich		
Instruction	**X** E 100%				**X** E 100%		
Documentation	**X** E 100%				**X** E 100%		
Examination	**X** E 100%				**X** E 100%		

Module Category

TSM Technical scientific module

Profile Recommendations

This module is recommended for the following profiles:

	Lausanne	Zurich
Profile	CS	CS

Lessons

2 lecture periods and 1 tutorial period per week

Entry level competences

Prerequisites, previous knowledge

- Object-oriented programming and design in more than one programming language
- Unified Modeling Language (UML)
- Design Patterns: Elements of Reusable Object-Oriented Software (Gamma, Helm, Johnson, Vlissides; ISBN 0-201-63361-2)
- Version and configuration management concepts
- Unit testing concepts and practice

Brief course description of module objectives and content

The module provides an in-depth view of selected topics of modern software engineering. These stem from the fields: modern software development processes, software architecture, and the principles of evolution of software systems.

Aims, content, methods

Learning objectives and competencies to be acquired

- The student applies and understands benefits and liabilities of agile and lean development
- The student knows about advanced architectural and design patterns and uses them to drive and reflect on design decisions
- The student has the awareness of software as a continuously evolving and complex system
- The student knows and can select maintenance and evolution techniques for continuous development of evolving and extension of legacy software systems while maintaining its quality

Module content with weighting of different components

Software Architectures (20%)

- Role of Software Architecture and Software Architects
  - reference models, reference architectures
  - architectural structures and views
  - software architecture documentation
- Advanced Design Concepts
  - Design by contract
  - The SOLID principles
- Architecture Styles
- Architecture Patterns (vs design patterns)
- Research in Software Architecture

Modern Software Engineering (50%)

- Agile Principles and Practices
  - effective communication among stakeholders
  - project retrospectives, feedback techniques
  - ongoing requirements, solicitation and management
- Agile Methodologies
- Automation in Agile Software Release Management
  - Testing approaches and types
  - Agile testing quadrants
  - CI/CD Continuous Integration and Continuous Deployment (with Docker)
  - Automated testing and CI/CD Practices for Embedded Systems and Web Applications

Software Evolution (30%)

- Principles of Software Evolution
  - development, maintenance, evolution
  - software aging
  - Program comprehension
- Software Quality & Analysis
  - software quality metrics
  - software visualization
  - continuous quality control
- Evolution of Legacy Code
  - “Re”-Techniques: Reverse Engineering, Re-Engineering, Re-Factoring
  - object-oriented re-engineering
  - Testing legacy systems
- Research in Software Evolution

Teaching and learning methods

Self-study, homework assignments.

Part of the module provides pre-recorded inputs to enable asynchronous learning combined with in-class labs and exercises. Part of the labs and assignments use a provided kit based on Raspberry Pi Pico-W (RP2040) with VS Code and provided software (C).

Literature

1. Mary & Tom Poppendiek: Lean Software Development
2. Kent Beck: eXtreme Programming Explained 2nd Ed.
3. Ken Schwaber et al, Agile Software Development with Scrum, Prentice Hall, 2002
4. Alistair Cockburn: Agile Software Development
5. Robert C. Martin: Agile Software Development
6. Tom Mens: Software Evolution
7. Doug Schmidt et.al.: Pattern-oriented Software Architecture, Vol. 2

Frank Buschmann et al: Pattern-oriented Software Architecture, Vol. 4
8. Len Bass, Paul Clements, Rick Kazman: Software Architecture in Practice 2nd Ed.
9. Gernot Starke: Effektive Software Architekturen 2. Auflage
10. Lehmann "Laws of Software Evolution Revisited"
11. Martin Fowler et al, Refactoring
    Joshua Kerievsky, Refactoring to Patterns
12. Michael Feathers, Working Effectively with Legacy Code
13. Andreas Zeller: Why Programs Fail ISBN 1558608664

Assessment

Additional performance assessment during the semester

The module contains additional performance assessment(s) during the semester. The achieved mark of the additional performance assessment(s) applies to both the regular and the resit exam.

Description of additional performance assessment during the semester

- Corrected individual homework assignments account for 6% of the final grade.

-A graded group project accounts for 24% of the final grade and requires applying various concepts covered in class to the project planning, design, implementation, and testing phases. The group project involves both software components and embedded systems.

Basic principle for exams

As a rule, all standard final exams are conducted in written form. For resit exams, lecturers will communicate the exam format (written/oral) together with the exam schedule.

Standard final exam for a module and written resit exam

Kind of exam

Written exam

Duration of exam

120 minutes

Permissible aids

Aids permitted as specified below:

Permissible electronic aids

No electronic aids permitted

Other permissible aids

A personal summary of max. 20 pages A4 (or 10 sheets) on paper, with the student name on it. It does not have to be handwritten, but the summary content must be personal, and not a copy of someone else. The summary will be collected with the exam and not returned.

Exception: In case of an electronic Moodle exam, adjustments to the permissible aids may occur. Lecturers will announce the final permissible aids prior to the exam session.

Special case: Resit exam as oral exam

Kind of exam

Oral exam

Duration of exam

30 minutes

Permissible aids

No aids permitted

Module Description, available in: EN

Statistical Digital Signal Processing and Modeling

General Information

Number of ECTS Credits

3

Module code

TSM_StatDig

Valid for academic year

2026-27

Last modification

2024-09-24

Coordinator of the module

Heinz Mathis (OST, heinz.mathis@ost.ch)

Explanations regarding the language definitions for each location:

- Instruction is given in the language specified for each location and module execution.
- Documentation is available in the language(s) listed for each location and module execution. If the documentation is in multiple languages, the percentage distributed is indicated (100% = all documentation provided).
- The examination, including both questions and answers, is provided entirely (100%) in the language(s) specified for each location and module execution. The exams are on-site.

	Lausanne			Lugano	Zurich		
Instruction					**X** E 100%		
Documentation					**X** E 100%		
Examination					**X** E 100%		

Module Category

TSM Technical scientific module

Profile Recommendations

This module is recommended for the following profiles:

	Zurich
Profile	EIE

Lessons

2 lecture periods and 1 tutorial period per week

Entry level competences

Prerequisites, previous knowledge

Understanding of the following concepts at the Bachelor of Science level

- Calculus
- Linear algebra
- Probability/Statistics
- Digital signal processing

Brief course description of module objectives and content

The goal of this module is to introduce the students to the powerful world of statistical digital signal processing. While at the bachelor level digital signal processing is most often taught with deterministic signals, in the real world most interesting signals are stochastic in nature. Hence in more advanced applications, such as prediction or noise removal, the theories presented in this module are essential.

The basic digital signal processing, linear algebra and probability theory necessary to understand the module are brushed-up at the beginning. Then stochastic processes are introduced which allows the proper formulation of the optimal filtering and spectral estimation problem later on. After an in-depth treatment of the optimal filtering and estimation problem, adaptive filters are introduced which are a popular choice for many advanced statistical digital signal processing problems.

Aims, content, methods

Learning objectives and competencies to be acquired

- The student becomes familiar with stochastic signals and systems
- The student understands and can apply the different methods for signal modeling
- The student has an in-depth understanding of Wiener filtering and knows how a discrete Kalman filter can be used to solve a stochastic filtering problem
- The student understands and can apply the different methods for spectrum estimation
- The student knows the most common adaptive filters and is able to select the proper one for the application at hand

Module content with weighting of different components

The module starts with a review of basic digital signal processing, linear algebra and probability theory. It then introduces some concepts about stochastic processes, which are necessary to understand the following applications of statistical signal processing. Then the module discusses several different ways of signal modeling which can be used for parametric methods later on. Then one of the core topics is presented, which is the optimal linear mean square error estimation of a signal which is corrupted by additive noise. The module then presents a chapter about the very important topic of spectral estimation and finally concludes with the application of the learned theory for designing adaptive filters.
The available 14 weeks are organized as follows:

- 2 weeks: Background (review of digital signal processing and linear algebra)
- 3 weeks. Discrete-time random processes (including a review of probability)
- 2 weeks: Signal modeling
- 3 weeks: Wiener filtering (including the discrete Kalman Filter)
- 2 weeks: Spectrum estimation
- 2 weeks: Adaptive filtering

Teaching and learning methods

- A three hour session each week for 14 weeks
- The first hour is a homework review session where the homework is discussed. The homework is “paper and pencil” homework and small Matlab programming assignments
- The next two hours are lecture hours, where new theory is introduced

Literature

“Statistical Digital Signal Processing and Modeling” by Monson H. Hayes

Assessment

Additional performance assessment during the semester

The module does not contain an additional performance assessment during the semester

Basic principle for exams

As a rule, all standard final exams are conducted in written form. For resit exams, lecturers will communicate the exam format (written/oral) together with the exam schedule.

