# Master of Science in Engineering

Module Descriptions
Modulbeschreibungen
Descriptions de module

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

# 2021-2022

**Module Description, available in: EN**

# *Academic Writing and Presenting*

## General Information

**Number of ECTS Credits**

3

**Module code**

CM_AcWritPre

**Valid for academic year**

2021-2022

**Last modification**

2021-02-04

**Coordinator of the module**

Patrick Studer (ZHAW, stup@zhaw.ch)

**Explanations regarding the language definitions for each location:**

- Instruction is given in the language defined below for each location/each time the module is held.
- Documentation is available in the languages defined below. Where documents are in several languages, the percentage distribution is shown (100% = all the documentation).
- The examination is available 100% in the languages shown for each location/each time it is held.

| | Berne | 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

**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 advanced academic texts and to present them to an audience in an accurate, appropriate and convincing manner. The module is divided into a writing and a speaking 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 speaking 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 acquired competencies

At the end of the module, students are able

- to produce advanced 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, referring to relevant theories;
- to assess their own writing and presentation abilities, using appropriate instruments for self-assessment;
- to define pathways for future development in the area of academic writing and presenting.

### Contents of module with emphasis on teaching content

**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

### Certification requirements

Module uses certification requirements

### Certification requirements for final examinations (conditions for attestation)

Two in-semester project assignments, both have to be rated "sufficient" by the lecturers

Assignment 1

- Collaborative writing project in small group

Assignment 2

- Collaborative presentation in small group

(Alternatively: Two in-semester project assignments, which will be graded separately. The projects count 30% towards the final grade; the final written exam counts 70%).

### Basic principle for exams

**As a rule, all the standard final exams for modules and also all resit exams are to be in written form**

**Standard final exam for a module and written resit exam**

**Kind of exam**

written

**Duration of exam**

120 minutes

**Permissible aids**

*Aids permitted as specified below:*

**Permissible electronic aids**

No electronic aids permitted

**Other permissible aids**

Open book

**Special case: Resit exam as oral exam**

**Kind of exam**

oral

**Duration of exam**

30 minutes

**Permissible aids**

No aids permitted

MSE MASTER OF SCIENCE IN ENGINEERING

**Module Description, available in: EN, FR**

# *Advanced Project Management*

## General Information

**Number of ECTS Credits**

3

**Module code**

CM_AdvProjMgmt

**Valid for academic year**

2021-2022

**Last modification**

2021-02-05

**Coordinator of the module**

Antonio Bassi (SUPSI, antonio.bassi@supsi.ch)

**Explanations regarding the language definitions for each location:**

- Instruction is given in the language defined below for each location/each time the module is held.
- Documentation is available in the languages defined below. Where documents are in several languages, the percentage distribution is shown (100% = all the documentation).
- The examination is available 100% in the languages shown for each location/each time it is held.

| | Berne | 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

**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 acquired competencies

- 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

### Contents of module with emphasis on teaching content

- 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

### Certification requirements

Module uses certification requirements

### Certification requirements for final examinations (conditions for attestation)

Positive evaluation of a Project Work (1/3 of final mark)

### Basic principle for exams

**As a rule, all the standard final exams for modules and also all resit exams are to be in written form**

### Standard final exam for a module and written resit exam

**Kind of exam**

written

**Duration of exam**

120 minutes

**Permissible aids**

No aids permitted

### Special case: Resit exam as oral exam

**Kind of exam**

oral

**Duration of exam**

30 minutes

**Permissible aids**

No aids permitted

MSE MASTER OF SCIENCE IN ENGINEERING

**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**

2021-2022

**Dernière modification**

2021-02-05

**Coordinateur/coordinatrice du module**

Antonio Bassi (SUPSI, antonio.bassi@supsi.ch)

**Explication des définitions de langue par lieu :**

- Les cours se dérouleront dans la langue définie ci-dessous par lieu/exécution.
- Les documents sont disponibles dans les langues définies ci-dessous. Pour le multilinguisme, voir la répartition en pourcentage (100% = documents complets)
- L'examen est disponible à 100% dans chaque langue sélectionnée pour chaque lieu/exécution.

| | Berne | 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

**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

### Conditions d'admission

Le module utilise les conditions d'admission

### Conditions d'admission à l'examen de fin de module (exigences du certificat)

Evaluation positive d'un travail de projet  (1/3 de la note finale)

### Principe pour les examens

**En règle générale, tous les examens de fin de module réguliers et les examens de rattrapage sont organisés sous la forme écrite**

**Examen de fin de module régulier et examen écrit de répétition**

**Type de l'examen**

écrit

**Durée de l'examen**

120 minutes

**Aides autorisées**

Sans aides

**Cas spécial: examen de répétition oral**

**Type de l'examen**

oral

**Durée de l'examen**

30 minutes

**Aides autorisées**

Sans aides

**Module Description, available in: EN, FR**

# *Management of Complex Processes*

## General Information

**Number of ECTS Credits**

3

**Module code**

CM_ComplPro

**Valid for academic year**

2021-2022

**Last modification**

2020-01-23

**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 defined below for each location/each time the module is held.
- Documentation is available in the languages defined below. Where documents are in several languages, the percentage distribution is shown (100% = all the documentation).
- The examination is available 100% in the languages shown for each location/each time it is held.

| | Berne | 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**

CM Context module

**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 acquired competencies

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

### Contents of module with emphasis on teaching content

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

### Certification requirements

Module does not use certification requirements

### Basic principle for exams

**As a rule, all the standard final exams for modules and also all resit exams are to be in written form**

### Standard final exam for a module and written resit exam

**Kind of exam**

written

**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

### Special case: Resit exam as oral exam

**Kind of exam**

oral

**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

MASTER OF SCIENCE
IN ENGINEERING

**Description du module, disponible en: EN, FR**

# Gestion de processus complexes

## Informations générales

**Nombre de crédits ECTS**

3

**Code du module**

CM_ComplPro

**Valable pour l'année académique**

2021-2022

**Dernière modification**

2020-01-23

**Coordinateur/coordinatrice du module**

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

**Explication des définitions de langue par lieu :**

- Les cours se dérouleront dans la langue définie ci-dessous par lieu/exécution.
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| | Berne | 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**

CM modules contextuels

**Leçons**

2 leçons et 1 leçon de pratique par semaine

## Compétences préalables

**Connaissances préalables, compétences initiales**

## Brève description du contenu et des objectifs

L’un des plus grands défis du management consiste à identifier et à percevoir les opportunités tout en pesant les risques qui y sont associés. L’augmentation incessante du dynamisme et de la complexité de l’environnement où évoluent les entreprises et les organisations complique la prise de décisions judicieuses. Les interactions multifactorielles, les non-linéarités, les rétro-actions et les décalages dans le temps rendent difficile de prévoir correctement les répercussions d’une décision.
Une introduction aux méthodes et aux outils de prise de décision face à des questions complexes est présentée aux étudiants. Ces derniers se familiarisent notamment avec les diagrammes de causes et effets, les modèles de simulation quantitatifs et les appliquent dans des études de cas.

## Objectifs, contenus, méthodes

### Objectifs d'apprentissage, compétences à acquérir

Les étudiants

- connaissent les approches systémiques, savent identifier les limites d’un système et sont conscients que les modèles représentent toujours la réalité de façon imparfaite
- sont en mesure d’analyser correctement et méthodiquement des processus complexes et de communiquer dessus
- savent gérer méthodiquement des conflits d’objectifs (p. ex. coût contre qualité)
- peuvent représenter des processus complexes sous forme de réseau de causes et effets
- peuvent représenter des processus techniques et organisationnels sous forme de modèles de simulation par type d’événement
- connaissent les principales étapes d’une étude de simulation
- comprennent le cycle de la résolution de problème comme un processus créatif
- ont appris à mettre en pratique opérationnelle des méthodes de résolution de problème systémiques

### Contenu des modules avec pondération du contenu des cours

1. Bases des types de décision, processus de prise de décision et six sources d'influence
2. Modèles mentaux partagés
3. Introduction à la dynamique des systèmes (diagrammes de boucles causales, flux et stocks, analyse du comportement dynamique)
4. Paradigmes de simulation appliqués à la compréhension du comportement de systèmes dynamiques régis par des décisions humaines

### Méthodes d'enseignement et d'apprentissage

Enseignement frontal avec des exemples à résoudre en groupe. Exercices d’application et études de cas.

### Bibliographie


- 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.


## Evaluation

### Conditions d'admission

Le module n'utilise pas de conditions d'admission.

### Principe pour les examens

**En règle générale, tous les examens de fin de module réguliers et les examens de rattrapage sont organisés sous la forme écrite**

### Examen de fin de module régulier et examen écrit de répétition

**Type de l'examen**

écrit

**Durée de l'examen**

120 minutes

**Aides autorisées**

*Les aides suivantes sont autorisées:*

**Aides électroniques autorisées**

Pas de moyens électroniques de communication

**Autres aides autorisées**

Tous documents

### Cas spécial: examen de répétition oral

**Type de l'examen**

oral

**Durée de l'examen**

30 minutes

**Aides autorisées**

*Les aides suivantes sont autorisées:*

**Aides électroniques autorisées**

Pas de moyens électroniques de communication

**Autres aides**

Tous documents

MASTER OF SCIENCE
IN ENGINEERING

**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**

2021-2022

**Last modification**

2020-03-04

**Coordinator of the module**

Kerstin Wagner (FHGR, kerstin.wagner@fhgr.ch)

**Explanations regarding the language definitions for each location:**

- Instruction is given in the language defined below for each location/each time the module is held.
- Documentation is available in the languages defined below. Where documents are in several languages, the percentage distribution is shown (100% = all the documentation).
- The examination is available 100% in the languages shown for each location/each time it is held.

| | Berne | 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

**Lessons**

2 lecture periods and 1 tutorial period per week

## Entry level competences

**Prerequisites, previous knowledge**

Basic Knowledge in Business Administration 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 acquired competencies

**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.

### Contents of module with emphasis on teaching content

**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

### Literature

## Assessment

### Certification requirements

Module does not use certification requirements

### Basic principle for exams

**As a rule, all the standard final exams for modules and also all resit exams are to be in written form**

### Standard final exam for a module and written resit exam

**Kind of exam**

written

**Duration of exam**

120 minutes

**Permissible aids**

No aids permitted

**Special case: Resit exam as oral exam**

**Kind of exam**

oral

**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**

2021-2022

**Dernière modification**

2020-03-04

**Coordinateur/coordinatrice du module**

Kerstin Wagner (FHGR, kerstin.wagner@fhgr.ch)

**Explication des définitions de langue par lieu :**

- Les cours se dérouleront dans la langue définie ci-dessous par lieu/exécution.
- Les documents sont disponibles dans les langues définies ci-dessous. Pour le multilinguisme, voir la répartition en pourcentage (100% = documents complets)
- L'examen est disponible à 100% dans chaque langue sélectionnée pour chaque lieu/exécution.

| | Berne | 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

**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

### Conditions d'admission

Le module n'utilise pas de conditions d'admission.

### Principe pour les examens

**En règle générale, tous les examens de fin de module réguliers et les examens de rattrapage sont organisés sous la forme écrite**

**Examen de fin de module régulier et examen écrit de répétition**

**Type de l'examen**

écrit

**Durée de l'examen**

120 minutes

**Aides autorisées**

Sans aides

**Cas spécial: examen de répétition oral**

**Type de l'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**

2021-2022

**Last modification**

2021-02-08

**Coordinator of the module**

Herbert Winistörfer (ZHAW, winh@zhaw.ch)

**Explanations regarding the language definitions for each location:**

- Instruction is given in the language defined below for each location/each time the module is held.
- Documentation is available in the languages defined below. Where documents are in several languages, the percentage distribution is shown (100% = all the documentation).
- The examination is available 100% in the languages shown for each location/each time it is held.

| | Berne | Lausanne | | | Lugano | Zurich | | |
|---|---|---|---|---|---|---|---|---|
| **Instruction** | | | | | | **X** E 100% | | |
| **Documentation** | | | | | | **X** E 100% | | |
| **Examination** | | | | | | **X** E 100% | | |

**Module Category**

CM Context module

**Lessons**

2 lecture periods and 1 tutorial period per week

## Entry level competences

**Prerequisites, previous knowledge**

## Brief course description of module objectives and content

In an environment that is changing increasingly quickly, students will be taught the ability to assume societal responsibility either as engineers or in management functions in companies. They will develop a profound awareness of the moral and ethical aspects of their actions and also for the ecological and social impacts of companies. In their subsequent professional careers, they will 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 philosophy of their organisations in a manner appropriate to their positions.

## Aims, content, methods

### Learning objectives and acquired competencies

- The students know the theoretical foundations of various ethical philosophies
- The students are familiar with various levels of ethics (individual ethics versus corporate ethics)
- The students can apply different ethical approaches in a specific situation
- The students are familiar with the concept of the broader societal Corporate Responsibility of organisations
- The students are familiar with the main elements of the implementation of Corporate Responsibility in companies
- The students are able to analyse and critically judge the Corporate Responsibility philosophy of a given company on the basis of publicly available information

### Contents of module with emphasis on teaching content

The courses of development of moral values (virtues) and systematic ethical concepts (norms) in the history of philosophy:

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; sustainability
- 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 organisations/companies in society
- The expectations of stakeholder groups and dealing with these expectations (Stakeholder Management)
- “Corporate Responsibility”: The various concepts of responsibility, Corporate Social Responsibility–CSR (various theoretical approaches), sustainability (Brundtland/Rio’92), “Triple Bottom Line” (Elkington, Savitz), Capital Stock Model (World Bank, IIRC), Corporate Citizenship CC
- Corporate Responsibility in the ecological, social, economic and technological areas (sample topics), 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 projects.

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

### Literature

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

## Assessment

### Certification requirements

Module uses certification requirements

### Certification requirements for final examinations (conditions for attestation)

Proof of active participation

### Basic principle for exams

**As a rule, all the standard final exams for modules and also all resit exams are to be in written form**

### Standard final exam for a module and written resit exam

#### Kind of exam

written

#### Duration of exam

120 minutes

**Permissible aids**

*Aids permitted as specified below:*

**Permissible electronic aids**

No electronic aids permitted

**Other permissible aids**

Specified by the lecturers

**Special case: Resit exam as oral exam**

**Kind of exam**

oral

**Duration of exam**

30 minutes

**Permissible aids**

No aids permitted

MSE MASTER OF SCIENCE IN ENGINEERING

**Module Description, available in: EN, FR**

# *Innovation and Changemanagement*

## General Information

**Number of ECTS Credits**

3

**Module code**

CM_InnChang

**Valid for academic year**

2021-2022

**Last modification**

2021-02-12

**Coordinator of the module**

Andreas Ziltener (FHGR, andreas.ziltener@fhgr.ch)

**Explanations regarding the language definitions for each location:**

- Instruction is given in the language defined below for each location/each time the module is held.
- Documentation is available in the languages defined below. Where documents are in several languages, the percentage distribution is shown (100% = all the documentation).
- The examination is available 100% in the languages shown for each location/each time it is held.

| | Berne | 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

**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 module aims to explain the operational planning and management of innovations to students on the basis of an integrated innovation management model, as well as introducing them to the relevant concepts. This will enable students to establish links to various company-internal and company-external interfaces as part of innovation projects and to correctly interpret and influence these. In this module, students will be trained as “innovation managers” in a broad sense.

## Aims, content, methods

### Learning objectives and acquired competencies

- 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

### Contents of module with emphasis on teaching content

The Innovation and Change Management module deals with the following topics:

- Foundations: definition and contents; types of innovations, commercial and economic importance of innovations
- Innovation system: international, national, regional innovation systems and the most important innovation promotion instruments
- Innovation cycle: innovation management model with innovation routine, dynamic capabilities and strategic areas of activity. Relevance to general management and its methods
- Innovation strategy: strategic fit, strategic alternatives, success factors, imitation strategies, related diversification, co-creation, new venture
- Innovation structure: innovation-friendly process and development organisation, change-capable organisation profiles, open vs. closed innovation
- Innovation culture: innovation-friendly corporate culture, initialisation, conception, mobilisation, implementation and embedding of change, Corporate Entrepreneurship
- Innovation controlling: indices, indicators, BSC approaches, creation and success participation for innovation initiatives
- Definition of terms, structure and history of the innovation process, demarcation of routine and innovation processes
- The dilemma of innovative companies (incremental, radical and disruptive innovations) and possible solutions for this
- Structuring of the corporate innovation process as a phase model
- Structuring of the initiative and selection phases in the innovation process
- Structuring of the implementation phase in the innovation process (development of new products as a risk-reduction process)
- The challenge of the “escalation of commitment” during the implementation phase in the innovation process
- Intangible property law and strategies for the protection of ideas

### Teaching and learning methods

Physical presence: teaching discussions, didactic case studies, practical exercises, presentations
Self-study: study of literature, preparations and follow-up, classroom teaching, group projects

The students apply what they have learned with the aid of practical examples by identifying innovation-relevant problems and selecting and correctly using appropriate tools and methods to solve these problems.

### Literature

Notes will be provided.

The following literature recommendations should also be taken into account:


- 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

### Certification requirements

Module uses certification requirements

### Certification requirements for final examinations (conditions for attestation)

During the course of the semester, the students regularly work on assignments, prepare a knowledge transfer report based on a practical example and present the results at the end of the semester. This midterm assessment is weighted with 30% to the module grade.

### Basic principle for exams

**As a rule, all the standard final exams for modules and also all resit exams are to be in written form**

### Standard final exam for a module and written resit exam

**Kind of exam**

written

**Duration of exam**

120 minutes

**Permissible aids**

*Aids permitted as specified below:*

**Permissible electronic aids**

No electronic aids permitted

**Other permissible aids**

In paper form: open book, summary

### Special case: Resit exam as oral exam

**Kind of exam**

oral

**Duration of exam**

30 minutes

**Permissible aids**

No aids permitted

MSE MASTER OF SCIENCE IN ENGINEERING

**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**

2021-2022

**Dernière modification**

2021-02-12

**Coordinateur/coordinatrice du module**

Andreas Ziltener (FHGR, andreas.ziltener@fhgr.ch)

**Explication des définitions de langue par lieu :**

- Les cours se dérouleront dans la langue définie ci-dessous par lieu/exécution.
- Les documents sont disponibles dans les langues définies ci-dessous. Pour le multilinguisme, voir la répartition en pourcentage (100% = documents complets)
- L'examen est disponible à 100% dans chaque langue sélectionnée pour chaque lieu/exécution.

| | Berne | 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

**Leçons**

2 leçons et 1 leçon de pratique par semaine

## Compétences préalables

**Connaissances préalables, compétences initiales**

aucun

## Brève description du contenu et des objectifs

Après une introduction aux différentes notions, le module a pour but d'expliquer aux étudiants la planification opérationnelle et la gestion des innovations à l'aide d'un modèle de gestion de l'innovation intégré. Les étudiants sont alors en mesure d'établir des liens avec des interfaces internes et externes à l'entreprise, de les interpréter et de les influencer. Les étudiants sont formés pour devenir des «managers de l'innovation» au sens large.

## 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 Gestion de l'innovation et du changement aborde les thèmes suivants:

- Bases: notions et contenu; natures des innovations, importance de l'innovation sur le plan à la fois micro- et macro-économique
- Systèmes d'innovation: systèmes d'innovation internationaux, nationaux, régionaux ainsi que les outils de promotion de l'innovation
- Carrefour de l'innovation: modèle de gestion de l'innovation avec une routine de l'innovation, capacités dynamiques et domaines d'activité stratégiques, rapport avec le management général et ses méthodes
- Stratégie de l'innovation: concordance stratégique, alternatives stratégiques, facteurs de réussite, stratégies d'imitation, diversification connexe, co-création, new venture
- Structure de l'innovation: process et procédures favorables à l'innovation, profils d'organisation flexibles, innovation ouverte vs. fermée
- Culture de l'innovation: culture d'entreprise favorable à l'innovation, initialisation, conception, mobilisation, réalisation et mise en étapes du changement, corporate entrepreneurship
- Contrôle de l'innovation: indices, chiffres clés, approches BSC, genèse et participation aux réussites dans le cadre des initiatives innovation
- Définition des notions, structure et histoire des processus d'innovation, délimitation des processus de routine et d'innovation
- Le dilemme des entreprises innovantes (innovations incrémentales, radicales et disruptives) et les solutions possibles
- Conception du processus d'innovation opérationnel sous forme de modèle de phases
- Conception de la phase d'initiatives et de sélection dans le processus d'innovation
- Conception de la phase de réalisation dans le processus d'innovation (développement de nouveaux produits comme processus de réduction des risques)
- Le défi de «l'escalade de l'engagement» durant la phase de réalisation dans le processus d'innovation
- Droit des biens immatériel et stratégies de protection pour la protection des idées

### Méthodes d'enseignement et d'apprentissage

Cours présentiels: discussions guidées, études de cas didactiques, exercices, mini-enseignements
Etude autonome: étude de biographie, préparation et révision des cours présentiels, groupes de travail
A l'aide d'exemples tirés de la pratique, les étudiants appliquent ce qu'ils ont appris en identifiant les problèmes liés à l'innovation, en choisissant et en appliquant à bon escient les outils et méthodes adaptés à leur solution.

### 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

### Conditions d'admission

Le module utilise les conditions d'admission

### Conditions d'admission à l'examen de fin de module (exigences du certificat)

Les étudiants travailleront régulièrement sur des devoirs tout au long du semestre, produiront un rapport de transfert de théorie à l'aide d'un exemple pratique et présenteront les résultats à la fin du semestre. Cette évaluation intermédiaire est pondérée de 30 % par rapport à la note du module.

### Principe pour les examens

**En règle générale, tous les examens de fin de module réguliers et les examens de rattrapage sont organisés sous la forme écrite**

### Examen de fin de module régulier et examen écrit de répétition

**Type de l'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

### Cas spécial: examen de répétition oral

**Type de l'examen**

oral

**Durée de l'examen**

30 minutes

**Aides autorisées**

Sans aides

MSE MASTER OF SCIENCE IN ENGINEERING

**Module Description, available in: EN**

# *Innovation and Lean*

## General Information

**Number of ECTS Credits**

3

**Module code**

CM_InnoLEAN

**Valid for academic year**

2021-2022

**Last modification**

2018-10-29

**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 defined below for each location/each time the module is held.
- Documentation is available in the languages defined below. Where documents are in several languages, the percentage distribution is shown (100% = all the documentation).
- The examination is available 100% in the languages shown for each location/each time it is held.

| | Berne | Lausanne | | | Lugano | Zurich | | |
|---|---|---|---|---|---|---|---|---|
| **Instruction** | | | | | **X** E 100% | | | |
| **Documentation** | | | | | **X** E 100% | | | |
| **Examination** | | | | | **X** E 100% | | | |

**Module Category**

CM Context module

**Lessons**

2 lecture periods and 1 tutorial period per week

## Entry level competences

**Prerequisites, previous knowledge**

Basic Knowledge in production management.

## 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 its innovation path. 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 acquired competencies

- 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

### Contents of module with emphasis on teaching content

- Basic Innovation management (Types of innovation, Technology Acceptance Model, Diffusion Of Innovation, Quantitative model for DOI)
- Lean approach
- Lean 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 little group or by themselves
Lean Lab – serious gaming to develop a deep understanding of the theoretical concepts

### Literature

## Assessment

### Certification requirements

Module uses certification requirements

### Certification requirements for final examinations (conditions for attestation)

Final Written Exam + positive evaluation of the Serious-Game report

### Basic principle for exams

**As a rule, all the standard final exams for modules and also all resit exams are to be in written form**

### Standard final exam for a module and written resit exam

**Kind of exam**

written

**Duration of exam**

120 minutes

**Permissible aids**

No aids permitted

### Special case: Resit exam as oral exam

**Kind of exam**

oral

**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**

2021-2022

**Last modification**

2018-10-31

**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 defined below for each location/each time the module is held.
- Documentation is available in the languages defined below. Where documents are in several languages, the percentage distribution is shown (100% = all the documentation).
- The examination is available 100% in the languages shown for each location/each time it is held.

| | Berne | Lausanne | | | Lugano | Zurich | | |
|---|---|---|---|---|---|---|---|---|
| **Instruction** | | | | | **X** E 100% | | | |
| **Documentation** | | | | | **X** E 100% | | | |
| **Examination** | | | | | **X** E 100% | | | |

**Module Category**

CM Context module

**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 acquired competencies

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.

### Contents of module with emphasis on teaching content

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 software.

### Literature

ISO 14001

OHSAS 18000

ISO 50001

ISO 26000

ISO 14040 and 14044

ISO 14020 series

ISO 14064

ISO 14067

## Assessment

### Certification requirements

Module does not use certification requirements

### Basic principle for exams

**As a rule, all the standard final exams for modules and also all resit exams are to be in written form**

### Standard final exam for a module and written resit exam

**Kind of exam**

written

**Duration of exam**

120 minutes

**Permissible aids**

No aids permitted

**Special case: Resit exam as oral exam**

**Kind of exam**

oral

**Duration of exam**

30 minutes

**Permissible aids**

No aids permitted

MASTER OF SCIENCE
IN ENGINEERING

**Module Description, available in: EN, FR**

# *Privacy and Law*

## General Information

**Number of ECTS Credits**

3

**Module code**

CM_PrivLaw

**Valid for academic year**

2021-2022

**Last modification**

2019-01-23

**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 defined below for each location/each time the module is held.
- Documentation is available in the languages defined below. Where documents are in several languages, the percentage distribution is shown (100% = all the documentation).
- The examination is available 100% in the languages shown for each location/each time it is held.

| | Berne | 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

**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 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 contractsetc.

## Aims, content, methods

### Learning objectives and acquired competencies

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.

### Contents of module with emphasis on teaching content

- 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, Blockchain etc.
- Formative tests

### Teaching and learning methods

Frontal instruction in the lectures (2 lessons per week)
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

### Certification requirements

Module uses certification requirements

### Certification requirements for final examinations (conditions for attestation)

80% attendance

### Basic principle for exams

**As a rule, all the standard final exams for modules and also all resit exams are to be in written form**

### Standard final exam for a module and written resit exam

**Kind of exam**

written

**Duration of exam**

120 minutes

**Permissible aids**

*Aids permitted as specified below:*

**Permissible electronic aids**

Laptop

**Other permissible aids**

Open Book

### Special case: Resit exam as oral exam

**Kind of exam**

oral

**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**

2021-2022

**Dernière modification**

2019-01-23

**Coordinateur/coordinatrice du module**

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

**Explication des définitions de langue par lieu :**

- Les cours se dérouleront dans la langue définie ci-dessous par lieu/exécution.
- Les documents sont disponibles dans les langues définies ci-dessous. Pour le multilinguisme, voir la répartition en pourcentage (100% = documents complets)
- L'examen est disponible à 100% dans chaque langue sélectionnée pour chaque lieu/exécution.

| | Berne | 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

**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 étudiants 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 experts.

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

### Bibliographie

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

## Evaluation

### Conditions d'admission

Le module utilise les conditions d'admission

### Conditions d'admission à l'examen de fin de module (exigences du certificat)

80% de présence

### Principe pour les examens

**En règle générale, tous les examens de fin de module réguliers et les examens de rattrapage sont organisés sous la forme écrite**

### Examen de fin de module régulier et examen écrit de répétition

**Type de l'examen**

écrit

**Durée de l'examen**

120 minutes

**Aides autorisées**

*Les aides suivantes sont autorisées:*

**Aides électroniques autorisées**

Laptop

**Autres aides autorisées**

Open Book

### Cas spécial: examen de répétition oral

**Type de l'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

MASTER OF SCIENCE
IN ENGINEERING

**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**

2021-2022

**Last modification**

2020-01-24

**Coordinator of the module**

Christian Zipper (ZHAW, christian.zipper@zhaw.ch)

**Explanations regarding the language definitions for each location:**

- Instruction is given in the language defined below for each location/each time the module is held.
- Documentation is available in the languages defined below. Where documents are in several languages, the percentage distribution is shown (100% = all the documentation).
- The examination is available 100% in the languages shown for each location/each time it is held.

| | Berne | 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

**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 acquired competencies

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 QRM 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.

### Contents of module with emphasis on teaching content

**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)
- 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)
- Qualitative approaches (Fishbone Diagram, Master Logic Diagram, Bow Tie Analysis, Hazard and Operability Study (HAZOP))
- Semi-quantitative approaches (Failure Mode and Effects Analysis (FMEA))
- Quantitative approaches (fault tree analysis, event tree analysis)
- Quantification and data sources
- 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 310000:2018, ONR 49000ff:2008, AS/NZS 4360
Literature on QM und RM (electronically distributed).

## Assessment

### Certification requirements

Module does not use certification requirements

### Basic principle for exams

**As a rule, all the standard final exams for modules and also all resit exams are to be in written form**

### Standard final exam for a module and written resit exam

**Kind of exam**

written

**Duration of exam**

120 minutes

**Permissible aids**

*Aids permitted as specified below:*

**Permissible electronic aids**

No electronic aids permitted

**Other permissible aids**

Notes as communicated with students (2 A4 pages)

**Special case: Resit exam as oral exam**

**Kind of exam**

oral

**Duration of exam**

30 minutes

**Permissible aids**

No aids permitted

**Description du module, disponible en: EN, FR**

# *Qualité et gestion de risque*

## Informations générales

**Nombre de crédits ECTS**

3

**Code du module**

CM_QRM

**Valable pour l'année académique**

2021-2022

**Dernière modification**

2020-01-24

**Coordinateur/coordinatrice du module**

Christian Zipper (ZHAW, christian.zipper@zhaw.ch)

**Explication des définitions de langue par lieu :**

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- L'examen est disponible à 100% dans chaque langue sélectionnée pour chaque lieu/exécution.

| | Berne | 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

**Leçons**

2 leçons et 1 leçon de pratique par semaine

## Compétences préalables

**Connaissances préalables, compétences initiales**

rien

## 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'évaluation 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 exemplaires (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)
- 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 de l'évaluation du risque (concepts de base, définitions)
- Méthodes qualitatives (diagramme en arêtes de poisson, Master Logic Diagram, méthode d'analyse dite du nœud papillon, étude HAZOP (Hazard and Operability)
- Méthodes semi-quantitatives (modes de défaillances et de leurs effets, AMDEC (FMEA Failure Mode and Effects Analysis))
- Méthodes quantitatives source de donnés
- Bases de l'analyse de fiabilité (paramètres de fiabilité, taux de défaillance, sources des données)
- Évaluation du risque (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 310000, ONR 49000, AS/NZS 4360 et al.
Bibliographie concernant la gestion de la qualité et la gestion du risque (distribuée électroniquement)

## Evaluation

### Conditions d'admission

Le module n'utilise pas de conditions d'admission.

### Principe pour les examens

**En règle générale, tous les examens de fin de module réguliers et les examens de rattrapage sont organisés sous la forme écrite**

### Examen de fin de module régulier et examen écrit de répétition

**Type de l'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 selon les indications données aux étudiants (2 pages A4)

### Cas spécial: examen de répétition oral

**Type de l'examen**

oral

**Durée de l'examen**

30 minutes

**Aides autorisées**

Sans aides

MASTER OF SCIENCE
IN ENGINEERING

**Module Description, available in: EN**

# *Smart services*

## General Information

**Number of ECTS Credits**

3

**Module code**

CM_SmartSer

**Valid for academic year**

2021-2022

**Last modification**

2019-12-11

**Coordinator of the module**

Jürg Meierhofer (ZHAW, meeo@zhaw.ch)

**Explanations regarding the language definitions for each location:**

- Instruction is given in the language defined below for each location/each time the module is held.
- Documentation is available in the languages defined below. Where documents are in several languages, the percentage distribution is shown (100% = all the documentation).
- The examination is available 100% in the languages shown for each location/each time it is held.

| | Berne | Lausanne | | | Lugano | Zurich | | |
|---|---|---|---|---|---|---|---|---|
| **Instruction** | | | | | | **X** E 100% | | |
| **Documentation** | | | | | | **X** E 100% | | |
| **Examination** | | | | | | **X** E 100% | | |

**Module Category**

CM Context module

**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 acquired competencies

- 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.

### Contents of module with emphasis on teaching content

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

**Certification requirements**

Module does not use certification requirements

**Basic principle for exams**

**As a rule, all the standard final exams for modules and also all resit exams are to be in written form**

**Standard final exam for a module and written resit exam**

**Kind of exam**

written

**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

**Special case: Resit exam as oral exam**

**Kind of exam**

oral

**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**

2021-2022

**Last modification**

2020-02-10

**Coordinator of the module**

Michael Bösch (FHNW, michael.boesch@fhnw.ch)

**Explanations regarding the language definitions for each location:**

- Instruction is given in the language defined below for each location/each time the module is held.
- Documentation is available in the languages defined below. Where documents are in several languages, the percentage distribution is shown (100% = all the documentation).
- The examination is available 100% in the languages shown for each location/each time it is held.

| | **Berne** | **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

**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 acquired competencies

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.

### Contents of module with emphasis on teaching content

- 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

### Certification requirements

### Basic principle for exams

**As a rule, all the standard final exams for modules and also all resit exams are to be in written form**

### Standard final exam for a module and written resit exam

**Kind of exam**

written

**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.

### Special case: Resit exam as oral exam

**Kind of exam**

oral

**Duration of exam**

30 minutes

**Permissible aids**

No aids permitted

MASTER OF SCIENCE
IN ENGINEERING

**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**

2021-2022

**Dernière modification**

2020-02-10

**Coordinateur/coordinatrice du module**

Michael Bösch (FHNW, michael.boesch@fhnw.ch)

**Explication des définitions de langue par lieu :**

- Les cours se dérouleront dans la langue définie ci-dessous par lieu/exécution.
- Les documents sont disponibles dans les langues définies ci-dessous. Pour le multilinguisme, voir la répartition en pourcentage (100% = documents complets)
- L'examen est disponible à 100% dans chaque langue sélectionnée pour chaque lieu/exécution.

| | Berne | 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

**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 résolument 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

### Conditions d'admission

### Principe pour les examens

**En règle générale, tous les examens de fin de module réguliers et les examens de rattrapage sont organisés sous la forme écrite**

### Examen de fin de module régulier et examen écrit de répétition

**Type de l'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

### Cas spécial: examen de répétition oral

**Type de l'examen**

oral

**Durée de l'examen**

30 minutes

**Aides autorisées**

Sans aides

**Module Description, available in: EN**

# Technology Management

## General Information

**Number of ECTS Credits**

3

**Module code**

CM_TechMgmt

**Valid for academic year**

2021-2022

**Last modification**

2019-11-23

**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 defined below for each location/each time the module is held.
- Documentation is available in the languages defined below. Where documents are in several languages, the percentage distribution is shown (100% = all the documentation).
- The examination is available 100% in the languages shown for each location/each time it is held.

| | Berne | Lausanne | | | Lugano | Zurich | | |
|---|---|---|---|---|---|---|---|---|
| **Instruction** | | | | | | **X** E 100% | | |
| **Documentation** | | | | | | **X** E 100% | | |
| **Examination** | | | | | | **X** E 100% | | |

**Module Category**

CM Context module

**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 of technologies and the related methods in Technology Management.

## Aims, content, methods

### Learning objectives and acquired competencies

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 the 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 stakeholders relevant for Technology Management.

### Contents of module with emphasis on teaching content

Technologies are among the most important strategic and operational assets of product and process driven companies. The module deals with mastering technologies to enable companies to achieve competitive advantage and differentiation by sound Technology Management. The focus of the module is on management of technology throughout its lifecycle, thus complementing topics such as Innovation, Solution, Product and Project Management, covering strategic and operational aspects including technology evaluation, planning, development/provision, implementation, distribution, exploitation and dismantling (de- and re-manufacturing). Examples of new technologies will be considered in group work and discussed as practice examples. 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, technology assessment, as well as technology communication and related aspects of effective stakeholder management.

### Teaching and learning methods

The module is taught by theory inputs, illustrative examples, case studies, discussion of controversal questions and exercises. Content is applied in the context of a project assignment.

### Literature

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

## Assessment

### Certification requirements

Module uses certification requirements

### Certification requirements for final examinations (conditions for attestation)

A project to be compiled through independent study.

### Basic principle for exams

**As a rule, all the standard final exams for modules and also all resit exams are to be in written form**

### Standard final exam for a module and written resit exam

#### Kind of exam

written

#### 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.

Dictionary.

**Special case: Resit exam as oral exam**

**Kind of exam**

oral

**Duration of exam**

30 minutes

**Permissible aids**

No 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**

2021-2022

**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 defined below for each location/each time the module is held.
- Documentation is available in the languages defined below. Where documents are in several languages, the percentage distribution is shown (100% = all the documentation).
- The examination is available 100% in the languages shown for each location/each time it is held.

| | Berne | Lausanne | | | Lugano | Zurich | | |
|---|---|---|---|---|---|---|---|---|
| **Instruction** | | | | | **X** E 100% | | | |
| **Documentation** | | | | | **X** E 100% | | | |
| **Examination** | | | | | **X** E 100% | | | |

**Module Category**

FTP Fundamental theoretical principles

**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 acquired competencies

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.

### Contents of module with emphasis on teaching content

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

### Certification requirements

Module does not use certification requirements

### Basic principle for exams

**As a rule, all the standard final exams for modules and also all resit exams are to be in written form**

### Standard final exam for a module and written resit exam

**Kind of exam**

written

**Duration of exam**

120 minutes

**Permissible aids**

No aids permitted

### Special case: Resit exam as oral exam

**Kind of exam**

oral

**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**

2021-2022

**Last modification**

2020-01-06

**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 defined below for each location/each time the module is held.
- Documentation is available in the languages defined below. Where documents are in several languages, the percentage distribution is shown (100% = all the documentation).
- The examination is available 100% in the languages shown for each location/each time it is held.

| | Berne | 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

**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 acquired competencies

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.

### Contents of module with emphasis on teaching content

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.

É. Taillard Introductions aux méta-heuristiques, WWW, 2015-2020


## Assessment

### Certification requirements

Module does not use certification requirements

**Basic principle for exams**

**As a rule, all the standard final exams for modules and also all resit exams are to be in written form**

**Standard final exam for a module and written resit exam**

**Kind of exam**

written

**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)

**Special case: Resit exam as oral exam**

**Kind of exam**

oral

**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**

2021-2022

**Dernière modification**

2020-01-06

**Coordinateur/coordinatrice du module**

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

**Explication des définitions de langue par lieu :**

- Les cours se dérouleront dans la langue définie ci-dessous par lieu/exécution.
- Les documents sont disponibles dans les langues définies ci-dessous. Pour le multilinguisme, voir la répartition en pourcentage (100% = documents complets)
- L'examen est disponible à 100% dans chaque langue sélectionnée pour chaque lieu/exécution.

| | **Berne** | **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

**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.

É. Taillard Introductions aux méta-heuristiques, WWW, 2015-2020

## Evaluation

### Conditions d'admission

Le module n'utilise pas de conditions d'admission.

### Principe pour les examens

**En règle générale, tous les examens de fin de module réguliers et les examens de rattrapage sont organisés sous la forme écrite**

### Examen de fin de module régulier et examen écrit de répétition

**Type de l'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)

### Cas spécial: examen de répétition oral

**Type de l'examen**

oral

**Durée de l'examen**

30 minutes

**Aides autorisées**

Sans aides

MASTER OF SCIENCE
IN ENGINEERING

**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**

2021-2022

**Last modification**

2021-03-30

**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 defined below for each location/each time the module is held.
- Documentation is available in the languages defined below. Where documents are in several languages, the percentage distribution is shown (100% = all the documentation).
- The examination is available 100% in the languages shown for each location/each time it is held.

| | Berne | 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

**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 acquired competencies

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.