Standard final exam for a module and written resit exam

Kind of exam

Written exam

Duration of exam

120 minutes

Permissible aids

Aids permitted as specified below:

Permissible electronic aids

No aids permitted

Other permissible aids

Open book

Exception: In case of an electronic Moodle exam, adjustments to the permissible aids may occur. Lecturers will announce the final permissible aids prior to the exam session.

Special case: Resit exam as oral exam

Kind of exam

Oral exam

Duration of exam

30 minutes

Permissible aids

No aids permitted

Module Description, available in: EN

Structural Vibrations

General Information

Number of ECTS Credits

3

Module code

TSM_StrVibr

Valid for academic year

2026-27

Last modification

2023-09-10

Coordinator of the module

Giacomo Bianchi (SUPSI, giacomo.bianchi@supsi.ch)

Explanations regarding the language definitions for each location:

- Instruction is given in the language specified for each location and module execution.
- Documentation is available in the language(s) listed for each location and module execution. If the documentation is in multiple languages, the percentage distributed is indicated (100% = all documentation provided).
- The examination, including both questions and answers, is provided entirely (100%) in the language(s) specified for each location and module execution. The exams are on-site.

	Lausanne			Lugano	Zurich		
Instruction				**X** E 100%			
Documentation				**X** E 100%			
Examination				**X** E 100%			

Module Category

TSM Technical scientific module

Profile Recommendations

This module is recommended for the following profiles:

	Lugano
Profile	ME

Lessons

2 lecture periods and 1 tutorial period per week

Entry level competences

Prerequisites, previous knowledge

- Linear algebra (matrices, eigenvalues, eigenvectors,…), linear differential equations.
- Dynamic equilibrium of mechanical systems (mass, springs, dampers,…)
- Fourier transform, Frequency Response Functions

- Experience with MATLAB/Simulink and NASTRAN NX

Brief course description of module objectives and content

Passive vibration control: dynamic isolation and Tuned Mass Dampers. Dynamic response of elastomeric materials. Damping due to friction. Numerical modeling of damping in Finite Element packages. Vibrations issues in high-performance machine tools.

Aims, content, methods

Learning objectives and competencies to be acquired

- Consolidate theoretical knowledge on structural vibrations
- Passive solutions for vibration alleviation: dynamic isolation, Tuned Mass Dampers
- Numerical modeling by lumped masses and Finite Elements (structural damping)

Module content with weighting of different components

- Energy dissipation: viscous and hysteretic damping. Elastomeric material: information available on commercial catalogues and corresponding numerical models. Dissipation due to guideways friction
- Dynamic vibrations isolation and Tuned Mass Dampers: design guidelines and numerical modelling in Matlab/Simulink
- Damping modelling and dynamic analysis of systems with non-proportional, frequency-dependent damping (modelling in Matlab-Simulink and Siemens NASTRAN NX)
- Dynamic issues in Machine Tools

Teaching and learning methods

Frontal theoretical lessons with interaction. Self-developed numerical exercises in MATLAB/Simulink and Siemens Nastran NX.

Group original projects under extensive teacher support, possibly with test bench design or experiments.

Literature

Lecture slides and lecture notes.

Assessment

Additional performance assessment during the semester

The module contains additional performance assessment(s) during the semester. The achieved mark of the additional performance assessment(s) applies to both the regular and the resit exam.

Description of additional performance assessment during the semester

Two guided exercises on dynamic suspensions and Tuned Mass Dampers, with matlab & simulink (15% of the final score).

Project work, with professor support (15% of the final score).

Executed in groups of 2-3 students.

Basic principle for exams

As a rule, all standard final exams are conducted in written form. For resit exams, lecturers will communicate the exam format (written/oral) together with the exam schedule.

Standard final exam for a module and written resit exam

Kind of exam

Written exam

Duration of exam

120 minutes

Permissible aids

Aids permitted as specified below:

Permissible electronic aids

calculator

Other permissible aids

list of main formulas, available on Moodle

Exception: In case of an electronic Moodle exam, adjustments to the permissible aids may occur. Lecturers will announce the final permissible aids prior to the exam session.

Special case: Resit exam as oral exam

Kind of exam

Oral exam

Duration of exam

30 minutes

Permissible aids

Aids permitted as specified below:

Permissible electronic aids

calculator

Other permissible aids

list of main formulas, available on Moodle

Modulbeschreibung, verfügbar in: DE

Baudynamik und Erdbebeningenieurwesen

Allgemeine Angaben

Anzahl ECTS-Credits

3

Modulkürzel

TSM_StrucEng

Gültig für akademisches Jahr

2026-27

Letzte Änderung

2019-08-31

Modul-Koordinator/in

Michael Baur (HSLU, michael.baur@hslu.ch)

Erläuterungen zu den Sprachdefinitionen je Standort:

- Der Unterricht findet in der pro Standort und Durchführung definierten Sprache statt.
- Die Unterlagen sind in den pro Standort und Durchführung definierten Sprachen verfügbar. Bei Mehrsprachigkeit ist die prozentuale Verteilung angegeben (100% = komplette Unterlagen).
- Die Prüfungsfragen und -antworten sind in jeder pro Standort und Durchführung definierten Sprache. Die Prüfung wird vor Ort durchgeführt.

	Lausanne			Lugano	Zurich		
Unterricht						**X** D 100%	
Dokumentation						**X** D 90%	**X** E 10%
Prüfung						**X** D 100%	

Modulkategorie

TSM Technisch-wissenschaftliche Vertiefung

Profilempfehlungen

Dieses Modul wird für die folgenden Profile empfohlen:

	Zurich
Profil	CE

Lektionen

2 Lektionen und 1 Übungslektion pro Woche

Eintrittskompetenzen

Vorkenntnisse, Eingangskompetenzen

Baustatik: gute Kenntnis baustatischer Methoden (Kraft- und Deformationsmethode)

Mathematik: Grundlagen der Bewegungs-Differentialgleichungen, der Fourieranalyse und der Matrizenrechnung

Physik: Grundlagen Kinematik und Kinetik des Massenpunktes

Kurzbeschreibung der Inhalte und Ziele

Der Modulinhalt ist in zwei Themengebiete, Baudynamik und Erdbebeningenieurwesen, untergliedert.

Die Baudynamik beinhaltet: Grundlagen der Kinematik und Kinetik des Massenpunktes; die Modellbildung von dynamischen Systemen und das Aufstellen der Bewegungsdifferentialgleichungen bei Ein- und Mehrmassenschwingern; die Berechnung der Systemantwort infolge dynamischer Einwirkungen; Massnahmen zur Reduzierung von Schwingungen.

Im aufbauenden Teil Erdbebeningenieurwesen folgt der erdbebengerechte Entwurf an Beispielen; Duktilität und Ermittlung von Antwortspektren; die Berechnung der Schnittkräfte mit Hilfe dem Ersatzkraft- und dem Antwortspektrenverfahren nach den SIA Tragwerksnormen; Grundlagen der verformungsbasierten Nachweise.

Ziele, Inhalte, Methoden

Lernziele und zu erwerbende Kompetenzen

Baudynamik

Die Studierenden:

- kennen die Arten von dynamischen Einwirkungen

- können die Tragstruktur auf ein dynamisches System reduzieren bzw. übertragen (Modellbildung)

- können die Bewegungsgleichungen für Ein- und Mehrmassenschwinger aufstellen und die Systemantwort infolge der dynamischen Einwirkungen berechnen und plausibilisieren

- kennen Massnahmen zur Reduzierung der dynamischen Systemantwort (Systemsteifigkeit, Dämpfung, Tilger) und können diese auf einfache Systeme anwenden

Erdbebeningenieurwesen

Die Studierenden:

- kennen die seismolgischen Grundlagen

- kennen die Grundlagen eines erdbebengerechten Entwurfs und können diese an Tragstrukturen umsetzen

- können die Auswirkungen (Schnittkräfte) infolge Erdbebenanregung mit dem Ersatzkraft- und dem Antwortspektrenverfahren nach den SIA Tragwerksnormen für Baustrukturen berechnen.