### Contents of module with emphasis on teaching content

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

### Certification requirements

Module does not use certification requirements

### Basic principle for exams

**As a rule, all the standard final exams for modules and also all resit exams are to be in written form**

### Standard final exam for a module and written resit exam

**Kind of exam**

written

**Duration of exam**

120 minutes

**Permissible aids**

*Aids permitted as specified below:*

**Permissible electronic aids**

pocket calculator

**Other permissible aids**

pens, ruler, manuscripts, books

### Special case: Resit exam as oral exam

**Kind of exam**

oral

**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**

2021-2022

**Dernière modification**

2021-03-30

**Coordinateur/coordinatrice du module**

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

**Explication des définitions de langue par lieu :**

- Les cours se dérouleront dans la langue définie ci-dessous par lieu/exécution.
- Les documents sont disponibles dans les langues définies ci-dessous. Pour le multilinguisme, voir la répartition en pourcentage (100% = documents complets)
- L'examen est disponible à 100% dans chaque langue sélectionnée pour chaque lieu/exécution.

| | **Berne** | **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

**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

### Conditions d'admission

Le module n'utilise pas de conditions d'admission.

### Principe pour les examens

**En règle générale, tous les examens de fin de module réguliers et les examens de rattrapage sont organisés sous la forme écrite**

### Examen de fin de module régulier et examen écrit de répétition

**Type de l'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

### Cas spécial: examen de répétition oral

**Type de l'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**

2021-2022

**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 defined below for each location/each time the module is held.
- Documentation is available in the languages defined below. Where documents are in several languages, the percentage distribution is shown (100% = all the documentation).
- The examination is available 100% in the languages shown for each location/each time it is held.

| | Berne | Lausanne | | | Lugano | Zurich | | |
|---|---|---|---|---|---|---|---|---|
| **Instruction** | | | | | **X** E 100% | | | |
| **Documentation** | | | | | **X** E 100% | | | |
| **Examination** | | | | | **X** E 100% | | | |

**Module Category**

FTP Fundamental theoretical principles

**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 acquired competencies

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.

### Contents of module with emphasis on teaching content

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

### Certification requirements

Module does not use certification requirements

### Basic principle for exams

**As a rule, all the standard final exams for modules and also all resit exams are to be in written form**

### Standard final exam for a module and written resit exam

**Kind of exam**

written

**Duration of exam**

120 minutes

**Permissible aids**

No aids permitted

### Special case: Resit exam as oral exam

**Kind of exam**

oral

**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**

2021-2022

**Last modification**

2019-12-09

**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 defined below for each location/each time the module is held.
- Documentation is available in the languages defined below. Where documents are in several languages, the percentage distribution is shown (100% = all the documentation).
- The examination is available 100% in the languages shown for each location/each time it is held.

| | Berne | Lausanne | | | Lugano | Zurich | | |
|---|---|---|---|---|---|---|---|---|
| **Instruction** | | | | | **X** E 100% | | | |
| **Documentation** | | | | | **X** E 100% | | | |
| **Examination** | | | | | **X** E 100% | | | |

**Module Category**

FTP Fundamental theoretical principles

**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 acquired competencies

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

- mammalian cell biology
- the most important physiological systems
- the anatomy systems
- human pathology

### Contents of module with emphasis on teaching content

Basics of mammalian cell biology including 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

### Certification requirements

Module does not use certification requirements

### Basic principle for exams

**As a rule, all the standard final exams for modules and also all resit exams are to be in written form**

### Standard final exam for a module and written resit exam

**Kind of exam**

written

**Duration of exam**

120 minutes

**Permissible aids**

*Aids permitted as specified below:*

**Permissible electronic aids**

No electronic aids permitted

**Other permissible aids**

The student can consult the course material.

### Special case: Resit exam as oral exam

**Kind of exam**

oral

**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**

2021-2022

**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 defined below for each location/each time the module is held.
- Documentation is available in the languages defined below. Where documents are in several languages, the percentage distribution is shown (100% = all the documentation).
- The examination is available 100% in the languages shown for each location/each time it is held.

| | Berne | 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

**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 acquired competencies

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

### Contents of module with emphasis on teaching content

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

### Certification requirements

Module does not use certification requirements

### Basic principle for exams

**As a rule, all the standard final exams for modules and also all resit exams are to be in written form**

### Standard final exam for a module and written resit exam

**Kind of exam**

written

**Duration of exam**

120 minutes

**Permissible aids**

*Aids permitted as specified below:*

**Permissible electronic aids**

No electronic aids permitted

**Other permissible aids**

Open Book

### Special case: Resit exam as oral exam

**Kind of exam**

oral

**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**

2021-2022

**Dernière modification**

2019-07-15

**Coordinateur/coordinatrice du module**

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

**Explication des définitions de langue par lieu :**

- Les cours se dérouleront dans la langue définie ci-dessous par lieu/exécution.
- Les documents sont disponibles dans les langues définies ci-dessous. Pour le multilinguisme, voir la répartition en pourcentage (100% = documents complets)
- L'examen est disponible à 100% dans chaque langue sélectionnée pour chaque lieu/exécution.

| | Berne | 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

**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

**Conditions d'admission**

Le module n'utilise pas de conditions d'admission.

**Principe pour les examens**

**En règle générale, tous les examens de fin de module réguliers et les examens de rattrapage sont organisés sous la forme écrite**

**Examen de fin de module régulier et examen écrit de répétition**

**Type de l'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

**Cas spécial: examen de répétition oral**

**Type de l'examen**

oral

**Durée de l'examen**

30 minutes

**Aides autorisées**

Sans aides

MASTER OF SCIENCE
IN ENGINEERING

**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**

2021-2022

**Last modification**

2018-11-01

**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 defined below for each location/each time the module is held.
- Documentation is available in the languages defined below. Where documents are in several languages, the percentage distribution is shown (100% = all the documentation).
- The examination is available 100% in the languages shown for each location/each time it is held.

| | Berne | 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

**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 acquired competencies

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

### Contents of module with emphasis on teaching content

- 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++)

| Week | Contents (Order and weighting may be adapted) |
|---|---|
| 1 | Algebraic basics:<br>modular arithmetic, Euclidean algorithm, extended Euclidean algorithm, Bezout theorem, Fermat Euler theorem, Chinese Remainder theorem |
| 2 | |
| 3 | Asymmetric (public key) cryptography:<br>Diffie Hellman key exchange, RSA algorithm, digital signatures |
| 4 | |
| 5 | Algebraic basics: polynomials and finite fields |
| 6 | Symmetric (secret key) cryptography:<br>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), modes of operation, authenticated encryption |
| 8 | Elliptic Curve Diffie Hellman (ECDH), digital signatures |
| 9 | |
| 10 | One-time pad (OTP), Quantum Cryptography |
| 11 | Error-correcting codes:<br>Cyclic codes, Reed-Solomon, BCH, Convolutional Codes, Turbo 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
- 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

### Certification requirements

Module uses certification requirements

### Certification requirements for final examinations (conditions for attestation)

Presence is required during at least 10 exercice sessions

### Basic principle for exams

**As a rule, all the standard final exams for modules and also all resit exams are to be in written form**

### Standard final exam for a module and written resit exam

**Kind of exam**

written

**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.

### Special case: Resit exam as oral exam

**Kind of exam**

oral

**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

MASTER OF SCIENCE
IN ENGINEERING

**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**

2021-2022

**Dernière modification**

2018-11-01

**Coordinateur/coordinatrice du module**

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

**Explication des définitions de langue par lieu :**

- Les cours se dérouleront dans la langue définie ci-dessous par lieu/exécution.
- Les documents sont disponibles dans les langues définies ci-dessous. Pour le multilinguisme, voir la répartition en pourcentage (100% = documents complets)
- L'examen est disponible à 100% dans chaque langue sélectionnée pour chaque lieu/exécution.

| | **Berne** | **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

**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++)

| Semaine | Contenu du cours (l'ordre des thèmes et leur pondération peuvent varier) |
|---|---|
| 1 | Algebraic basics:<br>modular arithmetic, Euclidean algorithm, extended Euclidean algorithm, Bezout theorem, Fermat Euler theorem, Chinese Remainder theorem |
| 2 | |
| 3 | Asymmetric (public key) cryptography:<br>Diffie Hellman key exchange, RSA algorithm, digital signatures |
| 4 | |
| 5 | Algebraic basics: polynomials and finite fields |
| 6 | Symmetric (secret key) cryptography:<br>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), modes of operation, authenticated encryption |
| 8 | Elliptic Curve Diffie Hellman (ECDH), digital signatures |
| 9 | |
| 10 | One-time pad (OTP), Quantum Cryptography |
| 11 | Error-correcting codes:<br>Cyclic codes, Reed-Solomon, BCH, Convolutional Codes, Turbo 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
- 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

### Conditions d'admission

Le module utilise les conditions d'admission

### Conditions d'admission à l'examen de fin de module (exigences du certificat)

Présence à 10 séances d'exercices au minimum

### Principe pour les examens

**En règle générale, tous les examens de fin de module réguliers et les examens de rattrapage sont organisés sous la forme écrite**

### Examen de fin de module régulier et examen écrit de répétition

**Type de l'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.

### Cas spécial: examen de répétition oral

**Type de l'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**

# Digital Image Processing

## General Information

**Number of ECTS Credits**

3

**Module code**

FTP_DigImPro

**Valid for academic year**

2021-2022

**Last modification**

2021-01-12

**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 defined below for each location/each time the module is held.
- Documentation is available in the languages defined below. Where documents are in several languages, the percentage distribution is shown (100% = all the documentation).
- The examination is available 100% in the languages shown for each location/each time it is held.

| | Berne | 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

**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 acquired competencies

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.

### Contents of module with emphasis on teaching content

**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

### Certification requirements

Module does not use certification requirements

### Basic principle for exams

**As a rule, all the standard final exams for modules and also all resit exams are to be in written form**

### Standard final exam for a module and written resit exam

**Kind of exam**

written

**Duration of exam**

120 minutes

**Permissible aids**

*Aids permitted as specified below:*

**Permissible electronic aids**

No electronic aids permitted

**Other permissible aids**

open book

**Special case: Resit exam as oral exam**

**Kind of exam**

oral

**Duration of exam**

30 minutes

**Permissible aids**

*Aids permitted as specified below:*

**Permissible electronic aids**

No electronic aids permitted

**Other permissible aids**

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**

2021-2022

**Last modification**

2018-11-06

**Coordinator of the module**

Elena-Lavinia Niederhäuser (HES-SO, elena-lavinia.niederhaeuser@hefr.ch)

**Explanations regarding the language definitions for each location:**

- Instruction is given in the language defined below for each location/each time the module is held.
- Documentation is available in the languages defined below. Where documents are in several languages, the percentage distribution is shown (100% = all the documentation).
- The examination is available 100% in the languages shown for each location/each time it is held.

| | Berne | 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

**Lessons**

2 lecture periods and 1 tutorial period per week

## Entry level competences

**Prerequisites, previous knowledge**

This course should sensitize students to the questions of sustainable energy employment and is directed towards a wide public. Knowledge of the fundamentals of thermodynamics and energy engineering is advantageous but not mandatory.
Generally, the course will be taught in English in ZH and in French in LS.

## Brief course description of module objectives and content

Energy is one of the major 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. The 2000-watt society envisages reducing the current output of 6 kW utilized by each citizen to 2 kW by the end of the century.

It is possible to end the existing dependence of a country’s Gross National Product on energy consumption. There are numerous ways to lower energy consumption without losing wealth. Often, these solutions are not implemented by decision makers in the political, economic and technological sectors because of a lack of knowledge of the physical connections in energy engineering. The law of supply and demand, which can lever new forms of energy, will only become effective when substantial price increases result from the serious bottlenecks in the power supply. The early discussion and implementation of solutions for the future energy supply is currently providing Switzerland with a long-term substantial economic advantage in international competition.

The objective of this course is threefold: We will begin by dealing with the subject of the energy problem using Switzerland as an example. Afterwards, we will develop feasible solutions, such as using energy rationally, recovering heat, or applying heat pumps for the use of energy potential at a lower temperature. In addition, we will discuss how to implement measures within the private sector, at an industrial site, or in a municipality.

In the course Energy: Production, Consumption and Management, we will address the necessary theoretical basic principles of energy technology. Using concrete examples, the functionality of various procedures of energy transformation and of systems with which energy can be used intelligently and efficiently will be conveyed.

This course is aimed particularly at students who have an interest in energy technology and related fields and have recognized the need to seek applicable solutions. The course provides the necessary basic principles for the multifaceted aspects of the topic.

## Aims, content, methods

### Learning objectives and acquired competencies

- To become acquainted with short, medium and long-term energy sources which are available nationally and/or world-wide; to gain an understanding of the technical connections of efficient employment of energy in the future (2000-watt society, the carbon dioxide problem);
- Ability to understand and communicate with specialists from the 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, and to do this without disregarding economic, ecological and social aspects. This involves:
  - the knowledge of the economical potential of energy systems,
  - the knowledge of methods of rational energy use, and
  - the ability to quantify energy conservation with thermodynamics methods.

### Contents of module with emphasis on teaching content

This module addresses the following aspects:

- Available forms of energy (renewable or non-renewable)
- The demand for these forms of energy and their stocks
- The value of the various forms of energy (‘Noblesse’)
- Small and large-scale power plants
- The potential of recycling energy
- Energy management in industry and in buildings
- The economical advantages of rational energy use
- Mobility
- LCA
- Sustainability

### Teaching and learning methods

Ex-cathedra teaching, presentations, case studies

### Literature

- Fundamentals of Engineering Thermodynamics, 5th INTERNATIONAL Edition
  Michael J. Moran, The Ohio State Univ.
  Howard N. Shapiro, Iowa State Univ. of Science and Technology
- Introduction to Thermal Systems Engineering: Thermodynamics, Fluid Mechanics, and Heat Transfer, INTERNATIONAL Edition
  Michael J. Moran, The Ohio State Univ.
  Howard N. Shapiro, Iowa State Univ.
  Bruce R. Munson, Iowa State Univ.
  David P. DeWitt, Purdue Univ.
- Thermodynamique et Energétique, Tome 1: de l’énergie à l’exergie, L. Borel & D. Favrat, Presses Polytechniques et Universitaires Romandes, 2005
- Technische Thermodynamik, Theoretische Grundlagen und praktische Anwendungen, G. Cerbe und G. Wilhelms, Hanser Verlag
- Plan directeur de la recherche énergétique de la Confédération pour les années 2013 à 2016, Office fédéral de l’énergie OFEN. Février 2013 (www.recherche-energetique.ch)

## Assessment

### Certification requirements

Module uses certification requirements

### Certification requirements for final examinations (conditions for attestation)

Evaluation of the seminar contributions from different sections that are co-requisites for the admission requirement for the module examination.

### Basic principle for exams

**As a rule, all the standard final exams for modules and also all resit exams are to be in written form**

### Standard final exam for a module and written resit exam

**Kind of exam**

written

**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

### Special case: Resit exam as oral exam

**Kind of exam**

oral

**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**

2021-2022

**Dernière modification**

2018-11-06

**Coordinateur/coordinatrice du module**

Elena-Lavinia Niederhäuser (HES-SO, elena-lavinia.niederhaeuser@hefr.ch)

**Explication des définitions de langue par lieu :**

- Les cours se dérouleront dans la langue définie ci-dessous par lieu/exécution.
- Les documents sont disponibles dans les langues définies ci-dessous. Pour le multilinguisme, voir la répartition en pourcentage (100% = documents complets)
- L'examen est disponible à 100% dans chaque langue sélectionnée pour chaque lieu/exécution.

| | Berne | 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

**Leçons**

2 leçons et 1 leçon de pratique par semaine

## Compétences préalables

**Connaissances préalables, compétences initiales**

Ce cours de sensibilisation à l’énergétique s’adresse à un très large public. Des connaissances de base de thermodynamique sont un avantage mais ne sont pas indispensables.

La connaissance de l’anglais, de la part de l’étudiant, se résume à la compréhension. Aucun critère lié à la maîtrise de la langue ne sera pris en compte.

## Brève description du contenu et des objectifs

L’énergie est une grande préoccupation d’aujourd’hui et le problème de la disponibilité de la ressource et de son utilisation optimale va encore s’amplifier demain. Alors que la consommation énergétique ne cesse de croître en Suisse, une volonté politique tend à vouloir réduire notre consommation (actuelle de 6 kW) à 2 kW, d’ici la fin du 21e siècle.

Bien qu’il existe une relation entre le PIB d’un pays et sa consommation d’énergie, une multitude de solutions existent pour limiter la consommation. Elles sont cependant rarement appliquées par méconnaissance du domaine, sur les plans politique, social, économique et technique. Basée sur la loi de l’offre et de la demande, la pénurie ne se fera sentir que lentement, à coup d’augmentations plus ou moins brutales. Il est donc nécessaire d’aborder maintenant les solutions de l’avenir afin d’anticiper les besoins du marché et de pouvoir en retirer les avantages.

L’approche de ce cours est de poser d’abord la problématique au niveau du pays et présenter des éléments de solutions applicables, tant pour les ressources, l’utilisation rationnelle ou encore la valorisation de rejets industriels. Puis la mise en application au niveau d’un site industriel, d’une communauté ou dans le domaine privé, est abordée.

Partant de constats et des mesures globales, le cours est guidé par des considérations théoriques tout en s’appuyant sur des exemples concrets, permettant de comprendre comment traiter intelligemment l’énergie.

Ce cours est spécialement conçu pour tout bachelor éprouvant le besoin ou l’intérêt de comprendre les enjeux énergétiques et de choisir les solutions appropriées au contexte. Il donne ainsi les bases indispensables aux multiples aspects des métiers de l’énergie.

## 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. (société à 2 kW, CO2)
- 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’économies 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 :

- Les ressources énergétiques existantes (renouvelables ou non)
- Les besoins et les réserves de ces différentes formes d’énergie
- La valeur des différentes formes d’énergie (noblesse)
- Les petites et grandes pertes d’énergie
- Les potentiels de revalorisation de l’énergie
- La gestion de l’énergie dans l’industrie et les bâtiments
- Les avantages économiques d’une utilisation rationnelle de l’énergie.
- La mobilité
- LCA
- Systèmes durables

### Méthodes d'enseignement et d'apprentissage

Cours frontal, exposés, séminaires, étude de cas

### Bibliographie


- Fundamentals of Engineering Thermodynamics, 5th INTERNATIONAL Edition
  Michael J. Moran, The Ohio State Univ.
  Howard N. Shapiro, Iowa State Univ. of Science and Technology
- Introduction to Thermal Systems Engineering: Thermodynamics, Fluid Mechanics, and Heat Transfer, INTERNATIONAL Edition
  Michael J. Moran, The Ohio State Univ.
  Howard N. Shapiro, Iowa State Univ.
  Bruce R. Munson, Iowa State Univ.
  David P. DeWitt, Purdue Univ.
- Thermodynamique et Energétique, Tome 1: de l’énergie à l’exergie, L. Borel & D. Favrat, Presses Polytechniques et Universitaires Romandes, 2005
- Technische Thermodynamik, Theoretische Grundlagen und praktische Anwendungen, G. Cerbe und G. Wilhelms, Hanser Verlag
- Plan directeur de la recherche énergétique de la Confédération pour les années 2008 à 2011, Office fédéral de l’énergie OFEN. Avril 2007 (www.recherche-energetique.ch)

## Evaluation

### Conditions d'admission

Le module utilise les conditions d'admission

### Conditions d'admission à l'examen de fin de module (exigences du certificat)

Evaluation des séminaires en plusieurs étapes attestant l’accès à l’examen de fin de module.

### Principe pour les examens

**En règle générale, tous les examens de fin de module réguliers et les examens de rattrapage sont organisés sous la forme écrite**

### Examen de fin de module régulier et examen écrit de répétition

**Type de l'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

### Cas spécial: examen de répétition oral

**Type de l'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

MASTER OF SCIENCE
IN ENGINEERING

**Modulbeschreibung, verfügbar in: DE, FR**

# *Raumplanungs-, Bau- und Umweltrecht*

## Allgemeine Angaben

**Anzahl ECTS-Credits**

3

**Modulkürzel**

FTP_EnviPlan

**Gültig für akademisches Jahr**

2021-2022

**Letzte Änderung**

2019-09-12

**Modul-Koordinator/in**

Meinrad Huser (FHNW, meinrad.huser@fhnw.ch)

**Erläuterungen zu den Sprachdefinitionen je Standort:**

- Der Unterricht findet in der unten definierten Sprache je Standort/Durchführung statt.
- Die Unterlagen sind in den unten definierten Sprachen verfügbar. Bei Mehrsprachigkeit, siehe prozentuale Verteilung (100% = komplette Unterlagen)
- Die Prüfung ist in jeder je Standort/Durchführung angekreuzten Sprache zu 100% verfügbar.

| | Berne | 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

**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, 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: Zürcher Planungs- und Baurecht. Band 1: Planungsrecht, Verfahren und Rechtsschutz. 5. Aufl. Zürich 2011.
- Fritzsche Christoph/Bösch Peter/Wipf Thomas: Zürcher Planungs- und Baurecht. Band 2: Bau- und Umweltrecht. 5. Aufl. Zürich 2011.
- 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;<br>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 2013.
- Vito Roberto / Hrubesch-Millauer Stephanie: Sachenrecht. 4. Aufl. Bern 2014.
- Skripte der Dozierenden

## Bewertung

**Zulassungsbedingungen**

Modul verwendet Zulassungsbedingungen

**Zulassungsbedingungen für die Modulabschlussprüfung (Testatbedingungen)**

90% Anwesenheit (d.h. 1 Woche fehlen ist erlaubt)

**Grundsatz Prüfungen**

**In der Regel werden alle regulären Modulabschlussprüfungen und Wiederholungsprüfungen in schriftlicher Form gehalten**

**Reguläre Modulschlussprüfung und schriftliche Wiederholungsprüfung**

**Art der Prüfung**

schriftlich

**Prüfungsdauer**

120 Minuten

**Erlaubte Hilfsmittel**

*Erlaubt sind die aufgeführten Hilfsmittel:*

**Zulässige elektronische Hilfsmittel**

PC (Laptop)

**Weitere erlaubte Hilfsmittel**

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

**Spezialfall: Wiederholungsprüfung als mündliches Examen**

**Art der Prüfung**

mündlich

**Prüfungsdauer**

30 Minuten

**Erlaubte Hilfsmittel**

Ohne Hilfsmittel

MASTER OF SCIENCE
IN ENGINEERING

**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**

2021-2022

**Dernière modification**

2019-09-12

**Coordinateur/coordinatrice du module**

Meinrad Huser (FHNW, meinrad.huser@fhnw.ch)

**Explication des définitions de langue par lieu :**

- Les cours se dérouleront dans la langue définie ci-dessous par lieu/exécution.
- Les documents sont disponibles dans les langues définies ci-dessous. Pour le multilinguisme, voir la répartition en pourcentage (100% = documents complets)
- L'examen est disponible à 100% dans chaque langue sélectionnée pour chaque lieu/exécution.

| | Berne | 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

**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: Zürcher Planungs- und Baurecht. Band 1: Planungsrecht, Verfahren und Rechtsschutz. 5 Aufl. Zürich 2011.
- Fritzsche Christoph/Bösch Peter/Wipf Thomas: Zürcher Planungs- und Baurecht. Band 2: Bau- und Umweltrecht. 5. Aufl. Zürich 2011. 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 2013. Vito Roberto / Hrubesch-Millauer Stephanie: Sachenrecht. 4. Aufl. Bern 2014.
- Notes des enseignants

## Evaluation

### Conditions d'admission

Le module utilise les conditions d'admission

### Conditions d'admission à l'examen de fin de module (exigences du certificat)

Assiduité 90% (1 semaine d'absence admise)

### Principe pour les examens

**En règle générale, tous les examens de fin de module réguliers et les examens de rattrapage sont organisés sous la forme écrite**

### Examen de fin de module régulier et examen écrit de répétition

**Type de l'examen**

écrit

**Durée de l'examen**

120 minutes

**Aides autorisées**

*Les aides suivantes sont autorisées:*

**Aides électroniques autorisées**

PC (Laptop)

**Autres aides autorisées**

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

### Cas spécial: examen de répétition oral

**Type de l'examen**

oral

**Durée de l'examen**

30 minutes

**Aides autorisées**

Sans aides

MASTER OF SCIENCE
IN ENGINEERING

**Module Description, available in: EN**

# *Lifecycle Management of Infrastructures*

## General Information

**Number of ECTS Credits**

3

**Module code**

FTP_Life

**Valid for academic year**

2021-2022

**Last modification**

2021-01-05

**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 defined below for each location/each time the module is held.
- Documentation is available in the languages defined below. Where documents are in several languages, the percentage distribution is shown (100% = all the documentation).
- The examination is available 100% in the languages shown for each location/each time it is held.

| | Berne | Lausanne | | | Lugano | Zurich | | |
|---|---|---|---|---|---|---|---|---|
| **Instruction** | | | | | | **X** E 100% | | |
| **Documentation** | | | | | | **X** E 100% | | |
| **Examination** | | | | | | **X** E 100% | | |

**Module Category**

FTP Fundamental theoretical principles

**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)

MS Excel (implementation of formulae, graphs)

## Brief course description of module objectives and content

In this module, students are introduced into basic concepts of lifecycle management of infrastructures with respect to costs vs benefit. Established cost and benefit models of infrastructures are discussed. Based on lifecycle costs analysis, we introduce different methods for the assessment of maintenance strategies, and for decision making with respect to construction, preservation, and replacement. The cost-based approaches are complemented with methods for the analysis of reliability, availability, and risk.

## Aims, content, methods

### Learning objectives and acquired competencies

- 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
- the students are familiar with concepts for deriving requirements for infrastructures, their verification and validation.
- the students are familiar with the most important methods for decision making in infrastructure management, and are able to apply 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.
- 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

### Contents of module with emphasis on teaching content

- 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
- Basic concepts of maintenance
  - Reliability and availability
  - failure and degradation behavior of systems and components, and modeling
  - Basic maintenance strategies and associated processes
- Maintenance management
  - decision making in maintenance
  - condition based maintenance
  - Reliability Centered Maintenance (RCM)
  - Risk based maintenance
  - Maintenance management in large asset portfolios

### Teaching and learning methods

Lecture: Introduction in the relevant concepts with examples

Exercises: applications and use cases

### Literature

Supplementary publications.

Note: Since part of the module content is based on Swiss standards, some literature is provided in German/French only.

## Assessment

### Certification requirements

Module does not use certification requirements

### Basic principle for exams

**As a rule, all the standard final exams for modules and also all resit exams are to be in written form**

### Standard final exam for a module and written resit exam

#### Kind of exam

written

**Duration of exam**

120 minutes

**Permissible aids**

*Aids permitted as specified below:*

**Permissible electronic aids**

calculator (not programmable)

**Other permissible aids**

summary of content (max 20 pages)

**Special case: Resit exam as oral exam**

**Kind of exam**

oral

**Duration of exam**

30 minutes

**Permissible aids**

No aids permitted

**Module Description, available in: EN**

# *Machine Learning*

## General Information

**Number of ECTS Credits**

3

**Module code**

FTP_MachLe

**Valid for academic year**

2021-2022

**Last modification**

2020-02-11

**Coordinator of the module**

Helmut Grabner (ZHAW, grbn@zhaw.ch)

**Explanations regarding the language definitions for each location:**

- Instruction is given in the language defined below for each location/each time the module is held.
- Documentation is available in the languages defined below. Where documents are in several languages, the percentage distribution is shown (100% = all the documentation).
- The examination is available 100% in the languages shown for each location/each time it is held.

| | Berne | Lausanne | | | Lugano | Zurich | | |
|---|---|---|---|---|---|---|---|---|
| **Instruction** | | **X** E 100% | | | | **X** E 100% | | |
| **Documentation** | | **X** E 100% | | **X** E 100% | | **X** E 100% | | |
| **Examination** | | **X** E 100% | | | | **X** E 100% | | |

**Module Category**

FTP Fundamental theoretical principles

**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 acquired competencies

- 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

### Contents of module with emphasis on teaching content

- **Introduction** (2 weeks): Convergence for participants with different backgrounds
- **Supervised learning** (7 weeks): Learn from labeled data
  Cross-cutting topics: Feature engineering; ensemble learning; debugging ML systems
  Algorithms: e.g. SVM, ensemble learning, graphical models (Bayesian networks)
- **Unsupervised learning** (3 weeks): Learning without labels
  Algorithms: e.g., dimensionality reduction, anomaly detection, archetypal analysis
- **Special chapters** (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)

### Literature

T. Mitchell, “Machine Learning”, 1997

C. M. Bishop, “Pattern Recognition and Machine Learning”, 2006

G. James et al., “An Introduction to Statistical Learning”, 2014

K. Murphy, “Machine Learning – A Probabilistic Perspective”, 2012

## Assessment

### Certification requirements

Module does not use certification requirements

### Basic principle for exams

**As a rule, all the standard final exams for modules and also all resit exams are to be in written form**

**Standard final exam for a module and written resit exam**

**Kind of exam**

written

**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 (no book, no slides, no further notes)

**Special case: Resit exam as oral exam**

**Kind of exam**

oral

**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 handwritten 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**

2021-2022

**Last modification**

2021-03-30

**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 defined below for each location/each time the module is held.
- Documentation is available in the languages defined below. Where documents are in several languages, the percentage distribution is shown (100% = all the documentation).
- The examination is available 100% in the languages shown for each location/each time it is held.

| | Berne | 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

**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)

## 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. Simulation, the exploration of the dynamic behavior of the model in time and space, is discussed for both continuous and discrete-event systems. Simulating a model allows the evaluation of indicators of the performance of the modelled system, improving our understanding of its behavior and dynamic complexity.

## Aims, content, methods

### Learning objectives and acquired competencies

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.

### Contents of module with emphasis on teaching content

- 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

### Certification requirements

Module uses certification requirements

### Certification requirements for final examinations (conditions for attestation)

*There are no conditions to be admitted to the final exam, but students are encouraged to actively participate to the lectures and the experimental classes.*

*The final exam is given in written form and it accounts for 100% of the course evaluation.*

### Basic principle for exams

**As a rule, all the standard final exams for modules and also all resit exams are to be in written form**

**Standard final exam for a module and written resit exam**

**Kind of exam**

written

**Duration of exam**

120 minutes

**Permissible aids**

*Aids permitted as specified below:*

**Permissible electronic aids**

No electronic aids permitted

**Other permissible aids**

*Two A4 sheets may be brought to the final exam. No other material will be allowed.*

**Special case: Resit exam as oral exam**

**Kind of exam**

oral

**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**

2021-2022

**Dernière modification**

2021-03-30

**Coordinateur/coordinatrice du module**

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

**Explication des définitions de langue par lieu :**

- Les cours se dérouleront dans la langue définie ci-dessous par lieu/exécution.
- Les documents sont disponibles dans les langues définies ci-dessous. Pour le multilinguisme, voir la répartition en pourcentage (100% = documents complets)
- L'examen est disponible à 100% dans chaque langue sélectionnée pour chaque lieu/exécution.

| | Berne | 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

**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)

## 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

### Conditions d'admission

Le module utilise les conditions d'admission

### Conditions d'admission à l'examen de fin de module (exigences du certificat)

Il n'y a aucune condition d'admission à l'examen final, mais les étudiant-e-s sont encouragé-e-s à participer activement aux cours et aux expérimentations.

La note finale du cours sera basée sur la sur un examen écrit qui représentera 100 % de l'évaluation finale.

### Principe pour les examens

**En règle générale, tous les examens de fin de module réguliers et les examens de rattrapage sont organisés sous la forme écrite**

### Examen de fin de module régulier et examen écrit de répétition

**Type de l'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**

Deux feuilles A4 peuvent être apportées à l'examen final. Aucun autre matériel ne sera autorisé.

### Cas spécial: examen de répétition oral

**Type de l'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**

2021-2022

**Last modification**

2020-01-27

**Coordinator of the module**

Alessandro Facchini (SUPSI, alessandro.facchini@supsi.ch)

**Explanations regarding the language definitions for each location:**

- Instruction is given in the language defined below for each location/each time the module is held.
- Documentation is available in the languages defined below. Where documents are in several languages, the percentage distribution is shown (100% = all the documentation).
- The examination is available 100% in the languages shown for each location/each time it is held.

| | Berne | Lausanne | | | Lugano | Zurich | | |
|---|---|---|---|---|---|---|---|---|
| **Instruction** | | | | | **X** E 100% | | | |
| **Documentation** | | | | | **X** E 100% | | | |
| **Examination** | | | | | **X** E 100% | | | |

**Module Category**

FTP Fundamental theoretical principles

**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. Based on this, mechanisms to impede possible undesired behaviour of systems and to stir the desired dynamics will be developed.

Throughout the course, several application areas such as cooperation and competition, social networks, opinion dynamics and social influence will be discussed.

## Aims, content, methods

### Learning objectives and acquired competencies

A successful participant of this course is able to

- understand the rationale of multi-agent systems, modelling and simulation.
- model scenarios with multiple interacting agents in the language of game theory
- evaluate the feasibility of achieving goals with agents using game theory
- 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 visualise, understand and analyse the corresponding outputs

### Contents of module with emphasis on teaching content

- Multi-agent interaction: games in normal form, dominant strategies, Nash equilibria, Pareto optimality, partial observability, Bayesian games, cooperative and coalition games, repeated games, multi-agent learning.

- Population dynamics: evolutionarily stable strategies, Replicator’s dynamics

- Network dynamics: Small world phenomenon, epidemics

- Multi-agent simulation: Cellular automata and the Game of life, demographic games, opinion dynamics and social influence.

### Teaching and learning methods

- Lectures
- Exercises and homework
- Practical work with appropriate tools and group project
- 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.
- *Generative Social Science*. Joshua Epstein. Princeton University Press, 2006.

## Assessment

### Certification requirements

Module does not use certification requirements

### Basic principle for exams

**As a rule, all the standard final exams for modules and also all resit exams are to be in written form**

### Standard final exam for a module and written resit exam

**Kind of exam**

written

**Duration of exam**

120 minutes

**Permissible aids**

*Aids permitted as specified below:*

**Permissible electronic aids**

Calculator.

**Other permissible aids**

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

**Special case: Resit exam as oral exam**

**Kind of exam**

oral

**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.

MASTER OF SCIENCE
IN ENGINEERING

**Module Description, available in: EN, FR**

# *Multiphysics*

## General Information

**Number of ECTS Credits**

3

**Module code**

FTP_Multiphy

**Valid for academic year**

2021-2022

**Last modification**

2020-03-04

**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 defined below for each location/each time the module is held.
- Documentation is available in the languages defined below. Where documents are in several languages, the percentage distribution is shown (100% = all the documentation).
- The examination is available 100% in the languages shown for each location/each time it is held.

| | Berne | 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

**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 acquired competencies

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.

### Contents of module with emphasis on teaching content

- 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, capacitive and inductive sensors for static and quasistatic problems, structural mechanics, coupling an incompressible flow with energy transport, 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

### Certification requirements

Module uses certification requirements

### Certification requirements for final examinations (conditions for attestation)

Successful completion of the modeling and simulation exercises.

### Basic principle for exams

**As a rule, all the standard final exams for modules and also all resit exams are to be in written form**

### Standard final exam for a module and written resit exam

**Kind of exam**

written

**Duration of exam**

120 minutes

**Permissible aids**

No aids permitted

**Special case: Resit exam as oral exam**

**Kind of exam**

oral

**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**

2021-2022

**Dernière modification**

2020-03-04

**Coordinateur/coordinatrice du module**

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

**Explication des définitions de langue par lieu :**

- Les cours se dérouleront dans la langue définie ci-dessous par lieu/exécution.
- Les documents sont disponibles dans les langues définies ci-dessous. Pour le multilinguisme, voir la répartition en pourcentage (100% = documents complets)
- L'examen est disponible à 100% dans chaque langue sélectionnée pour chaque lieu/exécution.

| | Berne | 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

**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, des capteurs capacitifs et inductifs pour les problèmes statiques et quasi-statiques, mécanique structurelle, relier un flux incompressible au transport d'énergie, 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

### Conditions d'admission

Le module utilise les conditions d'admission

### Conditions d'admission à l'examen de fin de module (exigences du certificat)

Réussir les exercices de modélisation et de simulation.

### Principe pour les examens

**En règle générale, tous les examens de fin de module réguliers et les examens de rattrapage sont organisés sous la forme écrite**

### Examen de fin de module régulier et examen écrit de répétition

**Type de l'examen**

écrit

**Durée de l'examen**

120 minutes

**Aides autorisées**

Sans aides

**Cas spécial: examen de répétition oral**

**Type de l'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**

2021-2022

**Last modification**

2021-02-05

**Coordinator of the module**

Andreas Klinkert (ZHAW, andreas.klinkert@zhaw.ch)

**Explanations regarding the language definitions for each location:**

- Instruction is given in the language defined below for each location/each time the module is held.
- Documentation is available in the languages defined below. Where documents are in several languages, the percentage distribution is shown (100% = all the documentation).
- The examination is available 100% in the languages shown for each location/each time it is held.

| | Berne | 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

**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 acquired competencies

- 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.

### Contents of module with emphasis on teaching content

| Week | Topics |
|---|---|
| 1 | **PART 1:** |
| 2 | **Introduction to Optimization**<br>• Basic concepts: models, variables, parameters, constraints, objective, optima<br>• Examples of problems and models of different types: linear/nonlinear, discrete/continuous, deterministic/stochastic constrained/unconstrained<br>• Solution methods: exact algorithms, constructive heuristics, improvement heuristics<br>• Global vs. local optima, basic ideas of convex optimization |
| 3<br>4<br>5 | **Linear Programming**<br>• Mathematical formulation and terminology, canonical and standard form, transformations<br>• Geometry: linear inequalities, polyhedra, graphical representation, examples<br>• Simplex algorithm |
| 6<br>7 | **Integer Programming**<br>• Basic concepts<br>• Branch-and-Bound method<br>• Cutting Planes method<br>• Various applications and modeling techniques |
| 8 | **PART 2:**<br>**Nonlinear Optimization**<br>• Unconstrained multidimensional optimization: optimality conditions, Gradient- and Newton-methods |
| 9<br>10<br>11 | **Graphs and Networks**<br>• Optimization in graphs<br>• Paths and cycles<br>• Network flows<br>• Selected combinatorial optimization problems |
| 12<br>13<br>14 | **Heuristics and Metaheuristics**<br>• Trajectory-based methods: hill climbing, tabu search, simulated annealing, ...<br>• Population-based methods: evolutionary algorithms, ant colony optimization, ... |

### Teaching and learning methods

Lectures and exercises

### Literature

## Assessment

### Certification requirements

Module does not use certification requirements

### Basic principle for exams

**As a rule, all the standard final exams for modules and also all resit exams are to be in written form**

### Standard final exam for a module and written resit exam

**Kind of exam**

written

**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.

### Special case: Resit exam as oral exam

**Kind of exam**

oral

**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**

2021-2022

**Dernière modification**

2021-02-05

**Coordinateur/coordinatrice du module**

Andreas Klinkert (ZHAW, andreas.klinkert@zhaw.ch)

**Explication des définitions de langue par lieu :**

- Les cours se dérouleront dans la langue définie ci-dessous par lieu/exécution.
- Les documents sont disponibles dans les langues définies ci-dessous. Pour le multilinguisme, voir la répartition en pourcentage (100% = documents complets)
- L'examen est disponible à 100% dans chaque langue sélectionnée pour chaque lieu/exécution.

| | Berne | 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

**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<br>2 | **PARTIE 1:**<br><br>**Introduction à l'optimisation**<br>• Idées de base: modèles, variables, paramètres, contraintes, objectifs, optima<br>• Exemples de problèmes et de modèles de différents types: linéaires/non linéaires, discrets/continus, déterministes/stochastiques, avec contraintes/sans contraintes<br>• Méthodes de résolution: algorithmes exactes, heuristiques constructives, heuristiques d'amélioration<br>• Optima globals vs. locals, concepts de base de l'optimisation convexe |
| 3<br>4<br>5 | **Programmation linéaire**<br>• Formulation mathématique et terminologie, forme canonique et standard, transformations<br>• Géométrie: inéquation linéaires, polyèdres, représentation graphique, exemples<br>• Algorithme du simplexe |
| 6<br>7 | **Programmation linéaire entière**<br>• Concepts de base<br>• Méthode Branch-and-Bound<br>• Méthode Cutting Planes<br>• Applications et techniques de modélisation diverses |
| 8 | **PARTIE 2:**<br><br>**Optimisation non linéaire**<br>• Optimisation multidimensionnelle sans contraintes: conditions d'optimalité, algorithme de gradient et algorithme de |
| 9<br>10<br>11 | **Graphes et réseaux**<br>• Optimization dans les graphes<br>• Cycles et chemins<br>• Flots de réseau<br>• Problèmes sélectionnés d'optimisation combinatoire |
| 12<br>13<br>14 | **Heuristiques et métaheuristiques**<br>• Méthodes de trajectoire: grimpeur, recherche tabou, recuit simulé, ...<br>• Méthodes basées sur une population: algorithmes évolutionnistes, colonies de fourmis, ... |

### Méthodes d'enseignement et d'apprentissage

Cours magistral et travaux dirigés

### Bibliographie

## Evaluation

### Conditions d'admission

Le module n'utilise pas de conditions d'admission.