- kennen den Einfluss der Duktilität auf die Systemantwort

- kennen die Grundlagen verformungsbasierter Nachweise und können diese auf ein einfaches System anwenden

Modulinhalt mit Gewichtung der Lehrinhalte

Baudynamik (Gewichtung 50%)

Kinematik und Kinetik des Massenpunktes; Einmassenschwinger - freie und erzwungene Schwingungen; Mehrmassenschwinger - modale Analyse, freie und erzwungene Schwingungen; Tilgersysteme; Rayleigh-Quotient

Erdbebeningenieurwesen (Gewichtung 50%)

Einführung seismologische Grundlagen; erdbebengerechter Entwurf an Beispielen; Schubmittelpunkt; horizontaler Lastabtrag; Duktilität und Antwortspektren; Ersatzkraft- und Antwortspektrenverfahren nach SIA 261; Einführung in verformungsbasierte Nachweisverfahren

Lehr- und Lernmethoden

Der Unterricht findet im Blended-Learning-Format (Flipped-Classroom) statt. Synchrone (Präsenzveranstaltungen) und asynchrone (geführtes Selbststudium) Lerneinheiten finden nach einer Einführung ins Lehrformat im 2 Wochen Rhythmus statt.

Die Grundlagen im Begleitskript werden mit Hilfe von Foliensätzen, ergänzt durch Tafelanschriebe, erläutert und diskutiert. Das Lösen von Beispielen erfolgt an der Tafel bzw. durch Erläuterungen mit Hilfe von Umdrucken.

Das Wissen und die Kompetenzen werden durch die Erarbeitung von Grundlagen und dem Lösen von Übungsaufgaben zum Themenbereich im Selbststudium vertieft. Diese werden in den Präsenzveranstaltungen im Plenum diskutiert.

Des Weiteren kommt ein FEM-Programm zur Anwendung, mit dessen Hilfe die Studierenden die Systemantwort von einfachen Systemen bei verschiedenen dynamischen Einwirkungen berechnen und die Ergebnisse plausibilisieren können. Neben dem Theorieteil ist dies Inhalt des Selbststudiums. Die Einführung in das FEM-Programm erfolgt mit Hilfe von Lernvideos.

Bibliografie

Dazio, Alessandro, 2008: "Foliensatz-Tragwerksdynamik und Schwingungsprobleme", ETH Zürich.

Dazio Alessandro, Wenk, Thomas, 2008: " Foliensatz-Erdbebensicherung von Bauwerken 1", ETH Zürich.

Dazio, Alessandro, 2009: "Foliensatz-Erdbebensicherung von Bauwerken 2", ETH Zürich.

Bachmann, Hugo, 2002: "Erdbebensicherung von Hochbauten", Birkhäuser Verlag.

Papula, Lothar, 2015: "Mathematik für Ingenieure und Naturwissenschaftler - Band 2", Vieweg und Teubner Verlag.

SIA-Tragwerksnormen 261-269

Bewertung

Zusätzliche Leistungsbewertung während des Semesters

Das Modul beinhaltet keine zusätzliche Leistungsbewertung während des Semesters.

Grundsatz Prüfungen

Grundsätzlich werden alle regulären Abschlussprüfungen in schriftlicher Form durchgeführt. Bei den Wiederholungsprüfungen teilen die Dozierenden das Prüfungsformat (schriftlich/mündlich) zusammen mit dem Prüfungsplan mit.

Reguläre Modulschlussprüfung und schriftliche Wiederholungsprüfung

Art der Prüfung

Schriftliche Prüfung

Prüfungsdauer

120 Minuten

Erlaubte Hilfsmittel

Erlaubt sind die aufgeführten Hilfsmittel:

Zulässige elektronische Hilfsmittel

programmierbarer Taschenrechner und Laptop (offline)

Weitere erlaubte Hilfsmittel

Open-Book (keine Einschränkungen)

Ausnahme: Im Falle einer elektronischen Moodle-Prüfung können Änderungen der Hilfsmittel vorkommen. Dozierende werden die endgültig zulässigen Hilfsmittel vor der Prüfung bekanntgeben.

Spezialfall: Wiederholungsprüfung als mündliches Examen

Art der Prüfung

Mündliche Prüfung

Prüfungsdauer

30 Minuten

Erlaubte Hilfsmittel

Ohne Hilfsmittel

Module Description, available in: EN

Spatio-temporal methods for sustainable environmental systems

General Information

Number of ECTS Credits

3

Module code

TSM_SustEnSys

Valid for academic year

2026-27

Last modification

2025-10-14

Coordinator of the module

Pia Bereuter (FHNW, pia.bereuter@fhnw.ch)

Explanations regarding the language definitions for each location:

- Instruction is given in the language specified for each location and module execution.
- Documentation is available in the language(s) listed for each location and module execution. If the documentation is in multiple languages, the percentage distributed is indicated (100% = all documentation provided).
- The examination, including both questions and answers, is provided entirely (100%) in the language(s) specified for each location and module execution. The exams are on-site.

	Lausanne			Lugano	Zurich		
Instruction					**X** E 100%		
Documentation					**X** E 100%		
Examination					**X** E 100%		

Module Category

TSM Technical scientific module

Profile Recommendations

This module is recommended for the following profiles:

	Zurich
Profile	Geo

Lessons

2 lecture periods and 1 tutorial period per week

Entry level competences

Prerequisites, previous knowledge

Basic programming and data handling knowledge (any programming language). Background knowledge in Geomatics or Planning or strong interest in the topics covered in this module.

Brief course description of module objectives and content

How resilient are urban and natural systems to various developments and changes? Such as changes in the urban fabric, water availability or heat. And what methods and processes exist to gain insights and derive an understanding of urban and natural systems? Our environment consists of complex systems. Understanding and managing them is the key to sustainable development of large settlement- and landscape areas.

This module introduces methods for data collection and processing, simulation and decision making that help to analyse interrelationships of spatial and environmental systems. The focus is on the analysis of large-scale systems and their integration into human settlement areas. This module explores questions regarding the resilience of urban and natural systems with regards to different topics such as urban climates, urban density, or water resources.

The module builds on previous knowledge and methods from geomatics and planning, but also welcomes people from different backgrounds with a strong interest, for instance MSE profiles Data Science or Energy & Environment. The module uses the didactic concept of the "flipped classroom" to align the students' knowledge in geomatics and planning and fosters self-study and project based learning in mixed groups.

Aims, content, methods

Learning objectives and competencies to be acquired

- The students can apply the theory and the knowledge of urban and natural systems to support the analysis and exploration of urban and natural system.
- The students understand the impact of environmental changes and consequences on various aspects in urban system such the availability of resources and future resilience of urban systems.
- The students can apply theory and methods of remote sensing techniques for acquiring, evaluating, and extracting information from spatial data for landscape planning and environmental assessment.
- The students know how to integrate and manage spatio-temporal data at different scales effectively to support decision-making processes.
- The students know the principles of simulation, including modelling, methods, and application, and can apply them to understand urban and natural systems.
- The students demonstrate critical thinking and problem-solving skills to study the effects on urban and natural systems, temporal evolution and effects of and on policies.
- The students are aware of ethical considerations and environmental impact assessments relevant to engineering projects in spatial and natural systems.
- The students understand and can apply methods to show the impact of changes in urban system and applied policies over time with means of quantitative and qualitative geospatial data sources.