### Principe pour les examens

**En règle générale, tous les examens de fin de module réguliers et les examens de rattrapage sont organisés sous la forme écrite**

### Examen de fin de module régulier et examen écrit de répétition

**Type de l'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.

### Cas spécial: examen de répétition oral

**Type de l'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**

2021-2022

**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 defined below for each location/each time the module is held.
- Documentation is available in the languages defined below. Where documents are in several languages, the percentage distribution is shown (100% = all the documentation).
- The examination is available 100% in the languages shown for each location/each time it is held.

| | Berne | 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

**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 acquired competencies

- 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

### Contents of module with emphasis on teaching content

- 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

### Certification requirements

Module does not use certification requirements

### Basic principle for exams

**As a rule, all the standard final exams for modules and also all resit exams are to be in written form**

### Standard final exam for a module and written resit exam

#### Kind of exam

written

#### 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

### Special case: Resit exam as oral exam

#### Kind of exam

oral

**Duration of exam**

30 minutes

**Permissible aids**

No aids permitted

MSE MASTER OF SCIENCE IN ENGINEERING

**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**

2021-2022

**Dernière modification**

2018-11-06

**Coordinateur/coordinatrice du module**

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

**Explication des définitions de langue par lieu :**

- Les cours se dérouleront dans la langue définie ci-dessous par lieu/exécution.
- Les documents sont disponibles dans les langues définies ci-dessous. Pour le multilinguisme, voir la répartition en pourcentage (100% = documents complets)
- L'examen est disponible à 100% dans chaque langue sélectionnée pour chaque lieu/exécution.

| | Berne | 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

**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

### Conditions d'admission

Le module n'utilise pas de conditions d'admission.

### Principe pour les examens

**En règle générale, tous les examens de fin de module réguliers et les examens de rattrapage sont organisés sous la forme écrite**

### Examen de fin de module régulier et examen écrit de répétition

**Type de l'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)

### Cas spécial: examen de répétition oral

**Type de l'examen**

oral

**Durée de l'examen**

30 minutes

**Aides autorisées**

Sans aides

MASTER OF SCIENCE
IN ENGINEERING

**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**

2021-2022

**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 defined below for each location/each time the module is held.
- Documentation is available in the languages defined below. Where documents are in several languages, the percentage distribution is shown (100% = all the documentation).
- The examination is available 100% in the languages shown for each location/each time it is held.

| | Berne | 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

**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 acquired competencies

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.

### Contents of module with emphasis on teaching content

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

### Certification requirements

Module does not use certification requirements

### Basic principle for exams

**As a rule, all the standard final exams for modules and also all resit exams are to be in written form**

### Standard final exam for a module and written resit exam

**Kind of exam**

written

**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).

### Special case: Resit exam as oral exam

**Kind of exam**

oral

**Duration of exam**

30 minutes

**Permissible aids**

No aids permitted

MSE MASTER OF SCIENCE IN ENGINEERING

**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**

2021-2022

**Dernière modification**

2021-02-05

**Coordinateur/coordinatrice du module**

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

**Explication des définitions de langue par lieu :**

- Les cours se dérouleront dans la langue définie ci-dessous par lieu/exécution.
- Les documents sont disponibles dans les langues définies ci-dessous. Pour le multilinguisme, voir la répartition en pourcentage (100% = documents complets)
- L'examen est disponible à 100% dans chaque langue sélectionnée pour chaque lieu/exécution.

| | Berne | 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

**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

### Conditions d'admission

Le module n'utilise pas de conditions d'admission.

### Principe pour les examens

**En règle générale, tous les examens de fin de module réguliers et les examens de rattrapage sont organisés sous la forme écrite**

### Examen de fin de module régulier et examen écrit de répétition

**Type de l'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)

### Cas spécial: examen de répétition oral

**Type de l'examen**

oral

**Durée de l'examen**

30 minutes

**Aides autorisées**

Sans aides

MASTER OF SCIENCE
IN ENGINEERING

**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**

2021-2022

**Last modification**

2020-03-16

**Coordinator of the module**

Silvia Schintke (HES-SO, Silvia.Schintke@heig-vd.ch)

**Explanations regarding the language definitions for each location:**

- Instruction is given in the language defined below for each location/each time the module is held.
- Documentation is available in the languages defined below. Where documents are in several languages, the percentage distribution is shown (100% = all the documentation).
- The examination is available 100% in the languages shown for each location/each time it is held.

| | Berne | Lausanne | | | Lugano | Zurich | | |
|---|---|---|---|---|---|---|---|---|
| **Instruction** | | | | | | **X** E 100% | | |
| **Documentation** | | | | | | **X** E 100% | | |
| **Examination** | | | | | | **X** E 100% | | |

**Module Category**

FTP Fundamental theoretical principles

**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 main topic of this module relates to surface effects. Microstructured surfaces, for example, play an important role in mechanical systems in terms of nano-roughness and nanotribological properties. 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. Another interesting topic is surface functionalisation, which can be designed to reduce e.g. wear, corrosion, ice-formation or bio-fouling on materials; surface functionalization is furthermore an important step in the design of chemical and biochemical sensors.

A second main 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 have an important meaning in modern electronics.

A third topic covers new materials structures on the micro and nanoscale. Nanoparticles and nanofibers in biology and medicine offer completely new opportunities in diagnostics and research. Graphene consists of only one layer of carbon atoms and has been the subject of the most modern research since its discovery. The unique properties of the thinnest material in the world could be used in many different ways - for mechanical components, solar cells, medical sensors or in electronics, due to its enormous conductivity and the quantum Hall effect, which already occurs at room temperature. Nanoparticles and nanostructures also play an important role in the field of nanophotonics. The interaction of light with nanostructures leads to novel effects such as plasmonics and opens up new possibilities in optoelectronics and microelectronics.

## Aims, content, methods

### Learning objectives and acquired competencies

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 colours, tribo-mechanical and wetting behaviour)
- know the processes that govern the functionalisation of surfaces
- 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 function and application of nanoparticles and nanofibers in biology and medicine
- know the interaction of light with dielectric, semiconductor and metallic nanoparticles (incl. plasmonics)

### Contents of module with emphasis on teaching content

- From macro to micro to nano: scaling of physical systems and the consequences (3 lessons)
- Quantum mechanics and Quantum Nature of the Nanoworld: Schrödinger equation, discrete energy levels, sizing effects (6 lessons)
- Nano- and microstructured surfaces: Physics of nano tribology, structural colours, and nanostructures for medical applications (6 lessons)
- Functional surfaces: Physics of wetting behaviour, adhesion, and applications (e.g. wear reduction, anti-icing or anti-sticking surfaces, surfaces for fluidic and sensor applications) (6 lessons)
- Electronic and photonic bandgaps: Physical basics and applications (6 lessons)
- Quantum dots and quantum wires: ISFETs (ion-sensitive field-effect transistors) and BioFETs (field effect biosensors) for electronics and biotechnology (3 lessons)
- Nanoparticles and fibers: Basics and applications in medicine, biology, and sensor developments (6 lessons)
- Nanophotonics: Interaction of light with nanoparticles and nanostructures (dielectric, metallic, semiconductor) (6 lessons)

### Teaching and learning methods

Lectures and self-study

Practical exercises and case studies

### Literature

Lecture notes, application oriented summary articles or slides with indication of sources for further reading will be distributed.

Introduction to Nanoscience & Nanotechnology, Gabor L Hornyak et al. , CRC Press, 2009.

Nanophysik und Nanotechnologie, Edward Wolf, Wiley-VCH, 2014

## Assessment

### Certification requirements

Module does not use certification requirements

### Basic principle for exams

**As a rule, all the standard final exams for modules and also all resit exams are to be in written form**

### Standard final exam for a module and written resit exam

**Kind of exam**

written

**Duration of exam**

120 minutes

**Permissible aids**

*Aids permitted as specified below:*

**Permissible electronic aids**

No electronic aids permitted

**Other permissible aids**

Personal formulary: two A4 pages

### Special case: Resit exam as oral exam

**Kind of exam**

oral

**Duration of exam**

30 minutes

**Permissible aids**

*Aids permitted as specified below:*

**Permissible electronic aids**

No electronic aids permitted

**Other permissible aids**

Personal formulary: two A4 pages

MSE MASTER OF SCIENCE IN ENGINEERING

**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**

2021-2022

**Dernière modification**

2020-12-23

**Coordinateur/coordinatrice du module**

Stefan Hengsberger (HES-SO, stefan.hengsberger@hefr.ch)

**Explication des définitions de langue par lieu :**

- Les cours se dérouleront dans la langue définie ci-dessous par lieu/exécution.
- Les documents sont disponibles dans les langues définies ci-dessous. Pour le multilinguisme, voir la répartition en pourcentage (100% = documents complets)
- L'examen est disponible à 100% dans chaque langue sélectionnée pour chaque lieu/exécution.

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

**Catégorie de module**

FTP bases théoriques élargies

**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$_r$* et le model de Bohr des atomes 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

### Conditions d'admission

Le module utilise les conditions d'admission

### Conditions d'admission à l'examen de fin de module (exigences du certificat)

Définis par les professeurs, p.ex. un certain nombre d'exercices résolus

### Principe pour les examens

**En règle générale, tous les examens de fin de module réguliers et les examens de rattrapage sont organisés sous la forme écrite**

### Examen de fin de module régulier et examen écrit de répétition

**Type de l'examen**

écrit

**Durée de l'examen**

120 minutes

**Aides autorisées**

*Les aides suivantes sont autorisées:*

**Aides électroniques autorisées**

Calculatrice

**Strictement PAS autorisés sont:**
Ordinateurs ou appareils de télécommunication

***conditions particulières pour les examens online***: pas de restriction

**Autres aides autorisées**

Papier à écrire

Crayon, stylo, …

**Strictement PAS autorisés sont:**
Tout autre document, notices ou supports de cours tel que des slides, polycopiés, exercices, corrigés,…

***conditions particulières pour les examens online***: pas de restriction

### Cas spécial: examen de répétition oral

**Type de l'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**

2021-2022

**Last modification**

2021-03-30

**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 defined below for each location/each time the module is held.
- Documentation is available in the languages defined below. Where documents are in several languages, the percentage distribution is shown (100% = all the documentation).
- The examination is available 100% in the languages shown for each location/each time it is held.

| | Berne | Lausanne | | | Lugano | Zurich | | |
|---|---|---|---|---|---|---|---|---|
| **Instruction** | | | | | | **X** E 100% | | |
| **Documentation** | | | | | | **X** E 100% | | |
| **Examination** | | | | | | **X** E 100% | | |

**Module Category**

FTP Fundamental theoretical principles

**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 an 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, time series models, and classification methods. 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 acquired competencies

Students are able to analyze data by means of regression 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, classification or time series problem. They are able to evaluate and compare statistical models.

### Contents of module with emphasis on teaching content

*Fundamental concepts of probability and statistics (repetition of basic courses):* concept of random variable, important probability distributions, covariance, parameter estimation, hypothesis testing, and confidence intervals.

*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, and variable selection.

*Classification:* Concepts of classification, logistic regression, CART, random forests, Support Vector Machines, and model evaluation by cross-validation.

*Time series analysis:* STL decomposition, confidence and prediction bands, AR models with parameter estimation, confidence and prediction bands, autocorrelation, and model selection.

### 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

### Certification requirements

Module does not use certification requirements

### Basic principle for exams

**As a rule, all the standard final exams for modules and also all resit exams are to be in written form**

### Standard final exam for a module and written resit exam

**Kind of exam**

written

**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**

Personal handwritten summary of 20 pages.

### Special case: Resit exam as oral exam

**Kind of exam**

oral

**Duration of exam**

30 minutes

**Permissible aids**

No aids permitted

MASTER OF SCIENCE
IN ENGINEERING

**Module Description, available in: EN**

# *Intelligent and Hyperconnected Machine*

## General Information

**Number of ECTS Credits**

3

**Module code**

FTP_SmartMach

**Valid for academic year**

2021-2022

**Last modification**

2021-03-18

**Coordinator of the module**

Jean-Claude Jeannerat (HES-SO, claude.jeannerat@he-arc.ch)

**Explanations regarding the language definitions for each location:**

- Instruction is given in the language defined below for each location/each time the module is held.
- Documentation is available in the languages defined below. Where documents are in several languages, the percentage distribution is shown (100% = all the documentation).
- The examination is available 100% in the languages shown for each location/each time it is held.

| | Berne | Lausanne | | | Lugano | Zurich | | |
|---|---|---|---|---|---|---|---|---|
| **Instruction** | | **X** E 100% | | | | | | |
| **Documentation** | | **X** E 100% | | | | | | |
| **Examination** | | **X** E 100% | | | | | | |

**Module Category**

FTP Fundamental theoretical principles

**Lessons**

2 lecture periods and 1 tutorial period per week

## Entry level competences

**Prerequisites, previous knowledge**

- General mechanics
- IT basics

## Brief course description of module objectives and content

Students learn and experience an advanced approach to designing an autonomous real-time process monitoring system (cyber-physical system)

## Aims, content, methods

### Learning objectives and acquired competencies

Students learn and experience an advanced approach to designing **an autonomous real-time process monitoring system**.

This will allow them to experience a development project by directly integrating an expert reflection on the digital autonomy expected of automated mechanisms in the Industry 4.0 world.

They will also be introduced to the multidisciplinary roles that the engineer-designer of tomorrow will have to play in the face of the **challenges of digitization** and the advent of intelligent and autonomous machines.

This course uses as a red thread **the Micro5 eco-demonstrator** developed in the framework of the HES-SO thematic programs (2013-2016) and recently equipped with an original and very advanced cognitive system.

### Contents of module with emphasis on teaching content

The learning objectives are to allow the student to develop a critical sense and to experience the steps and difficulties related to defining and developing an artificial intelligence system on a production tool.

The following steps will be covered:

- Positioning and role of the engineer-designer in the face of digitalization issues
- Definition of a digital cognitive system (prospective and decision-making capacities)
- Goals to be achieved by the system being developed (issues and methods)
- Definition of the tools to be developed
- Development of a relevant cyber-physical system in production (choice of relevant data, signal processing, documentation and data feedback, real-time management, data storage)
- Data processing and analysis
- Experimentation through monitored and precursor machining (visualization, experience report)
- Digitalisation of know-how (empowerment tools)
- Development of a digital behavioral twin

### Teaching and learning methods

**Theory:**

- Cognitive system (what and how)
- Prospective capabilities
- Cyber-physical system
- Data feedback and analysis

**Practical:**

- Application to machines
- Case studies

**Experimentation:**

- Machining with data feedback
- Labeling
- Analyses
- AI restitution

### Literature

## Assessment

**Certification requirements**

Module does not use certification requirements

**Basic principle for exams**

**As a rule, all the standard final exams for modules and also all resit exams are to be in written form**

**Standard final exam for a module and written resit exam**

**Kind of exam**

written

**Duration of exam**

120 minutes

**Permissible aids**

No aids permitted

**Special case: Resit exam as oral exam**

**Kind of exam**

oral

**Duration of exam**

30 minutes

**Permissible aids**

No aids permitted

**Modulbeschreibung, verfügbar in: DE**

# *Planungsmethodik*

## Allgemeine Angaben

**Anzahl ECTS-Credits**

3

**Modulkürzel**

FTP_StatPlan

**Gültig für akademisches Jahr**

2021-2022

**Letzte Änderung**

2020-03-13

**Modul-Koordinator/in**

Donato Acocella (OST, donato.acocella@ost.ch)

**Erläuterungen zu den Sprachdefinitionen je Standort:**

- Der Unterricht findet in der unten definierten Sprache je Standort/Durchführung statt.
- Die Unterlagen sind in den unten definierten Sprachen verfügbar. Bei Mehrsprachigkeit, siehe prozentuale Verteilung (100% = komplette Unterlagen)
- Die Prüfung ist in jeder je Standort/Durchführung angekreuzten Sprache zu 100% verfügbar.

| | Berne | Lausanne | | | Lugano | Zurich | | |
|---|---|---|---|---|---|---|---|---|
| **Unterricht** | | | | | | | **X** D 100% | |
| **Dokumentation** | | | | | | | **X** D 100% | |
| **Prüfung** | | | | | | | **X** D 100% | |

**Modulkategorie**

FTP Erweiterte theoretische Grundlagen

**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, 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

### Zulassungsbedingungen

Modul verwendet Zulassungsbedingungen

### Zulassungsbedingungen für die Modulabschlussprüfung (Testatbedingungen)

Erfolgreiche Bearbeitung des Semesterprojekts

### Grundsatz Prüfungen

**In der Regel werden alle regulären Modulabschlussprüfungen und Wiederholungsprüfungen in schriftlicher Form gehalten**

### Reguläre Modulschlussprüfung und schriftliche Wiederholungsprüfung

#### Art der Prüfung

schriftlich

#### 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)

### Spezialfall: Wiederholungsprüfung als mündliches Examen

#### Art der Prüfung

mündlich

#### Prüfungsdauer

30 Minuten

#### Erlaubte Hilfsmittel

Ohne Hilfsmittel

**Module Description, available in: EN**

# Stochastic Modelling

## General Information

**Number of ECTS Credits**

3

**Module code**

FTP_StochMod

**Valid for academic year**

2021-2022

**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 defined below for each location/each time the module is held.
- Documentation is available in the languages defined below. Where documents are in several languages, the percentage distribution is shown (100% = all the documentation).
- The examination is available 100% in the languages shown for each location/each time it is held.

| | Berne | Lausanne | | | Lugano | Zurich | | |
|---|---|---|---|---|---|---|---|---|
| **Instruction** | | | | | | **X** E 100% | | |
| **Documentation** | | | | | | **X** E 100% | | |
| **Examination** | | | | | | **X** E 100% | | |

**Module Category**

FTP Fundamental theoretical principles

**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, expectation, variance, random variable)
3. Linear algebra (matrix algebra, eigenvalues)

## Brief course description of module objectives and content

The ubiquitous presence of uncertainty and noise in the engineering sciences makes it mandatory to understand and quantify random phenomena. To achieve this goal the course will provide a solid introduction to the theory of stochastic processes. Special attention is given to applications. The applications include examples from various fields such as communications and vision, signal processing and control, production and traffic flows, queuing theory, financial market and physics of small systems (Brownian motion).

## Aims, content, methods

### Learning objectives and acquired competencies

The student is familiar with the main working tools and concepts of stochastic modelling (expectation, variance, covariance, autocorrelation, power spectral density). He/She is able to explain properties and limitations of stochastic processes (mainly Markov processes) as a modelling tool for noisy systems. He/She will be able to model and analyze simple random phenomena through adaptation of proposed stochastic models.

### Contents of module with emphasis on teaching content

- Probability review: random variables, conditional probabilities, theorem of large numbers, central limit theorem.
- General introduction to discrete and continuous stochastic processes. Applications: communications, Kalman filtering.
- Discrete, continuous and hidden Markov Chains. Applications: stochastic manufacturing systems, queuing systems, pattern recognition, speech recognition.
- Bernoulli, Poisson, Gaussian Processes, Brownian motion, white and coloured 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

### Certification requirements

Module does not use certification requirements

### Basic principle for exams

**As a rule, all the standard final exams for modules and also all resit exams are to be in written form**

### Standard final exam for a module and written resit exam

**Kind of exam**

written

**Duration of exam**

120 minutes

**Permissible aids**

*Aids permitted as specified below:*

**Permissible electronic aids**

CAS calculator (no access to internet)

**Other permissible aids**

Hardcopy form: no limitations

(*Script, books, solved examples, summary, tables etc.)*

### Special case: Resit exam as oral exam

**Kind of exam**

oral

**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**

2021-2022

**Last modification**

2018-10-27

**Coordinator of the module**

Markus Roos (ZHAW, roor@zhaw.ch)

**Explanations regarding the language definitions for each location:**

- Instruction is given in the language defined below for each location/each time the module is held.
- Documentation is available in the languages defined below. Where documents are in several languages, the percentage distribution is shown (100% = all the documentation).
- The examination is available 100% in the languages shown for each location/each time it is held.

| | Berne | Lausanne | | | Lugano | Zurich | | |
|---|---|---|---|---|---|---|---|---|
| **Instruction** | | | | | | **X** E 100% | | |
| **Documentation** | | | | | | **X** E 100% | | |
| **Examination** | | | | | | **X** E 100% | | |

**Module Category**

FTP Fundamental theoretical principles

**Lessons**

2 lecture periods and 1 tutorial period per week

## Entry level competences

**Prerequisites, previous knowledge**

- Physics, analysis, linear algebra at Bachelor's level ,
- The mathematical prerequisites are covered by the chapter 7-9 of [4]. The summaries of these chapters are in the appendix of this document.

## Brief course description of module objectives and content

The course starts with an overview of classical engineering physics with special emphasis of balance and constitutive equations (i.e., continuity equations and material laws). The basic concepts of vector analysis are applied to electrodynamics, various transport phenomena, mechanical elasticity and piezo-electric effects. The concept of tensors enables the description of important anisotropic effects of solid state physics. These effects are present in crystals as well as in layered material systems, which are more and more used in modern technology. The given overview facilitates the student's understanding and application of numerical simulation methods (e.g., FEA, multiphysics).

## Aims, content, methods

### Learning objectives and acquired competencies

- Students are familiar with the most important basic laws of engineering physics for isotropic materials in general view form, recognize 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 transport phenomena for 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)

### Contents of module with emphasis on teaching content

- Recapitulation of isotropic material laws (Ohm, Hook, electric polarization, heat conduction)
- 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 tensoralgebra: electrodynamics and anisotropic transport phenomena
- Elasticity theory with emphasis on 3D stress states
- Piezo-effect: physical fundamentals

| Week | Subject |
|---|---|
| MW1 | Introduction, motivation, repetition of fundamental physical laws from engineering physics |
| MW2 | Scalars, vectors, divergence, gradient, curl |
| MW3 | Integral theorems and applications of vector analysis in physics |
| MW4 | Maxwell I: Electro- and magnetostatics |
| MW5 | Fundamental mathematical properties of tensors, transformations of tensors |
| MW6 | Transport phenomena, Ohm's law,  heat conduction and diffusion |
| MW7 | Elasticity: stress and distortion tensor, thermal expansion |
| MW8 | Elasticity: Hooke's law, tensors of the fourth rank, engineering diagram |
| MW9 | Elasticity: 3D stress and distortion states |
| MW10 | Elasticity: 3D stress and distortion states |
| MW11 | Reserve |
| MW12 | Maxwell II: Electrodynamics |
| MW13 | Maxwell III: Waves, Maxwell |
| MW14 | Piezoelectricity |

### 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

### Certification requirements

Module does not use certification requirements

### Basic principle for exams

**As a rule, all the standard final exams for modules and also all resit exams are to be in written form**

### Standard final exam for a module and written resit exam

**Kind of exam**

written

**Duration of exam**

120 minutes

**Permissible aids**

*Aids permitted as specified below:*

**Permissible electronic aids**

Personal formula collection, pocket calculator, courseware

**Other permissible aids**

No other aids permitted

### Special case: Resit exam as oral exam

**Kind of exam**

oral

**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**

2021-2022

**Last modification**

2019-01-23

**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 defined below for each location/each time the module is held.
- Documentation is available in the languages defined below. Where documents are in several languages, the percentage distribution is shown (100% = all the documentation).
- The examination is available 100% in the languages shown for each location/each time it is held.

| | Berne | Lausanne | | | Lugano | Zurich | | |
|---|---|---|---|---|---|---|---|---|
| **Instruction** | | | | | | **X** E 100% | | |
| **Documentation** | | | | | | **X** E 100% | | |
| **Examination** | | | | | | **X** E 100% | | |

**Module Category**

FTP Fundamental theoretical principles

**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 acquired competencies

- 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.

### Contents of module with emphasis on teaching content

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

### Certification requirements

Module does not use certification requirements

### Basic principle for exams

**As a rule, all the standard final exams for modules and also all resit exams are to be in written form**

**Standard final exam for a module and written resit exam**

**Kind of exam**

written

**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

**Special case: Resit exam as oral exam**

**Kind of exam**

oral

**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**

2021-2022

**Last modification**

2020-01-07

**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 defined below for each location/each time the module is held.
- Documentation is available in the languages defined below. Where documents are in several languages, the percentage distribution is shown (100% = all the documentation).
- The examination is available 100% in the languages shown for each location/each time it is held.

| | Winterthur | | | |
|---|---|---|---|---|
| **Instruction** | **X** E 100% | | | |
| **Documentation** | **X** E 100% | | | |
| **Examination** | **X** E 100% | | | |

**Module Category**

TSM Technical scientific module

**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, and structures. The new technologies require a systems engineering approach, which guides the way towards a sustainable aircraft.

The whole design process will be discussed and the students will learn to do a preliminary design concept.

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 preliminary design concept. The course is structured in lectures as well as a conceptual aircraft design case study, which will be done in groups.

## Aims, content, methods

### Learning objectives and acquired competencies

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.

### Contents of module with emphasis on teaching content

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 will be introduced and the concept of hybrid propulsion with new aircraft layouts will be discussed.

The course will close with the outlook to new aircraft generations to meet the reduction of CO2 and noise footprint.

### Teaching and learning methods

- Lectures with focus on practical cases for commercial airplanes
- Self study and performance of literature research
- Performance of a case study for an aircraft design working together with teams which cover different design aspects
- Final presentation of aircraft design as team effort

### 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

### Certification requirements

Module does not use certification requirements

### Basic principle for exams

**As a rule, all the standard final exams for modules and also all resit exams are to be in written form**

**Standard final exam for a module and written resit exam**

**Kind of exam**

written

**Duration of exam**

120 minutes

**Permissible aids**

*Aids permitted as specified below:*

**Permissible electronic aids**

- No programmable calculator

**Other permissible aids**

- Closed book
- Written summary of 4 pages (A4 size, hand written, single sided)

**Special case: Resit exam as oral exam**

**Kind of exam**

oral

**Duration of exam**

30 minutes

**Permissible aids**

No aids permitted

MSE MASTER OF SCIENCE IN ENGINEERING

**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**

2021-2022

**Dernière modification**

2021-08-16

**Coordinateur/coordinatrice du module**

Tewfiq El Maliki (HES-SO, tewfiq.elmaliki@hesge.ch)

**Explication des définitions de langue par lieu :**

- Les cours se dérouleront dans la langue définie ci-dessous par lieu/exécution.
- Les documents sont disponibles dans les langues définies ci-dessous. Pour le multilinguisme, voir la répartition en pourcentage (100% = documents complets)
- L'examen est disponible à 100% dans chaque langue sélectionnée pour chaque lieu/exécution.

| | Berne | 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

**Leçons**

2 leçons et 1 leçon de pratique par semaine

## Compétences préalables

**Connaissances préalables, compétences initiales**

- Knowledge on IP stacks and all the corresponding protocols (Ethernet, IP, TCP/UDP and current application as HTTP)
- Deep knowledge on data transmission and protocol principles

## Brève description du contenu et des objectifs

The course will first stabilize some ground knowledge as security, detailed IP stack, network mobility background and quality of service approach. Based on this, the module will define a red thread that starts with set of service availability requirements used for defining architectures. Exploring different architectures solutions will be the next aim that will let the student have a complete overview how a modern and complex network providing advanced services. The third section depicts prospective concepts like Next Generation Network (NGN), Software Defined Network (SDN) and Network virtualization Functions (NVF) that are actually deployed by the operators. The course is completed with hands on exercises and measurement on a real IMS (IP Multimedia Subsystem) operator infrastructure located in a data center.

The course covers the following core topics:

- Reminder of basic knowledge

- Modern architecture
- Broadband technologies
- Advanced and forward-looking solutions

## Objectifs, contenus, méthodes

### Objectifs d'apprentissage, compétences à acquérir

At the end of the module the MSE student will be able to:

- Depict the communication networks complexity and the corresponding architectures
- Describe the management conditions of a complex and modern network
- Describe and understand the failures and disturbances origins
- Interpret and understand different network operation conditions

### Contenu des modules avec pondération du contenu des cours

**Basics:**

- Network security (AAA, VPN, etc.)
- IP Stack detailed description (for both IPv4 and IPv6)
- Mobility for IP (MIP)
- Quality of Service (QoS) and Service Level Agreement (SLA)
- Signaling and layer orchestration (control plane)

**Architectures:**

- Set of service availability requirements used for defining architectures
- Alternatives and solutions
- Interaction with Broadband technologies

**Advanced solutions:**

- Next Generation Network (NGN)
- Software Defined Network (SDN)
- Network virtualization Functions (NVF)

**Hands on :**

- IMS (IP Multimedia Subsystem) configuration through HEIA-FR and Swisscom infrastructure
- Network elements configuration and real traffic measurement

### Méthodes d'enseignement et d'apprentissage

This course involves theoretical presentations and hands on exercises and measurement on a real IMS (IP Multimedia Subsystem) operator infrastructure located in a data center.

**Bibliographie**

Lecture slides, references to internet resources and books are mentioned during the module introduction.

## Evaluation

**Conditions d'admission**

Le module n'utilise pas de conditions d'admission.

**Principe pour les examens**

**En règle générale, tous les examens de fin de module réguliers et les examens de rattrapage sont organisés sous la forme écrite**

**Examen de fin de module régulier et examen écrit de répétition**

**Type de l'examen**

écrit

**Durée de l'examen**

120 minutes

**Aides autorisées**

Sans aides

**Cas spécial: examen de répétition oral**

**Type de l'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**

2021-2022

**Last modification**

2019-12-11

**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 defined below for each location/each time the module is held.
- Documentation is available in the languages defined below. Where documents are in several languages, the percentage distribution is shown (100% = all the documentation).
- The examination is available 100% in the languages shown for each location/each time it is held.

| | Berne | Lausanne | | | Lugano | Zurich | | |
|---|---|---|---|---|---|---|---|---|
| **Instruction** | | | | | **X** E 100% | | | |
| **Documentation** | | | | | **X** E 100% | | | |
| **Examination** | | | | | **X** E 100% | | | |

**Module Category**

TSM Technical scientific module

**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)

## Brief course description of module objectives and content

The goal of this course is to provide theoretical and practical insights on selected topics related to the algorithms and solutions adopted by modern real-time 3D Computer Graphics (CG) systems.

This class relies on in-depth, hands-on experiences with the implementation of recent GPU programming techniques for increasing the realism and performance of 3D rendering software to deal with complex synthetic images featuring a more accurate lighting model, shadows, multiple post-processing filters, correct transparency, etc.

## Aims, content, methods

### Learning objectives and acquired competencies

Through this course, the student acquires a better understanding of the ecosystem, the technology and mathematics behind current generation's real-time rendering software, and gets solid foundations to further move in this field on his/her own.

The course contents are not only approached from a theoretical or introductory point of view, but always discussed in-depth and supported by their direct, effective implementation (via tutorials and assignments) on dedicated hardware.

Thanks to the direct experience gained in dealing with the complexity of modern GPU programming and selected state-of-the-art techniques used by the leading industry, students can integrate similar solutions in their projects.

### Contents of module with emphasis on teaching content

The module covers the following topics:

- GPU programming via a modern API and with particular focus on performance implications.
- Realistic lighting through Physically-Based Rendering (PBR), global illumination, real-time ray tracing and shadow mapping.
- Deferred rendering: advantages and limitations.
- The problem of correct Order-Independent Transparency (OIT) and its solutions.
- Post-processing effects to enhance image quality: anti-aliasing, High-Dynamic Range (HDR), tone mapping and ambient occlusion.

### 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

Graham Sellers, Richard S. Wright, and Nicholas Haemel. 2015. OpenGL Superbible: Comprehensive Tutorial and Reference (7th ed.). Addison-Wesley Professional.

## Assessment

### Certification requirements

Module does not use certification requirements

### Basic principle for exams

**As a rule, all the standard final exams for modules and also all resit exams are to be in written form**

### Standard final exam for a module and written resit exam

**Kind of exam**

written

**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**

Slides and lecture notes.

### Special case: Resit exam as oral exam

**Kind of exam**

oral

**Duration of exam**

30 minutes

**Permissible aids**

*Aids permitted as specified below:*

**Permissible electronic aids**

No electronic aids permitted

**Other permissible aids**

The student can bring and consult a brief 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**

2021-2022

**Last modification**

2018-07-02

**Coordinator of the module**

Markus Kottmann (OST, markus.kottmann@ost.ch)

**Explanations regarding the language definitions for each location:**

- Instruction is given in the language defined below for each location/each time the module is held.
- Documentation is available in the languages defined below. Where documents are in several languages, the percentage distribution is shown (100% = all the documentation).
- The examination is available 100% in the languages shown for each location/each time it is held.

| | Berne | 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

**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 ends with an introduction to robust controller design using H-Infinity.

## Aims, content, methods

### Learning objectives and acquired competencies

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.

### Contents of module with emphasis on teaching content

- 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 (incl. integral controller action), SISO and MIMO-Systems
- Introduction to system identification (4W)
  - Models, design of experiments, signal conditioning
  - Least Square, 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

### Certification requirements

Module does not use certification requirements

### Basic principle for exams

**As a rule, all the standard final exams for modules and also all resit exams are to be in written form**

### Standard final exam for a module and written resit exam

#### Kind of exam

written

#### 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

**Special case: Resit exam as oral exam**

**Kind of exam**

oral

**Duration of exam**

30 minutes

**Permissible aids**

No aids permitted

MASTER OF SCIENCE
IN ENGINEERING

**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**

2021-2022

**Dernière modification**

2018-07-02

**Coordinateur/coordinatrice du module**

Markus Kottmann (OST, markus.kottmann@ost.ch)

**Explication des définitions de langue par lieu :**

- Les cours se dérouleront dans la langue définie ci-dessous par lieu/exécution.
- Les documents sont disponibles dans les langues définies ci-dessous. Pour le multilinguisme, voir la répartition en pourcentage (100% = documents complets)
- L'examen est disponible à 100% dans chaque langue sélectionnée pour chaque lieu/exécution.

| | Berne | 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

**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

### Conditions d'admission

Le module n'utilise pas de conditions d'admission.

### Principe pour les examens

**En règle générale, tous les examens de fin de module réguliers et les examens de rattrapage sont organisés sous la forme écrite**

### Examen de fin de module régulier et examen écrit de répétition

#### Type de l'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

**Cas spécial: examen de répétition oral**

**Type de l'examen**

oral

**Durée de l'examen**

30 minutes

**Aides autorisées**

Sans aides

MSE MASTER OF SCIENCE IN ENGINEERING

**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**

2021-2022

**Dernière modification**

2020-12-14

**Coordinateur/coordinatrice du module**

Marcelo Pasin (HES-SO, marcelo.pasin@he-arc.ch)

**Explication des définitions de langue par lieu :**

- Les cours se dérouleront dans la langue définie ci-dessous par lieu/exécution.
- Les documents sont disponibles dans les langues définies ci-dessous. Pour le multilinguisme, voir la répartition en pourcentage (100% = documents complets)
- L'examen est disponible à 100% dans chaque langue sélectionnée pour chaque lieu/exécution.

| | **Berne** | **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

**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

L'hétérogénéité des exigences des applications modernes n'est pas toujours bien prise en compte par les systèmes de gestion des données classiques. L'utilisation d'un système de gestion de données approprié peut répondre correctement à des exigences telles que la réplication, l'extensibilité, la disponibilité, la flexibilité du modèle de données ou la performance des requêtes.

Ce cours vise à fournir une approche critique des systèmes de gestion de données polyglottes, en prenant compte leurs forces et leurs faiblesses, afin d'aider l'architecte de logiciels de données à utiliser le système approprié dans chaque contexte.

Le cours couvre les sujets principaux suivants :

- Architectures de bases de données
- Au-delà du modèle relationnel,
- Architectures logicielles orientées bases de données.

## Objectifs, contenus, méthodes

### Objectifs d'apprentissage, compétences à acquérir

A la fin de ce module, les étudiant-e-s seront capables de :

- Comprendre et utiliser des bases de données parallèles et distribuées ;
- Utiliser correctement les modèles de cohérence stricte et relaxée et comprendre les compromis sous-jacents ;
- Comprendre et utiliser les bases de données alternatives au modèle relationnel ;
- Choisir un système de base de données approprié en fonction du contexte et du type de données disponibles ;
- Comprendre les différentes implications des architectures logicielles orientées base de données ;
- Mettre en œuvre des architectures logicielles orientées base de données efficaces ;
- Appliquer les connaissances acquises dans leur propre environnement de travail ;
- Identifier les orientations actuelles de la recherche dans ces domaines.

### Contenu des modules avec pondération du contenu des cours

Architectures de bases de données (30%)

- Architectures distribuées
- Réplication et passage à l’échelle
- Architectures parallèles
- Modèles de cohérence de données

Au-delà du modèle relationnel (30%)

- Bases de données orientées documents
- Bases de données pour graphes
- Bases de données clé-valeur
- Bases de données spatio-temporelles

Architectures logicielles orientées bases de données (40%)

- Database-first et code-first
- Bases de données embarquées
- Tests et évolution
- Plans de requêtes, indexation, contraintes d'intégrité et validation des données
- Administration des bases de données

### 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.

## Evaluation

### Conditions d'admission
Le module n'utilise pas de conditions d'admission.

### Principe pour les examens
**En règle générale, tous les examens de fin de module réguliers et les examens de rattrapage sont organisés sous la forme écrite**

### Examen de fin de module régulier et examen écrit de répétition
**Type de l'examen**

écrit

**Durée de l'examen**

120 minutes

**Aides autorisées**

*Les aides suivantes sont autorisées:*

**Aides électroniques autorisées**

Diapositives annotées et/ou un résumé manuscrit de 4 pages maximum.

**Autres aides autorisées**

Aucune autre aide autorisée

### Cas spécial: examen de répétition oral
**Type de l'examen**

oral

**Durée de l'examen**

30 minutes

**Aides autorisées**

*Les aides suivantes sont autorisées:*

**Aides électroniques autorisées**

Diapositives annotées et/ou un résumé manuscrit de 4 pages maximum.

**Autres aides**

Aucune autre aide autorisée

MASTER OF SCIENCE
IN ENGINEERING

**Module Description, available in: EN**

# *Advanced Data Management – non standard database systems*

## General Information

**Number of ECTS Credits**

3

**Module code**

TSM_AdvDataMgmt

**Valid for academic year**

2021-2022

**Last modification**

2021-01-15

**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 defined below for each location/each time the module is held.
- Documentation is available in the languages defined below. Where documents are in several languages, the percentage distribution is shown (100% = all the documentation).
- The examination is available 100% in the languages shown for each location/each time it is held.

| | Berne | Lausanne | | | Lugano | Zurich | | |
|---|---|---|---|---|---|---|---|---|
| **Instruction** | | | | | **X** E 100% | | | |
| **Documentation** | | | | | **X** E 100% | | | |
| **Examination** | | | | | **X** E 100% | | | |

**Module Category**

TSM Technical scientific module

**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 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 traditional relational and object-relational systems and centralised architectures.