Module content with weighting of different components

- Introduction to *spatial development* or *GIS* based on prior knowledge in the form of flipped classroom with the aim of aligning for prior knowledge of the students with different backgrounds notably in geomatics and urban planning. This approach entails students independently studying foundational materials before class. During class sessions, emphasis is placed on active learning and application, ensuring alignment with diverse backgrounds.
- The module introduces urban and natural systems, with a focus on application cases. It explores issues within systems such as urban climate, urban density, water distribution, regional urban systems and questions regarding the resilience of such systems. Case studies are used to illustrate concepts and principles, where students explore characteristics of urban and natural systems such as metropolitan areas or river delta, and examine issues related to land use, environmental impact, and sustainable development.
- Students learn about and can use remote sensing data, especially with satellite-based data collection. The students learn about data acquisition methods, sensor technology and the different types of remote sensing data. Practical exercises focus on accessing and working with remote sensing data. Students acquire skills in data evaluation, image processing and information extraction. They analyse land cover, vegetation indices and other relevant data for the analysis of urban and natural systems.
- The module covers the integration and management of spatio-temporal data, emphasising its importance for environmental decision-making. Students learn to combine data, perform spatio-temporal data management and analysis, data integration techniques and data quality considerations. Students perform practical exercises, learn to combine, and manage spatio-temporal datasets.
- The module introduces the basic principles of simulation, its modelling, methods, and application. Students learn to develop simulations based on use cases e.g. 15 min cities and better understand the process of developing simulations.
- The module follows and encourages an interdisciplinary approach particularly between the field of geomatics and planning with a focus on GIS and urban planning.

Teaching and learning methods

Lectures, exercises (individual and group work), flipped class room. Flipped classroom with 50% of lectures on site with input sessions, interactive group work, discussions and 50% remote sessions with self-study, stand-ups and interdisciplinary group work. For on site lectures physical attendance is encouraged.

Literature

- Slides given during the course from the Lecturers
- Reference books details will be given at the beginning of the course

Assessment

Additional performance assessment during the semester

The module does not contain an additional performance assessment during the semester

Basic principle for exams

As a rule, all standard final exams are conducted in written form. For resit exams, lecturers will communicate the exam format (written/oral) together with the exam schedule.

Standard final exam for a module and written resit exam

Kind of exam

Written exam

Duration of exam

120 minutes

Permissible aids

Aids permitted as specified below:

Permissible electronic aids

Open book, all materials and documents
No information search is allowed (PC in flight mode, no connection available, no use of artificial intelligence system local or remote)

Other permissible aids

No other aids permitted

Exception: In case of an electronic Moodle exam, adjustments to the permissible aids may occur. Lecturers will announce the final permissible aids prior to the exam session.

Special case: Resit exam as oral exam

Kind of exam

Oral exam

Duration of exam

30 minutes

Permissible aids

Aids permitted as specified below:

Permissible electronic aids

Open book, all materials and documents
No information search is allowed (PC in flight mode, no connection available, no use of artificial intelligence system local or remote)

Other permissible aids

No other aids permitted

Modulbeschreibung, verfügbar in: DE

Entwerfen und Planen in grösseren Räumen – Theorie und Praxis (Theorien in Planung und Entwurf)

Allgemeine Angaben

Anzahl ECTS-Credits

3

Modulkürzel

TSM_TheoPlan

Gültig für akademisches Jahr

2026-27

Letzte Änderung

2023-01-16

Modul-Koordinator/in

Susanne Karn (OST, susanne.karn@ost.ch)

Erläuterungen zu den Sprachdefinitionen je Standort:

- Der Unterricht findet in der pro Standort und Durchführung definierten Sprache statt.
- Die Unterlagen sind in den pro Standort und Durchführung definierten Sprachen verfügbar. Bei Mehrsprachigkeit ist die prozentuale Verteilung angegeben (100% = komplette Unterlagen).
- Die Prüfungsfragen und -antworten sind in jeder pro Standort und Durchführung definierten Sprache. Die Prüfung wird vor Ort durchgeführt.

	Lausanne			Lugano	Zurich		
Unterricht						**X** D 100%	
Dokumentation						**X** D 100%	
Prüfung						**X** D 100%	

Modulkategorie

TSM Technisch-wissenschaftliche Vertiefung

Profilempfehlungen

Dieses Modul wird für die folgenden Profile empfohlen:

	Zurich
Profil	ReLa

Lektionen

2 Lektionen und 1 Übungslektion pro Woche

Eintrittskompetenzen

Vorkenntnisse, Eingangskompetenzen

- Grundlegende Kenntnisse in Landschaftsarchitektur, Städtebau oder Raumplanung
- Basiserfahrung in Planen und Entwerfen
- Grundlagen in Erörterung und Darstellung von Entwurfsaufgaben in Plänen und Berichten

Kurzbeschreibung der Inhalte und Ziele

Das Modul behandelt für die unterschiedlichen Vertiefungsrichtungen des Masterstudienganges die wichtigsten Entwurfs- und Planungstheorien und -methoden zur Arbeit in grösseren Räumen und mit unterschiedlichen Planungsmassstäben, wie sie beispielsweise in Siedlungsgebieten der Agglomerationsräume und siedlungsnahen Frei- und Erholungsräumen zur Anwendung kommen können. Theoretisches Wissen wird fortlaufend mit aktuellen Beispielen aus der Praxis abgeglichen. Besonderes Interesse gilt sowohl der Vielfalt wie auch der Kongruenz der Methoden in den verschiedenen Planungsrichtungen und auf den verschiedenen Massstabsebenen. In diesem Sinne werden im Modul interdisziplinäre und spezialisierte Kompetenzen in Planung, Konzeption und Entwurf vermittelt.
Das Modul behandelt mit Schwerpunkt in der Landschaftsarchitektur, speziell der Freiraum- und Landschaftsplanung und Ansätze zum ‚konzeptionellen Entwurf'. Es geht dabei auf Aspekte der Raumplanung und des Städtebaus ein. Damit kann es neben der Vertiefung in Landschaftsarchitektur auch einen besonderen Gewinn für Studierende der Raumentwicklung, des Städtebaus und der Verkehrsplanung darstellen und deren ‚Freiraum- und Landschaftskompetenz' erweitern.

Die Übungen haben das Ziel, zentrale Methoden zu erproben und ein Verständnis von Entwurfs- und Planungsaufgaben zu erlangen. Sie sind am Ende des Moduls in der Lage, räumliche Entwicklungsvorstellungen wirksam bildhaft zu vermitteln und zu konkretisieren, Planung und Entwurf als System zu erkennen und für deren Lösung adäquate Prozesse vorzuschlagen.

Ziele, Inhalte, Methoden

Lernziele und zu erwerbende Kompetenzen

Fachliche Ziele:

- Kenntnisse über die Entwicklung von Theorien und Methoden in der Landschaftsarchitektur sowie über deren Bedeutung in aktuellen Planungsaufgaben. Damit die Kompetenz, die Aufgabenstellungen in Bezug auf Landschaftstheorien zu interpretieren und mit den dafür geeigneten Methoden zu organisieren.
- Kenntnisse über die aktuelle Praxis der Landschafts- und Freiraumentwicklung sowie die Kompetenz, neue Aufgabenstellungen an Best-Practice zu messen und dementsprechend anspruchsvolle Prozesse in die Wege zu leiten.
- Kompetenz, teamorientiert zu arbeiten, sich in interdisziplinären Entwicklungsaufgaben kompetent einbringen zu können und mit anderen beteiligten Entwerfenden und Planungsspezialisten kommunizieren zu können.

Methodische Ziele:

- Bedarfsanalyse unter Einbezug verschiedener Akteure, Potentialanalyse
- Arbeit mit Typologien und Morphologie in grossen Räumen
- Leitbild und Strategiebausteine
- ergebnisoffenes, komplexes Landschaftsentwerfen.
- Strukturieren des Planungsprozesses mit interdisziplinärer Beteiligung
- Mitwirkungsformen im regionalen und kommunalen Massstab

Modulinhalt mit Gewichtung der Lehrinhalte

- Grundverständnis Landschaft, Einführung Theorien und Methoden, Planungsinstrumente (25%)
- Entwurfstheorien im städtebaulichen und freiraumplanerischen Entwerfen (25%)
- komplexe Planungmethoden (25%)
- interdisziplinäre Zusammenarbeit beim Planen und Entwerfen, Fallbeispiele / Werkstattberichte, Prozessgestaltung und Partizipation (25%)

Lehr- und Lernmethoden

- Vorlesungen
- Textexegesen,
- Übungen

Bibliografie

- Berr, K. (Hg.): Landschaftsarchitekturtheorie, Springer 2018
- Foxley, A.: Distance and Engagement, Lars Müller, Edition 2010
- Girot, C.: Fragen zur Topologie der Landschaft, in: Anthos, H.4, 2012
- Hirschfeld, C.C.L: Theorie der Gartenkunst, 1775
- Kühne, O.: Landschaftstheorie und Landschaftspraxis, Springer Verlag, 2012
- Prominski, M.: Landschaft entwerfen. Reimer Verlag 2004
- Prominski, M., Maass, M., Funke, L., Haaren, C.von, Kirsch-Stracke, R.: Urbane Natur gestalten - Entwurfsperspektiven zur Verbindung von Naturschutz und Freiraumnutzung., Birkhäuser Verlag, 2014

Bewertung

Zusätzliche Leistungsbewertung während des Semesters

Das Modul beinhaltet eine oder mehrere zusätzliche Leistungsbewertung(en) während des Semesters. Die erzielte Note der zusätzlichen Leistungsbewertung(en) gilt sowohl für die reguläre als auch für die Wiederholungsprüfung.

Beschreibung zusätzliche Leistungsbewertung während des Semesters

Bearbeitung der Übungen (Einzel- und Teamarbeiten). Eine individuelle Beurteilung von Teamresultaten bleibt vorbehalten. Die Übungsresultate fliessen mit folgender Gewichtung als Vornote in die Endnote ein: Übung 30 % - Prüfung 70 %

Grundsatz Prüfungen

Grundsätzlich werden alle regulären Abschlussprüfungen in schriftlicher Form durchgeführt. Bei den Wiederholungsprüfungen teilen die Dozierenden das Prüfungsformat (schriftlich/mündlich) zusammen mit dem Prüfungsplan mit.

Reguläre Modulschlussprüfung und schriftliche Wiederholungsprüfung

Art der Prüfung

Schriftliche Prüfung

Prüfungsdauer

120 Minuten

Erlaubte Hilfsmittel

Erlaubt sind die aufgeführten Hilfsmittel:

Zulässige elektronische Hilfsmittel

Keine elektronischen Hilfsmittel zulässig

Weitere erlaubte Hilfsmittel

Summary Umfang 4 A4 Seiten (zweiseitig beschrieben)

Ausnahme: Im Falle einer elektronischen Moodle-Prüfung können Änderungen der Hilfsmittel vorkommen. Dozierende werden die endgültig zulässigen Hilfsmittel vor der Prüfung bekanntgeben.

Spezialfall: Wiederholungsprüfung als mündliches Examen

Art der Prüfung

Mündliche Prüfung

Prüfungsdauer

30 Minuten

Erlaubte Hilfsmittel

Erlaubt sind die aufgeführten Hilfsmittel:

Zulässige elektronische Hilfsmittel

Keine elektronischen Hilfsmittel zulässig

Andere zulässige Hilfsmittel

Summary Umfang 4 A4 Seiten (zweiseitig beschrieben)

Module Description, available in: EN

Advanced thin film technology

General Information

Number of ECTS Credits

3

Module code

TSM_ThinFilm

Valid for academic year

2026-27

Last modification

2021-12-23

Coordinator of the module

Martin Krejci (FHNW, martin.krejci@fhnw.ch)

Explanations regarding the language definitions for each location:

- Instruction is given in the language specified for each location and module execution.
- Documentation is available in the language(s) listed for each location and module execution. If the documentation is in multiple languages, the percentage distributed is indicated (100% = all documentation provided).
- The examination, including both questions and answers, is provided entirely (100%) in the language(s) specified for each location and module execution. The exams are on-site.

	Lausanne			Lugano	Zurich		
Instruction					**X** E 100%		
Documentation					**X** E 100%		
Examination					**X** E 100%		

Module Category

TSM Technical scientific module

Profile Recommendations

This module is recommended for the following profiles:

	Zurich
Profile	Pho

Lessons

2 lecture periods and 1 tutorial period per week

Entry level competences

Prerequisites, previous knowledge

- Optics: Basics of wave and geometrical optics;
- Physics basics for engineers
- Analysis and linear algebra on FH bachelor level recommended

The students are required to fill possible gaps by self-study. Students without basic knowledge in optics are requested to complete the EVA module

"Fundamentals of Light" prior to the "Advanced Thin Film Technology" TSM module.

Brief course description of module objectives and content

The Technology of thin films is a core element in the design and fabrication of photonic components. The objective of the module "Advanced Thin Film Technology" is the introduction to this important technology and to the applications of thin films in the field of photonics with the focus on optical coatings. This includes the design and fabrication of thin films as well as the characterization of their physical properties.

Aims, content, methods

Learning objectives and competencies to be acquired

The students

- are familiar with the main deposition and structuring methods used in thin film technology. They know the advantages and drawbacks of the different methods and are able to select a suitable method for a given thin film design
- know important microstructural, chemical, mechanical, optical, electrical and thermal properties of thin films and are familiar with the relevant methods used in industry to characterize these properties
- understand the main physical concepts related to the application of thin films in photonics and are able to solve simple problems involving thin layers. They are able to perform calculations and evaluations of optical coating designs.
- know the most important applications of thin layers in passive and active devices

Module content with weighting of different components

There will be several thematic blocks. Although several different types of thin layers will be discussed, the focus will be set on optical coatings:

- Fabrication methods (~3 weeks)
  - A detailed discussion of deposition methods, with the focus on the following deposition method categories: Physical evaporation, Plasma enhanced physical and chemical deposition, liquid phase deposition
  - A rough introduction to structuring methods such as photo-, e-beam and imprint lithography, plasma assisted physical – and chemical dry etching, wet etching, lift-off
- Properties and characterization methods of thin films (~3 weeks)
  - Properties such as morphology, microstructure, optical and electric properties, chemical and mechanical properties
  - Methods such as atomic force microscopy and profilometry, optical an electron microscopy, focused ion beam, x-ray analytical methods, ion beam based methods (SIMS, RBS) as well ellipsometric and spectroscopic methods
- Physics of thin films (~3 weeks)
  - Optical properties:
    - Behavior of radiation in thin layers and at layer interfaces
    - Reflection, transmission and absorption properties of thin layers and and multilayer stacks
  - Material diffusion in thin layers
  - Mechanical behavior and adhesion of thin films
- Simulations of thin films (2 weeks)
  - Numerical simulation of optical properties
- Applications (~3 weeks)
  - Coatings designs for optical components such as lenses, mirrors and filters
  - Planar wave guide structures, gratings or plasmonic structures
  - Thin films in photonic devices

Teaching and learning methods

Will be defined by the lecturers

Literature

Used in lecture:

- Materials Science of Thin Films, 2nd edition, Milton Ohring, Academic Press
- Introduction to Optics, Frank Pedrotti, Pearson

Additional Literature:

- Optical Thin Films and Coatings, Editors: Angela Piegari, François Flory, Elsevier

Assessment

Additional performance assessment during the semester

The module does not contain an additional performance assessment during the semester

Basic principle for exams

As a rule, all standard final exams are conducted in written form. For resit exams, lecturers will communicate the exam format (written/oral) together with the exam schedule.

Standard final exam for a module and written resit exam

Kind of exam

Written exam

Duration of exam

120 minutes

Permissible aids

Aids permitted as specified below:

Permissible electronic aids

- Calculator

Other permissible aids

- Summary and personal formula collection without solved problems (number of pages to be defined by lecturers)

Exception: In case of an electronic Moodle exam, adjustments to the permissible aids may occur. Lecturers will announce the final permissible aids prior to the exam session.

Special case: Resit exam as oral exam

Kind of exam

Oral exam

Duration of exam

30 minutes

Permissible aids

No aids permitted

Module Description, available in: EN

Two-phase flows with heat and mass transport

General Information

Number of ECTS Credits

3

Module code

TSM_TwoPhase

Valid for academic year

2026-27

Last modification

2021-02-12

Coordinator of the module

Daniel Weiss (FHNW, daniel.weiss@fhnw.ch)

Explanations regarding the language definitions for each location:

- Instruction is given in the language specified for each location and module execution.
- Documentation is available in the language(s) listed for each location and module execution. If the documentation is in multiple languages, the percentage distributed is indicated (100% = all documentation provided).
- The examination, including both questions and answers, is provided entirely (100%) in the language(s) specified for each location and module execution. The exams are on-site.