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
- Distributed Ledger Technology and Blockchain

## Aims, content, methods

### Learning objectives and acquired competencies

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.

### Contents of module with emphasis on teaching content

The module is organised around the following core subject areas:

- Parallel databases (30%)
- Distributed databases (30%)
- No-SQL databases (25%)
- DLT and Blockchain (15%)

Contents:

- Parallel architectures
- Serializability
- Distributed architectures
- Replication
- CAP
- Distributed Consensus
- Eventual consistency
- DLT and Blockchain
- Hadoop and MapReduce
- Data processing with Spark
- Stream processing
- Document systems
- Graph systems
- Key value systems
- Column family stores

### Teaching and learning methods

- Lectures with integrated exercises
- Self study of literature
- case studies

### Literature

Lecture slides, references to internet resources and books

## Assessment

### Certification requirements

Module uses certification requirements

### Certification requirements for final examinations (conditions for attestation)

The successful delivery of solved exercises is condition for entering the examination, but will not contribute to final mark.

### Basic principle for exams

**As a rule, all the standard final exams for modules and also all resit exams are to be in written form**

### Standard final exam for a module and written resit exam

**Kind of exam**

written

**Duration of exam**

120 minutes

**Permissible aids**

No aids permitted

### Special case: Resit exam as oral exam

**Kind of exam**

oral

**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**

2021-2022

**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 defined below for each location/each time the module is held.
- Documentation is available in the languages defined below. Where documents are in several languages, the percentage distribution is shown (100% = all the documentation).
- The examination is available 100% in the languages shown for each location/each time it is held.

| | Berne | Lausanne | | | Lugano | Zurich | | |
|---|---|---|---|---|---|---|---|---|
| **Instruction** | | | | | | **X** E 100% | | |
| **Documentation** | | | | | | **X** E 100% | | |
| **Examination** | | | | | | **X** E 100% | | |

**Module Category**

TSM Technical scientific module

**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
- Electrical and magnetic fields
- 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:

- a mixed-signal PCB (Printed Circuit Board)

- 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 acquired competencies

- The student is able to design a high-performance electronic board 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 blocs and complex digital ICs

### Contents of module with emphasis on teaching content

| Course | Title | Weeks | Emphasis |
|---|---|---|---|
| 1 | High-speed digital electronic design :<br>• high-speed signaling and timing, clock distribution, skew, jitter, latch-based design, low-power | 1 – 5 | ~35% |
| 2 | Advanced analogue electronic design :<br>• Advanced operational amplifier applications: low level and sensor signal conditioning, electronic noise, high-speed and low-power amplifiers, frequency response analysis<br>• Advanced ADC and DAC implementations: high-speed, high-resolution, sigma-delta converter, low-power, anti-aliasing and post-filter | 6 – 14 | ~65% |

### Teaching and learning methods

- Lecture
- Exercises
- Presentation and discussion of case studies
- Self-study of the presented cases and exercises

### Literature


*The Op Amp Applications Handbook*, Walt Jung, Analog Devices, 2006

*Design with Operational Amplifiers and Analog Integrated Circuits*, Sergio Franco, McGraw-Hill 2002.

*The Data Conversion Handbook,* Walt Kester, Analog devices, March 2004.

*High Speed Signal Propagation: Advanced Black Magic*, Howard Johnson – Martin Graham, Prentice Hall, 2003.


## Assessment

### Certification requirements

Module does not use certification requirements

### Basic principle for exams

**As a rule, all the standard final exams for modules and also all resit exams are to be in written form**

### Standard final exam for a module and written resit exam

#### Kind of exam

written

#### Duration of exam

120 minutes

**Permissible aids**

*Aids permitted as specified below:*

**Permissible electronic aids**

pocket calculator

**Other permissible aids**

Course material

**Special case: Resit exam as oral exam**

**Kind of exam**

oral

**Duration of exam**

30 minutes

**Permissible aids**

No aids permitted

**Description du module, disponible en: FR**

# *Advanced Embedded Software*

## Informations générales

**Nombre de crédits ECTS**

3

**Code du module**

TSM_AdvEmbSof

**Valable pour l'année académique**

2021-2022 DRAFT

**Dernière modification**

2021-03-18

**Coordinateur/coordinatrice du module**

Serge Ayer (HES-SO, serge.ayer@hefr.ch)

**Explication des définitions de langue par lieu :**

- Les cours se dérouleront dans la langue définie ci-dessous par lieu/exécution.
- Les documents sont disponibles dans les langues définies ci-dessous. Pour le multilinguisme, voir la répartition en pourcentage (100% = documents complets)
- L'examen est disponible à 100% dans chaque langue sélectionnée pour chaque lieu/exécution.

| | Berne | Lausanne | | | Lugano | Zurich | | |
|---|---|---|---|---|---|---|---|---|
| **Leçons** | | | **X** F 100% | | | | | |
| **Documentation** | | | **X** F 0% | **X** E 100% | | | | |
| **Examen** | | | **X** F 100% | | | | | |

**Catégorie de module**

TSM approfondissement technico-scientifique

**Leçons**

2 leçons et 1 leçon de pratique par semaine

## Compétences préalables

**Connaissances préalables, compétences initiales**

- Knowledge of the C programming langage and of an object-oriented language.
- Good knowledge of computer and microprocessor architecture.
- Basic understanding of operating system concepts (scheduling, process/thread).
- Basic concurrent programming

## Brève description du contenu et des objectifs

An embedded system is a specialized computer system with embedded hardware. There exists a wide variety of embedded systems, but in general such systems are processing systems capable of sensing physical inputs from their environment and of communicating the results. Usually embedded systems are designed to perform repeating tasks, either periodically or spontaneously, for low cost, low power, and optimal performance.
In this module, we investigate how microcontroller-based embedded systems can be developed, by emphasizing on the following advantages:

- Provide flexibility with a software-based approach, with the right partition of the system into hardware and software components.
- Provide extensibility of the system.
- Provide easier error detection and debugging capabilities.
- Provide portability with the use of an embedded operating system and allow the programmer to abstract the hardware details of each platform.

## Objectifs, contenus, méthodes

### Objectifs d'apprentissage, compétences à acquérir

The students will learn the most important features of a modern RTOS by implementing their own scenario on an IoT development platform that offers a wide range of sensing, processing and communication capabilities. Starting from a basic super loop/bare metal implementation, the students will rapidly reach the limitations of this implementation. These limitations will be studied and improved solutions using scheduling, threading and synchronization will be put in place by the students for the development of a robust, portable and easily maintainable software. In addition, the students will also:

- Implement methods for analyzing the CPU and memory usage of the system.

- Develop methods for automated testing including unit tests and integration tests, toward CI/CD of embedded systems.

At the end of the module, the students will be able to:

- Develop a multi-tasking application on a microcontroller-based embedded system, using a RTOS
- Use the debugging capabilities and build the test environment for an embedded application.
- Understand the memory organization and usage of their application.
- Develop a framework for updating embedded applications, including a bootloader application.

### Contenu des modules avec pondération du contenu des cours

Introduction to Embedded Systems and Software
- Applications for Embedded Systems
- Attributes of Embedded Systems
- Options for Building Embedded Systems
- Microcontroller-based Embedded Systems
- Internet Of Things (IoT) and Embedded Systems
- Embedded Systems and Operating Systems (OS)
- Introduction to Mbed OS

Scheduling for Embedded Systems
- Programming models of Embedded Systems
- Overview of Scheduling Algorithms
- Static cyclic scheduling
- Event-driven scheduling and Interrupts
- Dynamic RTC Scheduling
- Dynamic Preemptive Scheduling
- Comparison of Scheduling Algorithms

Tasks and Concurrency
- Design of Embedded Software into Multiple Tasks
- Multitasking and Embedded OS (Mbed OS)
- Tasks and Real-Time OS
- Mbed OS Task Scheduling
- Mbed OS Threads
- Concurrency Mechanisms (Events, Mutex, Semaphore, Queue, Mail)
- Priority Inversion and Resource Access Protocols

Memory of Embedded Systems
- Principles of Memory Management
- Cortex-M Program Image Structure
- Mbed OS Memory Model
- Code, Data and Memory
- Memory Protection Unit of Cortex-M Processors

Bootloader
- Deploying Updates to Embedded Systems
- Bootloader Principles
- Bootloader Requirements and Application
- Memory Model for Bootloaders

Testing

- Levels of Testing
- Unit Testing on Mbed OS
- Integrations Testing on Mbed OS
- CI/CD for Embedded Systems

**Méthodes d'enseignement et d'apprentissage**

This module uses lecture notes and practical exercises which are given in the form of codelabs. The students have to develop their own software based on a specification, with the help of lecture notes and codelabs material.

**Bibliographie**

References are given in the lecture notes and in the codelabs.

## Evaluation

**Conditions d'admission**

Le module n'utilise pas de conditions d'admission.

**Principe pour les examens**

**En règle générale, tous les examens de fin de module réguliers et les examens de rattrapage sont organisés sous la forme écrite**

**Examen de fin de module régulier et examen écrit de répétition**

**Type de l'examen**

écrit

**Durée de l'examen**

120 minutes

**Aides autorisées**

*Les aides suivantes sont autorisées:*

**Aides électroniques autorisées**

The exam is separated in two parts.

Part 1 : no numerical help

Part 2 : computer allowed

**Autres aides autorisées**

Two two-sided A4-pages with personal notes

**Cas spécial: examen de répétition oral**

**Type de l'examen**

oral

**Durée de l'examen**

30 minutes

**Aides autorisées**

*Les aides suivantes sont autorisées:*

**Aides électroniques autorisées**

None

**Autres aides**

Two two-sided A4-pages with personal notes

**Module Description, available in: EN, FR**

# Advanced structural mechanics

## General Information

**Number of ECTS Credits**

3

**Module code**

TSM_AdvMech

**Valid for academic year**

2021-2022

**Last modification**

2021-02-10

**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 defined below for each location/each time the module is held.
- Documentation is available in the languages defined below. Where documents are in several languages, the percentage distribution is shown (100% = all the documentation).
- The examination is available 100% in the languages shown for each location/each time it is held.

| | Berne | 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

**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 acquired competencies

| Week | Subject |
|---|---|
| MW1 | **Basic Tensor Algebra & Calculus 1**<br>- Vector and tensor algebra |
| MW2 | **Basic Tensor Algebra & Calculus 2**<br>- Selected tensor properties and problems<br>- Tensor calculus |
| MW3 | **Continuum Mechanics 1**<br>- Basic definitions<br>- Kinematics of continuums |
| MW4 | **Continuum Mechanics 2**<br>- Kinetics of continuums |
| MW5 | **Continuum Mechanics 3**<br>- Equilibrium equations, equations of motion<br>- Overview of balance laws |
| MW6 | **Material Behaviour & Models for Metals 1**<br>- Material behaviour overview<br>- Basic modelling principles<br>- Elasticity |
| MW7 | **Material Behaviour & Models for Metals 2**<br>- Plasticity<br>- Visco-plasticity, creep / relaxation |
| MW8 | **Failure Mechanisms & Assessment Methods 1**<br>- Failure mechanisms of metals<br>- Static assessment methods for metals |
| MW9 | **Failure Mechanisms & Assessment Methods 2**<br>- Fatigue assessment methods for metals |
| MW10 | **Workshop 1**<br>Application of Material Models and Assessment Methods for Metals |
| MW11 | **Material Behaviour & Models for Polymers 1**<br>- Material behaviour overview<br>- Plasticity (influence of hydrostatic pressure)<br>- Hyperelasticity |
| MW12 | **Material Behaviour & Models for Polymers 2**<br>- Visco-elasticity, visco-plasticity, creep / relaxation<br>- Cohesive zone models for bonded interfaces |
| MW13 | **Material Behaviour & Models for Polymers 3**<br>- Parameter identification and optimisation methods |
| MW14 | **Workshop 2**<br>Application of Material and Damage Models for Polymers |

### Contents of module with emphasis on teaching content

- 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

**Certification requirements**

Module uses certification requirements

**Certification requirements for final examinations (conditions for attestation)**

Active participation in two Workshops (MW10, MW14) with submission of two reports in teams of two

**Basic principle for exams**

**As a rule, all the standard final exams for modules and also all resit exams are to be in written form**

**Standard final exam for a module and written resit exam**

**Kind of exam**

written

**Duration of exam**

120 minutes

**Permissible aids**

*Aids permitted as specified below:*

**Permissible electronic aids**

Pocket calculator

**Other permissible aids**

Open book

**Special case: Resit exam as oral exam**

**Kind of exam**

oral

**Duration of exam**

30 minutes

**Permissible aids**

*Aids permitted as specified below:*

**Permissible electronic aids**

Pocket calculator

**Other permissible aids**

Open book

**Description du module, disponible en: EN, FR**

# *Advanced structural mechanics*

## Informations générales

**Nombre de crédits ECTS**

3

**Code du module**

TSM_AdvMech

**Valable pour l'année académique**

2021-2022

**Dernière modification**

2021-02-10

**Coordinateur/coordinatrice du module**

Thomas Mayer (ZHAW, thomas.mayer@zhaw.ch)

**Explication des définitions de langue par lieu :**

- Les cours se dérouleront dans la langue définie ci-dessous par lieu/exécution.
- Les documents sont disponibles dans les langues définies ci-dessous. Pour le multilinguisme, voir la répartition en pourcentage (100% = documents complets)
- L'examen est disponible à 100% dans chaque langue sélectionnée pour chaque lieu/exécution.

| | Berne | 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

**Leçons**

2 leçons et 1 leçon de pratique par semaine

## Compétences préalables

**Connaissances préalables, compétences initiales**

Connaissances de base en mécanique des structures, analyse et algèbre linéaire ainsi que simulation d'éléments EF de niveau Bachelor en génie mécanique.

Un bref résumé des concepts d'ingénierie mécanique pertinents sera fourni avant le cours sous forme de mise à niveau en auto-apprentissage.

## Brève description du contenu et des objectifs

Ce cours fournit une introduction complète aux concepts de base de la mécanique de milieux continus, de la modélisation des matériaux et de l'évaluation des défaillances pour les métaux et les polymères.

Les étudiant-e-s apprennent les bases de l'algèbre des tenseurs et acquièrent un aperçu des concepts mécaniques et thermo-mécaniques régissant la mécanique de milieux continus. Sur cette base, un aperçu est donné des modèles de matériaux de pointe pour les métaux et les polymères permettant aux étudiant-e-s de sélectionner intélligement des modèles de matériaux avancés tels qu'ils sont mis en œuvre dans les outils modernes des éléments finis. Enfin, le cours donne un aperçu clair des fondements microstructuraux de la défaillance des métaux ainsi qu'un aperçu des méthodes d'évaluation mécanique telles qu'elles sont appliquées dans la pratique de l'ingénierie. Le cours est accompagné d'exercices réguliers et d'ateliers pratiques dans lesquels des modèles de matériaux avancés et des méthodes d'évaluation sont appliqués à des problèmes pratiques.

## Objectifs, contenus, méthodes

### Objectifs d'apprentissage, compétences à acquérir

| Semaine | Sujet |
|---|---|
| Sem. 1 | **Algèbre tensorielle de base et calcul 1**<br>- Algèbre vectorielle et tensorielle |
| Sem. 2 | **Algèbre tensorielle de base et calcul 2**<br>- Propriétés et problèmes des tenseurs sélectionnés<br>- Calcul du tenseur |
| Sem. 3 | **Mécanique de milieux continus 1**<br>- Définitions<br>- Cinématique des milieux continus |
| Sem. 4 | **Mécanique de milieux continus 2**<br>- Cinétique des milieux continus |
| Sem. 5 | **Mécanique de milieux continus 3**<br>- Équations d'équilibre, équations de mouvement<br>- Aperçu des lois d'équilibre |
| Sem. 6 | **Comportement des matériaux et modèles pour les métaux 1**<br>- Aperçu du comportement des matériaux<br>- Principes de base de la modélisation<br>- Élasticité |
| Sem. 7 | **Comportement des matériaux et modèles pour les métaux 2**<br>- Plasticité<br>- Visco-plasticité, fluage / relaxation |
| Sem. 8 | **Mécanismes de défaillance et méthodes d'évaluation 2**<br>- Mécanismes de défaillance des métaux<br>- Méthodes d'évaluation statique des métaux |
| Sem. 9 | **Mécanismes de défaillance et méthodes d'évaluation 2**<br>- Méthodes d'évaluation de la fatigue pour les métaux |
| Sem. 10 | **Atelier 1**<br>Application des modèles de matériaux et des méthodes d'évaluation pour les métaux |
| Sem. 11 | **Comportement des matériaux et modèles pour les polymères 1**<br>- Aperçu du comportement des matériaux<br>- Plasticité (influence de la pression hydrostatique)<br>- Hyperélasticité |
| Sem. 12 | **Comportement des matériaux et modèles pour les polymères 2**<br>- Visco-élasticité, visco-plasticité, fluage / relaxation<br>- Modèles de zones cohésives pour les interfaces collées |
| Sem. 13 | **Comportement des matériaux et modèles pour les polymères 3**<br>- Méthodes d'identification et d'optimisation des paramètres |
| Sem. 14 | **Atelier 2**<br>Application des modèles de matériaux et de dommages pour les polymères |

### Contenu des modules avec pondération du contenu des cours

- Les étudiant-e-s sont familiarisé-e-s avec l'algèbre des tenseurs de base pour comprendre les concepts fondamentaux de la mécanique du continuum.
- Les étudiant-e-s sont familiarisé-e-s avec les éléments de base de la mécanique du continuum tels que les concepts de cinématique et de cinétique ainsi que les équations d'équilibre et les lois d'équilibre comme équations directrices des problèmes mécaniques.
- Les étudiant-e-s ont une large compréhension du comportement de base des matériaux des métaux et des polymères, y compris l'élasticité, l'hyperélasticité, la plasticité, la viscoélasticité, la visco-plasticité et le fluage / la relaxation ainsi que l'isotropie, l'orthotropie et l'anisotropie.
- Les étudiant-e-s sont capables de sélectionner et de déployer de manière appropriée des modèles de matériaux linéaires et non linéaires dans des simulations par éléments finis.

- Les étudiant-e-s connaissent les mécanismes de défaillance de base des métaux et des polymères ; ils sont capables de sélectionner des méthodes d'évaluation mécanique appropriées et de réaliser des évaluations de base.

### Méthodes d'enseignement et d'apprentissage

Enseignement frontal (environ 60%), exercices et 2 ateliers, y compris la méthode des *éléments finis* (environ 40%)

### Bibliographie


Script

Documentation complémentaire (triée par degré d'exhaustivité et de difficulté) :

- 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)


## Evaluation

### Conditions d'admission

Le module utilise les conditions d'admission

### Conditions d'admission à l'examen de fin de module (exigences du certificat)

Participation active à deux ateliers (SEM10, SEM14) avec présentation de deux rapports par équipe de deux

### Principe pour les examens

**En règle générale, tous les examens de fin de module réguliers et les examens de rattrapage sont organisés sous la forme écrite**

### Examen de fin de module régulier et examen écrit de répétition

**Type de l'examen**

écrit

**Durée de l'examen**

120 minutes

**Aides autorisées**

*Les aides suivantes sont autorisées:*

**Aides électroniques autorisées**

Calculatrice de poche

**Autres aides autorisées**

Livre ouvert

### Cas spécial: examen de répétition oral

**Type de l'examen**

oral

**Durée de l'examen**

30 minutes

**Aides autorisées**

*Les aides suivantes sont autorisées:*

**Aides électroniques autorisées**

Calculatrice de poche

**Autres aides**

Livre ouvert

**Module Description, available in: EN**

# *Advanced Programming Paradigms*

## General Information

**Number of ECTS Credits**

3

**Module code**

TSM_AdvPrPa

**Valid for academic year**

2021-2022

**Last modification**

2019-10-26

**Coordinator of the module**

Edgar Lederer (FHNW, edgar.lederer@fhnw.ch)

**Explanations regarding the language definitions for each location:**

- Instruction is given in the language defined below for each location/each time the module is held.
- Documentation is available in the languages defined below. Where documents are in several languages, the percentage distribution is shown (100% = all the documentation).
- The examination is available 100% in the languages shown for each location/each time it is held.

| | Berne | Lausanne | | | Lugano | Zurich | | |
|---|---|---|---|---|---|---|---|---|
| **Instruction** | | | | | | **X** E 100% | | |
| **Documentation** | | | | | | **X** E 100% | | |
| **Examination** | | | | | | **X** E 100% | | |

**Module Category**

TSM Technical scientific module

**Lessons**

2 lecture periods and 1 tutorial period per week

## Entry level competences

**Prerequisites, previous knowledge**

Good knowledge of object-oriented programming.