	Lausanne			Lugano	Zurich		
Instruction					**X** E 100%		
Documentation					**X** E 100%		
Examination					**X** E 100%		

Module Category

TSM Technical scientific module

Profile Recommendations

This module is recommended for the following profiles:

	Zurich
Profile	EnEn

Lessons

2 lecture periods and 1 tutorial period per week

Entry level competences

Prerequisites, previous knowledge

Students should have a keen interest in transport phenomena and their description and modelling. Advanced knowledge of thermodynamics, fluid dynamics, heat transport and applied mathematics (ordinary and partial differential equations, algebraic equations, integral calculus) is of great benefit for students.

Brief course description of module objectives and content

This module deals with transport phenomena at postgraduate level with a focus on technical problems in material, heat and momentum transport, especially in the environment of multiphase flows. Working on the basis of conservation principles, transport equations are derived in a general form. In order to obtain closed solutions for specific problems, the general balance equations are combined with material laws and also with initial and boundary conditions. This then highlights the analogies and relations between transport phenomena in different technical fields.
In this way, students expand the knowledge and skills in thermodynamics, fluid dynamics and heat transport that they have acquired during their undergraduate studies and apply them to solving technical problems of practical relevance.

Aims, content, methods

Learning objectives and competencies to be acquired

Upon successful completion of the module

- students are familiar with the most important phenomena of mass, heat and momentum transport (this is the aim pursued in contact teaching, in particular.)
- the students can independently study similar topics in greater depth (this is the aim pursued through the self-study of selected chapters, in particular.)
- students are able to apply the methods covered to actual technical problems (this is the aim of the exercises between the contact lessons, in particular.)
- students are in a position to conduct analyses independently.

Module content with weighting of different components

The first half deals with general transport phenomena (with the focus on mass transport).
The second half covers phenomena with multiphase flows.

Teaching and learning methods

Frontal teaching, incorporating examples (lectures with 3 lessons)
Self-study of selected chapters from different sources
Between the lectures, exercises are to be solved; these will, if necessary, be discussed in class afterwards.

Literature

Experience has shown that the subjects cannot be covered by a single book. Instead, students are told to consult various books.
Selected sources are made available electronically:

- presentations from frontal teaching
- selected chapters from textbooks
- selected original works

Assessment

Additional performance assessment during the semester

The module does not contain an additional performance assessment during the semester

Basic principle for exams

As a rule, all standard final exams are conducted in written form. For resit exams, lecturers will communicate the exam format (written/oral) together with the exam schedule.

Standard final exam for a module and written resit exam

Kind of exam

Written exam

Duration of exam

120 minutes

Permissible aids

Aids permitted as specified below:

Permissible electronic aids

pocket calculator

Other permissible aids

All documents

Exception: In case of an electronic Moodle exam, adjustments to the permissible aids may occur. Lecturers will announce the final permissible aids prior to the exam session.

Special case: Resit exam as oral exam

Kind of exam

Oral exam

Duration of exam

30 minutes

Permissible aids

No aids permitted

Modulbeschreibung, verfügbar in: DE

Siedlungstransformation und nachhaltige Mobilität

Allgemeine Angaben

Anzahl ECTS-Credits

3

Modulkürzel

TSM_Urban

Gültig für akademisches Jahr

2026-27

Letzte Änderung

2023-09-26

Modul-Koordinator/in

Carsten Hagedorn (OST, carsten.hagedorn@ost.ch)

Erläuterungen zu den Sprachdefinitionen je Standort:

- Der Unterricht findet in der pro Standort und Durchführung definierten Sprache statt.
- Die Unterlagen sind in den pro Standort und Durchführung definierten Sprachen verfügbar. Bei Mehrsprachigkeit ist die prozentuale Verteilung angegeben (100% = komplette Unterlagen).
- Die Prüfungsfragen und -antworten sind in jeder pro Standort und Durchführung definierten Sprache. Die Prüfung wird vor Ort durchgeführt.

	Lausanne			Lugano	Zurich		
Unterricht						**X** D 100%	
Dokumentation						**X** D 100%	
Prüfung						**X** D 100%	

Modulkategorie

TSM Technisch-wissenschaftliche Vertiefung

Profilempfehlungen

Dieses Modul wird für die folgenden Profile empfohlen:

	Zurich
Profil	Geo

Lektionen

2 Lektionen und 1 Übungslektion pro Woche

Eintrittskompetenzen

Vorkenntnisse, Eingangskompetenzen

Vorkenntnisse in einem Teilbereich der räumlichen Planung, z.B. Raumplanung, Landschaftsarchitektur, Geografie, Verkehrsplanung oder in Bauingenieurwesen, Architektur

Kurzbeschreibung der Inhalte und Ziele

Das Modul behandelt die Disziplinen Verkehrsplanung, Städtebau und Stadtplanung anhand der Themen nachhaltige Mobilität, Innenentwicklung, Transformation des öffentlichen Raums sowie Klimaanpassung und Klimaschutz. Für die zentralen Themen werden Zielsetzungen und Umsetzungsmöglichkeiten einer nachhaltigen Mobilität und Siedlungsentwicklung erläutert sowie verkehrsplanerische und siedlungsplanerische Strategien aufgezeigt, diskutiert und angewendet.

Ziele, Inhalte, Methoden

Lernziele und zu erwerbende Kompetenzen

Den Studierenden soll folgendes vermittelt werden:

- Grundlagenwissen im Themenbereich Mobilität und Siedlungsplanung
- Beurteilungsmassstäbe für Fragestellungen der Raum- und Verkehrsplanung
- Instrumente und Verfahren der Verkehrsplanung

In den Übungsteilen sollen die Studierenden folgende Kompetenzen erreichen:

- Befähigung zum Erkennen von Zielkonflikten im Bereich Siedlung-Mobilität
- Überblick über raumstrukturelle Charakteristiken der Siedlungsplanung erhalten
- Bewusstseinsbildung für das Thema „nachhaltige Mobilität“ auf den Ebenen der Verkehrs- und Siedlungsplanung
- Befähigung zur Entwicklung konzeptioneller Lösungen im Bereich Mobilität, Verkehr und Transport

Die Studierenden kennen und verstehen:

- die Ebenen, Strukturen und Planungsschritte der Verkehrsplanung
- konzeptionelle und prozessuale Ansätze der Verkehrs- und Siedlungsplanung
- die wesentlichen Zusammenhänge zwischen Mobilität und Siedlung
- planerische, technologische und infrastrukturelle Bausteine einer nachhaltigen Mobilität

Die Studierenden sind in der Lage,

- komplexe Probleme im Bereich Siedlung und Mobilität zu erfassen
- Planungsaufgaben zu verstehen und Problemlösungen nachzuvollziehen

Modulinhalt mit Gewichtung der Lehrinhalte

Anwendung von Grundlagenwissen aus den Disziplinen Mobilität, Verkehrsplanung, Städtebau und Siedlungsentwicklung zu den Themenschwerpunkten: Innenentwicklung / Urbane Transformation, Gestaltung öffentlicher Raum, Klimaanpassung / Klimaschutz

Die Gewichtung der Lehrinhalte beträgt: Städtebau / Siedlungsentwicklung (50%) und Mobilität / Verkehrsplanung (50%).

Grundlagen:
Zusammenhänge zwischen Raumentwicklung und Mobilität
Einflussfaktoren der Mobilität
Städtebau, Innenentwicklung und Urbane Transformation
Die Planung und Gestaltung des öffentlichen Raums
Städtebau, Klimaschutz und Klimaanpassung

Städtebau / Siedlungsentwicklung:
Historische und aktuelle Raumtheorien
Modelle und Konzepte im Fokus von Zentralität, Urbanität und Identität
Räumliche und städtebauliche Typologien in Theorie und Praxis
Planerische Grundlagen zum nachhaltigen Umgang mit Dichte, Mischung und Nutzflächenbedarf
Zukunftsfähige Siedlungsstrukturen im Kontext
Klimaschutzes Zukunftsfähige Siedlungsstrukturen im Kontext der Klimaanpassung
Urbane Transformation und die Umgestaltung des öffentlichen Raums

Verkehrsplanung
Ebenen und Instrumente der Verkehrsplanung
Ziele und Wege zur Reduzierung der Umweltauswirkungen des Verkehrs
Stadt und Verkehr, Stadtverkehrskonzepte
Parkraumkonzepte und Parkraummanagement
Velo- und Fussverkehrsplanung

Lehr- und Lernmethoden

- Vorlesung und Referate
- Projektbezogenes Lernen
- Betreute Kurzübungen mit Fallstudien
- Seminardiskussionen
- Selbststudium

Bibliografie

laufend Vorlesungsunterlagen zu den angegebenen Themen des Kurses, Skripte

Bewertung

Zusätzliche Leistungsbewertung während des Semesters

Das Modul beinhaltet keine zusätzliche Leistungsbewertung während des Semesters.

Grundsatz Prüfungen

Grundsätzlich werden alle regulären Abschlussprüfungen in schriftlicher Form durchgeführt. Bei den Wiederholungsprüfungen teilen die Dozierenden das Prüfungsformat (schriftlich/mündlich) zusammen mit dem Prüfungsplan mit.

Reguläre Modulschlussprüfung und schriftliche Wiederholungsprüfung

Art der Prüfung

Schriftliche Prüfung

Prüfungsdauer

120 Minuten

Erlaubte Hilfsmittel

Erlaubt sind die aufgeführten Hilfsmittel:

Zulässige elektronische Hilfsmittel

Taschenrechner

Weitere erlaubte Hilfsmittel

Die erlaubten Hilfsmittel werden im Rahmen der Vorlesung auf Moodle bekannt gegeben.

Ausnahme: Im Falle einer elektronischen Moodle-Prüfung können Änderungen der Hilfsmittel vorkommen. Dozierende werden die endgültig zulässigen Hilfsmittel vor der Prüfung bekanntgeben.

Spezialfall: Wiederholungsprüfung als mündliches Examen

Art der Prüfung

Mündliche Prüfung

Prüfungsdauer

30 Minuten

Erlaubte Hilfsmittel

Ohne Hilfsmittel

Module Description, available in: EN

Advanced User Interfaces

General Information

Number of ECTS Credits

3

Module code

TSM_UseInf

Valid for academic year

2026-27

Last modification

2025-11-21

Coordinator of the module

Yanick Lukic (ZHAW, luki@zhaw.ch)

Explanations regarding the language definitions for each location:

- Instruction is given in the language specified for each location and module execution.
- Documentation is available in the language(s) listed for each location and module execution. If the documentation is in multiple languages, the percentage distributed is indicated (100% = all documentation provided).
- The examination, including both questions and answers, is provided entirely (100%) in the language(s) specified for each location and module execution. The exams are on-site.

	Lausanne			Lugano	Zurich		
Instruction					**X** E 100%		
Documentation					**X** E 100%		
Examination					**X** E 100%		

Module Category

TSM Technical scientific module

Profile Recommendations

This module is recommended for the following profiles:

	Zurich
Profile	CS

Lessons

2 lecture periods and 1 tutorial period per week

Entry level competences

Prerequisites, previous knowledge

- Basic principles of human cognition and human-machine interaction
- Basic knowledge of graphical user interfaces.

Brief course description of module objectives and content

Graphical User Interfaces have long become standard UIs for computers, and mobile devices have not only adopted these GUIs but augmented them with multi-touch screens, speech in- and output, gesture, handwriting recognition, and several additional sensors. This has fostered innovative ways of user interaction with the information available on these devices that were only been seen in professional environments so far. In the professional environment, the trend has further developed into more and more immersive systems where the user dives more or less entirely into a virtual world to interact with the vast amount of available information efficiently. In these scenarios, true hand tracking is gaining significant momentum vs. glove-based tracking systems.

This module gives a solid introduction to the fundamental concepts and techniques of both advanced user interfaces with different input and output channels and interaction modalities, as well as immersive systems with haptic interaction. Insight into developing these advanced user interfaces and immersive systems with hand-tracking interaction will be given through hands-on exercises.

Aims, content, methods

Learning objectives and competencies to be acquired

Students attending this module

- have complemented their knowledge about the user-centered UI design process and its major activities
- are familiar with a wide range of non-standard and advanced user interfaces and can discriminate and explain their characteristics, strengths and limitations
- possess a sound knowledge of the principles and (potential) application areas of non-standard user interfaces such as voice, gesture-based or haptic user interfaces as well as immersive systems and technologies
- know the required components and underlying technologies for these advanced user interfaces and are able to evaluate and design simple applications
- have extended their knowledge of user-centred design and usability to environments and applications using non-standard user interfaces and can evaluate their suitability for specific tasks or projects

Module content with weighting of different components

- The User-Centered Design Process (15%)
  - Fundamentals of Human-Computer Interaction (Recapitulation/Convergence)
  - UI Requirements Elicitation & Analysis: Stakeholders, Users, Business, Tasks and Context
  - UI Design & Evaluation: Principles, Patterns, Guidelines, and Techniques
  - Aligning with the Software Engineering process
- Recognition Based User Interfaces (45%)
  - Fundamentals of recognition-based interaction and pipelines (from raw input signals to interpreted user actions)
  - Statistical pattern classification for input recognition (HMMs, DNNs; handling uncertainty and errors)
  - Modern neural and sequence models as recognizers (for text, speech, and other sensed input)
  - Conversational user interfaces (design principles, dialog flows, prompts, and personas)
  - Implementation and evaluation of conversational and multimodal UIs (frameworks, APIs, UX considerations)
- Immersive Systems (40%)
  - Fundamentals of Virtual Reality (VR), Augmented Reality (AR) and Mixed Reality (MR) systems.
  - Technology for VR applications (human depth perception, 3D stereoscopic and volumetric displays, tracking and motion capturing technologies, locomotion interfaces)
  - PC-based VR system vs. stand-alone VR systems based on Android and iOS, cross-platform development
  - Use of game engines like "Unity" and "Unreal Engine"
  - Sonification

Teaching and learning methods

- Ex cathedra
- Self study of literature / publications
- Practical exercises

Literature

Assessment

Additional performance assessment during the semester

The module contains additional performance assessment(s) during the semester. The achieved mark of the additional performance assessment(s) applies to both the regular and the resit exam.

Description of additional performance assessment during the semester

The labs are graded. The overall grade of the labs accounts for 20% of the final module grade.

Basic principle for exams

As a rule, all standard final exams are conducted in written form. For resit exams, lecturers will communicate the exam format (written/oral) together with the exam schedule.

Standard final exam for a module and written resit exam

Kind of exam

Written exam

Duration of exam

120 minutes

Permissible aids

Aids permitted as specified below:

Permissible electronic aids

No electronic aids permitted

Other permissible aids

- Slides

- Own lecture notes

Exception: In case of an electronic Moodle exam, adjustments to the permissible aids may occur. Lecturers will announce the final permissible aids prior to the exam session.

Special case: Resit exam as oral exam

Kind of exam

Oral exam

Duration of exam

30 minutes

Permissible aids

No aids permitted

Module Description, available in: EN

Environmental Technologies: Wastewater Treatment

General Information

Number of ECTS Credits

3

Module code

TSM_WWTreat

Valid for academic year

2026-27

Last modification

2025-10-08

Coordinator of the module

Roger König (SUPSI, roger.koenig@supsi.ch)

Explanations regarding the language definitions for each location:

- Instruction is given in the language specified for each location and module execution.
- Documentation is available in the language(s) listed for each location and module execution. If the documentation is in multiple languages, the percentage distributed is indicated (100% = all documentation provided).
- The examination, including both questions and answers, is provided entirely (100%) in the language(s) specified for each location and module execution. The exams are on-site.

	Lausanne			Lugano	Zurich		
Instruction					**X** E 100%		
Documentation					**X** E 100%		
Examination					**X** E 100%		

Module Category

TSM Technical scientific module

Profile Recommendations

This module is recommended for the following profiles:

	Zurich
Profile	EnEn

Lessons

2 lecture periods and 1 tutorial period per week

Entry level competences

Prerequisites, previous knowledge

Basics in chemistry and physics

Brief course description of module objectives and content

The student learns the mechanical, chemical and biological processes used for environmental engineering (wastewater treatment). The course covers chemical, physical and biological treatment technologies. Furthermore, the topic of water reuse (greywater) and nutrient recovery is lectured.

Aims, content, methods

Learning objectives and competencies to be acquired

Knowing the classical areas of environmental technology, namely the sustainable treatment of

- Wastewater and
- reuse and nutrient recovery from wastewater

Wastewater:

- Know different applied wastewater treatment technologies and be able to identify their pros and cons.;
- Insides of technological aspects of the different technologies;
- Knowledge acquisition on the adequate technology for different wastewater compositions;

Reuse and nutrient recycling

- Know the importance of nutrient recovery;
- Know the available technologies for nutrient recovery in wastewater treatment;
- Acquire know-how on water reuse and application with case studies

Module content with weighting of different components

- Introduction: (1/3) - 30%
    - Overview water management Switzerland/Global
    - Wastewater treatment essentials (WWTP visit)
    - Fundamentals of chemical, physical and biological wastewater treatment
- Water treatment (municipal and industrial) technologies (2/3) - 50%
    - Physical and chemical wastewater treatment technologies
    - Biological Nutrient Removal technologies
    - Technologies for the elimination of emerging contaminants (Micropollutants)
- Water recycling and nutrient recovery (3/3) - 20%
    - Water reuse (Greywater reuse, Drinking water)
    - Nutrient recovery (P, N)

Teaching and learning methods

Front lecturing (theory) with open discussion and classworks.

Literature

- Slides given at the course from the Lecturer;
- Tchobanoglous et al. (2003) Wastewater Engineering Treatment and Reuse, Metcalf & Eddy, McGraw Hill, 4th Edition.
- Stuez Richard (2009) Principles of Water and Wastewater Treatment Processes, IWA Publishing
- Jud Simon (2009) Process Science and Engineering for Water and Wastewater Treatment, IWA Publishing

Assessment

Additional performance assessment during the semester

The module contains additional performance assessment(s) during the semester. The achieved mark of the additional performance assessment(s) applies to both the regular and the resit exam.

Description of additional performance assessment during the semester

Throughout the semester, students will collaborate on designing a wastewater treatment plant. This project will culminate in a report, which contributes 20% to the final grade.

The evaluation will be based on three key criteria:

1. The quality of the final design and results.
2. The approach and process followed to achieve these results.
3. The effectiveness of teamwork and collaboration.

Basic principle for exams

As a rule, all standard final exams are conducted in written form. For resit exams, lecturers will communicate the exam format (written/oral) together with the exam schedule.

Standard final exam for a module and written resit exam

Kind of exam

Written exam

Duration of exam

120 minutes

Permissible aids

No aids permitted

Exception: In case of an electronic Moodle exam, adjustments to the permissible aids may occur. Lecturers will announce the final permissible aids prior to the exam session.

Special case: Resit exam as oral exam

Kind of exam

Oral exam

Duration of exam

30 minutes

Permissible aids

No aids permitted

Module Description, available in: EN

Wireless Communications

General Information

Number of ECTS Credits

3

Module code

TSM_WireCom

Valid for academic year

2026-27

Last modification

2025-09-30

Coordinator of the module

Luciano Sarperi (ZHAW, sarp@zhaw.ch)

Explanations regarding the language definitions for each location:

- Instruction is given in the language specified for each location and module execution.
- Documentation is available in the language(s) listed for each location and module execution. If the documentation is in multiple languages, the percentage distributed is indicated (100% = all documentation provided).
- The examination, including both questions and answers, is provided entirely (100%) in the language(s) specified for each location and module execution. The exams are on-site.

	Lausanne			Lugano	Zurich		
Instruction					**X** E 100%		
Documentation					**X** E 100%		
Examination					**X** E 100%		

Module Category

TSM Technical scientific module

Profile Recommendations

This module is recommended for the following profiles:

	Zurich
Profile	CS

Lessons

2 lecture periods and 1 tutorial period per week

Entry level competences

Prerequisites, previous knowledge

The students are expected to have basic knowledge on serial communication, communication topologies (e.g. point-to-point, point-to-multipoint), OSI reference model, statistics and Fourier analysis.

Brief course description of module objectives and content

The module starts with the physical properties of radio propagation, analog and digital modulation and forward error correction.

Then the students will be exposed to the functioning and characteristics of a selection of the most important wireless standards at the present time. The focus will be on the physical layer and the medium-access layer.

Exercises will be used throughout the course to exemplify the use and application of the module content to examine existing standards for a given problem in the context of the merits and limitations of each technology.

Aims, content, methods

Learning objectives and competencies to be acquired

The student will be able to

- discriminate between the various advanced modulation, coding and transmission concepts and explain their benefits and limitations
- explain the key characteristics of a selection of the most important wireless standards at the present time in regards to the Physical and Data Link layers
- research information on different wireless technologies
- select the most suitable wireless technology for a practical problem.

Module content with weighting of different components

Common Fundamentals (25%)

Applications, requirements, market and frequency spectrum issues in wireless communications. Wireless receivers and transmitters, Radio propagation and Digital modulation and coding.

Standards(75%)

Introduction to a selection of the most important standards and technologies at the time of the course (the actual technologies taught may differ somewhat fom this list) :

- GSM / UMTS / LTE / 5G / IoT
- GNSS (GPS, Galileo)
- Satellite Communication
- WLAN / Bluetooth
- RFID
- DAB
- etc.

Teaching and learning methods

- Lectures
- Work through exercises
- Self-study:
  - completion of exercises
  - research using online and print resources
  - Analysis of case studies

Literature

- Ke-Lin Du, M.N.S. Swamy, "Wireless Communication Systems", Cambridge University Press, 2010
- J.-F. Wagen, "Mobile & Wireless Networks and Services", HEIA-FR book
- J. Proakis, M. Salehi, "Digital Communications", McGraw-Hill Press
- A. Paulraj, N. Nabar, D. Gore, "Introduction to Space-Time Wireless Communications", Cambridge University Press
- C. Lüders, "Mobilfunksysteme", Vogel Verlag
- M. Sauter, "Grundkurs Mobile Kommunikationssysteme", Springer Vieweg Verlag
- D. von Grünigen, "Digitale Signalverarbeitung", Fachbuchverlag Leipzig
- Klaus Finkenzeller, "RFID-Handbuch", 7. Auflage, Hanser Verlag
- J. Schiller, "Mobilkommunikation", Addison-Wesley
- B. Bhatta, "Global Navigation Satellite Systems: New Technologies and Applications", CRC Press
- R. Tanner (ed.), J. Woodard (ed.), "WCDMA Requirements and Practical Design", Wiley
- M. Sauter, "From GSM to LTE Advanced PRO and 5G", Wiley
- E. Dahlman, St. Parkvall, J. Skold, "4G LTE / LTE Advanced for Mobile Broadband", Elsevier
- E. Dahlman, St. Parkvall, J. Skold, "5G NR: The Next Generation Wireless Access Technology", Academic Press
- Gordon Colbach, "The WiFi Networking Book"
- G. Maral et al, "Satellite Communications Systems: Systems, Techniques and Technology", Wiley
- Standards, e.g. 3GPP, IEEE 802.x, ETS 300 401, ISO/IEC 18000-6C, ISO/IEC 15693

Assessment

Additional performance assessment during the semester

The module does not contain an additional performance assessment during the semester

Basic principle for exams

As a rule, all standard final exams are conducted in written form. For resit exams, lecturers will communicate the exam format (written/oral) together with the exam schedule.

Standard final exam for a module and written resit exam

Kind of exam

Written exam

Duration of exam

120 minutes

Permissible aids

Aids permitted as specified below:

Permissible electronic aids

Calculator

Other permissible aids

Part of the exam will be open book and there may be also a part in which no reference material is allowed.

Exception: In case of an electronic Moodle exam, adjustments to the permissible aids may occur. Lecturers will announce the final permissible aids prior to the exam session.

Special case: Resit exam as oral exam

Kind of exam

Oral exam

Duration of exam

30 minutes

Permissible aids

Aids permitted as specified below:

Permissible electronic aids

Calculator.

Other permissible aids

No reference material will be allowed.

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