## Brief course description of module objectives and content

A wealth of fascinating technologies exists alongside the ubiquitous object-oriented programming and the inadequate testing methods. This module introduces students to the most relevant of these emerging technologies from a general programming-language point of view.

**Paradigms** Besides object-orientation as today's mainstream programming paradigm, other quite different paradigms have been developed and brought to maturity during the last decades: in particular functional programming, but also logic and constraint programming. None of these paradigms is well suited to solving all the different kinds of problems but each has its own particular strengths in specific areas. Since modern software encompasses many such areas, simultaneous application of several paradigms seems appropriate, and consequently, their seamless integration into multi-paradigm languages.

**Types** Programming languages with a rich and consistent type system make it possible to detect certain errors at the time of compilation already. Using the type system, invariants can be declared in one's own data types, which are then checked by the compiler. Programming in and with a strong type system can be regarded as the first step in the direction of program verification. With even stronger type systems, it is possible to formulate complete program specifications. The compiler does then, however, generally require support for verification.

**Correctness** Choosing the right programming paradigm for a given problem simplifies its solution, but does not guarantee its correctness – the most important of all software qualities. Such a guarantee requires, in addition to the actual implementation (the "How?"), a specification (the "What?") and proof of correctness (the "Why?"). Continuous research right from the very outset of computing has now led to a verification technology that is entering industrial application. Since object-oriented programming is ubiquitous, its specification and verification is of particular importance.

This module will provide:

- an overview of programming concepts, paradigms and languages;
- a comprehensive introduction to functional programming (using Haskell or Scala);
- an introduction to multi-paradigm programming, with special emphasis on types (using Scala, which is a combination of functional and object-oriented programming);
- an introduction to the theory and practice of specification and verification of imperative programs (as a basis for the verification of object-oriented programs - example Dafny) and/or of functional programs (example Coq).

## Aims, content, methods

### Learning objectives and acquired competencies

Students will acquire an understanding of the emerging paradigms, practical skills in modern functional, multiparadigm and type-full programming, and a basic understanding of the increasingly important field of software specification and verification.

### Contents of module with emphasis on teaching content

Functional programming (6 weeks)

- Programming concepts, paradigms and languages.
- Absence of state, referential transparency, reasoning about programs.
- Eager versus lazy evaluation.
- Types and type inference, higher-order functions, concrete data types and pattern matching.
- Functors, applicative functors, monads.
- An application: interpreter for a small imperative programming language (IML).

Multi-paradigm and strong typed programming (4 weeks)

- Trait types (and Mixin composition as a variant on classical inheritance).
- Generic types (co- and contravariance for type parameters).
- Type classes and implicit parameters.
- Type-secure DSLs (Domain Specific Languages).

Program verification (4 weeks)

- Reliability via testing and verification.
- Hoare logic and weakest preconditions.
- Architecture of verification tools.
- An application: verification condition generator.
- A current verification tool: Dafny and/or Coq.

### Teaching and learning methods

- Ex-cathedra teaching.
- Programming and verification exercises.

### Literature


- Graham Hutton, Programming in Haskell, Second Edition, Cambridge, 2016.
- Miran Lipovaca, Learn You a Haskell for Great Good!, No Starch Press, 2011.
- Martin Odersky, Lex Spoon and Bill Venners, Programming in Scala, Artima, 2008.
- David Gries, The Science of Programming, Springer, 1981 (a classical text).
- José Bacelar Almeida et al., Rigorous Software Development, Springer, 2011.
- Federico Biancuzzi und Shane Warden, Masterminds of Programming: Conversations with the Creators of Major Programming Languages, O'Reilly, 2009 (for recreation).

## Assessment

### Certification requirements

Module does not use certification requirements

### Basic principle for exams

**As a rule, all the standard final exams for modules and also all resit exams are to be in written form**

### Standard final exam for a module and written resit exam

**Kind of exam**

written

**Duration of exam**

120 minutes

**Permissible aids**

*Aids permitted as specified below:*

**Permissible electronic aids**

No electronic aids permitted

**Other permissible aids**

a summary on at most 4 pages DIN A4 (= 2 sheets DIN A4, written by hand or electronically and printed out)

### Special case: Resit exam as oral exam

**Kind of exam**

oral

**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**

2021-2022

**Last modification**

2019-11-11

**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 defined below for each location/each time the module is held.
- Documentation is available in the languages defined below. Where documents are in several languages, the percentage distribution is shown (100% = all the documentation).
- The examination is available 100% in the languages shown for each location/each time it is held.

| | Berne | Lausanne | | | Lugano | Zurich | | |
|---|---|---|---|---|---|---|---|---|
| **Instruction** | | | | | | **X** E 100% | | |
| **Documentation** | | | | | | **X** E 100% | | |
| **Examination** | | | | | | **X** E 100% | | |

**Module Category**

TSM Technical scientific module

**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 acquired competencies

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.

### Contents of module with emphasis on teaching content

- **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
  - Modeling friction, gear backlash, efficiency and stiffness
  - 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”, Springer-Verlag, Berlin, 2017.


## Assessment

### Certification requirements

Module uses certification requirements

### Certification requirements for final examinations (conditions for attestation)

Submission of the given exercises

### Basic principle for exams

**As a rule, all the standard final exams for modules and also all resit exams are to be in written form**

**Standard final exam for a module and written resit exam**

**Kind of exam**

written

**Duration of exam**

120 minutes

**Permissible aids**

*Aids permitted as specified below:*

**Permissible electronic aids**

All electronic aids permitted

**Other permissible aids**

Open book

**Special case: Resit exam as oral exam**

**Kind of exam**

oral

**Duration of exam**

30 minutes

**Permissible aids**

*Aids permitted as specified below:*

**Permissible electronic aids**

All electronic aids permitted

**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**

2021-2022

**Last modification**

2019-09-25

**Coordinator of the module**

Andreas Ruckstuhl (ZHAW, rkst@zhaw.ch)

**Explanations regarding the language definitions for each location:**

- Instruction is given in the language defined below for each location/each time the module is held.
- Documentation is available in the languages defined below. Where documents are in several languages, the percentage distribution is shown (100% = all the documentation).
- The examination is available 100% in the languages shown for each location/each time it is held.

| | Berne | Lausanne | | | Lugano | Zurich | | |
|---|---|---|---|---|---|---|---|---|
| **Instruction** | | | | | | **X** E 100% | | |
| **Documentation** | | | | | | **X** E 100% | | |
| **Examination** | | | | | | **X** E 100% | | |

**Module Category**

TSM Technical scientific module

**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 covers the very popular and growing field of Bayesian statistics. We start with the fundamental principles of a Bayesian approach to the analysis of data that allows for a better accounting of uncertainty and more explicit statements of assumptions. We illustrate the basic mathematical framework as well as explanations of philosophy and interpretation. We set up and discuss introducing examples and extend them to more challenging modelling approaches, where we assess the outcome of a parameter in the face of uncertainty of other parameters. Completion of this part will give you an understanding and the ability to perform basic data analyses doing the Bayesian way.

## Aims, content, methods

### Learning objectives and acquired competencies

- 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.
- They also perceive the difference between a frequentist and a Bayesian modelling approach.
- 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.

### Contents of module with emphasis on teaching content

First Part (8 weeks):

- Review of the concepts of multiple linear regression analysis with respect to inference, prediction, model evaluation and variable selection. 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):

- Concepts of Bayesian statistics. Set up and make inference in a Bayesian model with specifying suitable prior distributions. (2 weeks)
- Making inference in a Bayesian framework by simulating from the model directly, via an exact approach and by applying MCMC-techniques, e.g. the Metropolis–Hastings sampling algorithm. (4 weeks)

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.

### Literature

Slides and lecture notes will be available in addition to recommended book chapters.

## Assessment

### Certification requirements

Module does not use certification requirements

### Basic principle for exams

**As a rule, all the standard final exams for modules and also all resit exams are to be in written form**

### Standard final exam for a module and written resit exam

**Kind of exam**

written

**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, if technically feasible

**Other permissible aids**

- open book

**Special case: Resit exam as oral exam**

**Kind of exam**

oral

**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**

2021-2022

**Last modification**

2018-11-06

**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 defined below for each location/each time the module is held.
- Documentation is available in the languages defined below. Where documents are in several languages, the percentage distribution is shown (100% = all the documentation).
- The examination is available 100% in the languages shown for each location/each time it is held.

| | Berne | 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

**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 this module reviews the subjects of basic engineering thermodynamics (energy, entropy and material balances, fluid properties, and important thermodynamic cycles) and extends knowledge to deal with real fluids, phase and chemical equilibria, system stability, and processes with chemical transformation.

Additionally, in Part B the students will learn to draw connections between detailed, thermodynamic formulae and full thermodynamic systems. The basic tools of thermodynamics (balances of conservative quantities) will be employed to model any complex, thermodynamic system. Selected examples will illustrate the utility of applying thermodynamics in various practical fields.

## Aims, content, methods

### Learning objectives and acquired competencies

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:
- Intensify the understanding of some areas from Part A, by applying the gained knowledge in terms of model building of dynamic systems (e.g.: chemically reacting systems, irreversible levelling processes)
- Understand examples of how Advanced Thermodynamics is applied in practice (modeling of complex thermo-chemical processes, e.g. wood gasification, Richardson Ellingham diagram, analysis of cycle processes)

### Contents of module with emphasis on teaching content

Part A:
Part A starts 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 introduced and used as the basis for calculating deviations from ideal gas behavior using a cubic equation of state. The necessity for partial molar properties to describe real mixtures is shown and the chemical potential is introduced. Conditions for phase and chemical equilibrium are derived and employed in simple systems.

Weekly problem sets dealing with the topics are distributed and solutions discussed with the class.

Part B:
Part B starts with the repetition and consolidation of selected fields from part A by transferring the knowledge to application via modelling thermodynamic systems. Introducing and using a System Dynamic methodology (supported by the software Berkeley Madonna, to model interacting systems (e.g.: chemically reacting species, irreversible levelling), two goals are achieved:
- Students get a visualized impression of dependencies
- Students can connect detailed formulae with a large scale system overview.

As part B progresses, application examples from practice are presented:
- The structure of modern thermodynamic equilibrium solvers in the context of modelling complex thermo-chemical processes (e.g. wood gasification)
- The Richardson Ellingham, its connection to the learned content and its wide spread application within metallurgy
- Analysis of basic and more advanced cycle processes (e.g.: Diesel cycle, Stirling cycle)

The thermodynamic basics of chemical reactor engineering (heat-, mass balancing in tank- and tube reactors, reaction- and flame temperatures) are discussed as well.

### Teaching and learning methods

Lectures with discussion, Interactive derivations on blackboard, supported by PPT slides, weekly problem sets with solutions. In Part A some exercises will be solved using Matlab and/or Excel software.  In Part B exercises require the System Dynamic software Berkeley Madonna. Trial versions (sufficient for the course) available online for free.

### Literature


Sandler, S.I..(1940). Chemical and Engineering Thermodynamics, 1989, ISBN 978-0-471-66174-0

Dunn I.J., et., al. (2003). Appendix: Using the Berkeley Madonna Language, in Biological Reaction Engineering: Dynamic Modelling Fundamentals with Simulation Examples. 2003, Doi: 10.1002/3527603050.app1

Boiger, G., (2014). System Dynamic modeling approach for resolving the thermo-chemistry of wood gasification. Int. J. Mult. Ph. 2015.


## Assessment

### Certification requirements

Module does not use certification requirements

### Basic principle for exams

**As a rule, all the standard final exams for modules and also all resit exams are to be in written form**

### Standard final exam for a module and written resit exam

Kind of exam

written

**Duration of exam**

120 minutes

**Permissible aids**

*Aids permitted as specified below:*

**Permissible electronic aids**

Notes and printed course presentations, course textbooks

**Other permissible aids**

No other aids permitted

**Special case: Resit exam as oral exam**

**Kind of exam**

oral

**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**

2021-2022

**Dernière modification**

2018-11-06

**Coordinateur/coordinatrice du module**

Timothy Griffin (FHNW, timothy.griffin@fhnw.ch)

**Explication des définitions de langue par lieu :**

- Les cours se dérouleront dans la langue définie ci-dessous par lieu/exécution.
- Les documents sont disponibles dans les langues définies ci-dessous. Pour le multilinguisme, voir la répartition en pourcentage (100% = documents complets)
- L'examen est disponible à 100% dans chaque langue sélectionnée pour chaque lieu/exécution.

| | Berne | 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

**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

### Conditions d'admission

Le module n'utilise pas de conditions d'admission.

### Principe pour les examens

**En règle générale, tous les examens de fin de module réguliers et les examens de rattrapage sont organisés sous la forme écrite**

**Examen de fin de module régulier et examen écrit de répétition**

**Type de l'examen**

écrit

**Durée de l'examen**

120 minutes

**Aides autorisées**

*Les aides suivantes sont autorisées:*

**Aides électroniques autorisées**

Notes et présentations de cours imprimées, manuels de cours

**Autres aides autorisées**

Aucune autre aide autorisée

**Cas spécial: examen de répétition oral**

**Type de l'examen**

oral

**Durée de l'examen**

30 minutes

**Aides autorisées**

Sans aides

MASTER OF SCIENCE
IN ENGINEERING

**Module Description, available in: EN**

# *Analysis of Sequential Data*

## General Information

**Number of ECTS Credits**

3

**Module code**

TSM_AnSeqDa

**Valid for academic year**

2021-2022

**Last modification**

2021-02-12

**Coordinator of the module**

Giorgio Corani (SUPSI, giorgio@idsia.ch)

**Explanations regarding the language definitions for each location:**

- Instruction is given in the language defined below for each location/each time the module is held.
- Documentation is available in the languages defined below. Where documents are in several languages, the percentage distribution is shown (100% = all the documentation).
- The examination is available 100% in the languages shown for each location/each time it is held.

| | Berne | 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

**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

Many data sets are temporal by nature.

The first part of the course presents techniques for analysis of time series. It starts from visualization techniques; then it shows techniques for characterizing trend and seasonality; eventually it present structured statistical approaches based on exponential smoothing and arima techniques. Several examples referring to real data sets are shown.

In the second part of the course students learn how to analyze digital signals in different domains, i.e. time and spectral domain; they learn how to extract meaningful features from digital signals suitable for classification. Finally, they learn how to set up and learn statistical models, such as HMMs or DNNs, for recognizing and classifying time series.

The course adopts a practical approach: theoretical concepts are illustrated and applied in specific case studies.

A probabilistic approach is emphasized throughout the course.

The labs are done using environments for scientific programming such as R or Matlab or Python.

## Aims, content, methods

### Learning objectives and acquired competencies

- Students know how to visualize time series and how to characterize their main features.
- Students know how to evaluate forecast accuracy.
- Students know how to model trends, seasonalities and non-stationarities adopting exponential smoothing and ARIMA models.
- Students know how to perform model estimation, model selection and probabilistic prediction with these models.
- Students know different methods to analyse digital signals in different domains
- Students know how to extract important features used in speech processing
- Students learn to apply Bayes rule for classifying digital signals.
- Students can apply modern deep learning approaches to classify digital signals

### Contents of module with emphasis on teaching content

Part 1: Forecasting sequential data

- Time series graphics.
- Main features of time series.
- Assessment of the predictions.
- Exponential smoothing
- ARIMA models

Practical case studies.

Part 2: Analysis and classification of digital signals

- Analysis of digital signals in different domains
- Feature extraction
- Modelling, classification & recognition of digital signals
    - Classic Approaches: Dynamic Time Warping, Vector Quantization
    - Statistical modelling: Hidden Markov Models
    - Deep Learning Approaches

Practical case studies.

### Teaching and learning methods

- Ex cathedra
- Self study

- Practical exercises with computer
- Graded homeworks / project.

### Literature

Slides will be available covering the topics of the course.

In addition, recommended books are:

*For forecasting:*

R. Hyndman and G. Athanasopoulos., Forecasting: Principles and Practice, Springer, 2018 (online free textbook at https://otexts.org/fpp2/)

*For digital signal processing:*

X. Huang, A. Acero, H.-W. Hon: Spoken Language Processing, Prentice Hall, 2001, ISBN 0-13-22616-5

L. R. Rabiner und B.-H. Juang, Fundamentals of Speech Recognition. Prentice Hall, 1993.

D. Yu und L. Deng, Automatic Speech Recognition: A Deep Learning Approach. Springer London, 2014.

## Assessment

**Certification requirements**

Module uses certification requirements

**Certification requirements for final examinations (conditions for attestation)**

The students will be required to do a small project and some graded homeworks. Such activities will determine 20% of the final grade.

**Basic principle for exams**

**As a rule, all the standard final exams for modules and also all resit exams are to be in written form**

**Standard final exam for a module and written resit exam**

**Kind of exam**

written

**Duration of exam**

120 minutes

**Permissible aids**

*Aids permitted as specified below:*

**Permissible electronic aids**

Scientific calculator

**Other permissible aids**

2 Handwritten summary sheets

**Special case: Resit exam as oral exam**

**Kind of exam**

oral

**Duration of exam**

30 minutes

**Permissible aids**

No aids permitted

MASTER OF SCIENCE
IN ENGINEERING

**Module Description, available in: EN, FR**

# *Analysis of Text Data*

## General Information

**Number of ECTS Credits**

3

**Module code**

TSM_AnTeDe

**Valid for academic year**

2021-2022

**Last modification**

2018-11-02

**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 defined below for each location/each time the module is held.
- Documentation is available in the languages defined below. Where documents are in several languages, the percentage distribution is shown (100% = all the documentation).
- The examination is available 100% in the languages shown for each location/each time it is held.

| | Berne | 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**

TSM Technical scientific module

**Lessons**

2 lecture periods and 1 tutorial period per week

## Entry level competences

**Prerequisites, previous knowledge**

- Mathematics: basic linear algebra (e.g. matrix multiplications), probability theory (e.g. Bayes theorem)
- Statistics: basic descriptive statistics (e.g., mean, variance, hypothesis testing)
- Programming: good command of a structured programming language (e.g., Python, C++, Java, etc.)
- Machine learning: experimental framework, simple classifiers (e.g. decision trees, Naive Bayes, SVMs)

## Brief course description of module objectives and content

This module introduces the main methods of text analysis using natural language processing (NLP) techniques, from a computer / data science perspective. The methods are introduced in relation to concrete applications, in order to extract meaningful, structured knowledge in several dimensions from large amounts of unstructured texts. The knowledge and applications are complementary to those of information retrieval, with several commonalities (e.g. document representation), and advanced IR topics will be included as well.

This module is divided into three parts, each of them starting with the description of one or more text analysis problems. Then, the main methods needed to address them are defined, emphasizing their generality and reusability. Finally, for each part, the methods are instantiated and combined to enable concrete applications.

The three parts are organized by increased sophistication of the analysis of language in texts:

- Text analysis using bags-of-words (i.e. texts are considered as sets of independent words)
- Text analysis using sequences of words
- Text analysis using sentence structure (i.e. considering also the dependencies between words)

## Aims, content, methods

### Learning objectives and acquired competencies

- The students are able to categorize a text analysis problem and relate the type of analysis that is required and the features to be extracted to a range of known problems.
- The students are able to identify text processing methods to leverage for solving a new problem.
- The students are aware of text processing tools and can adapt off-the-shelf systems to their needs.
- The students understand the role of data and evaluation metrics. Given a text analysis problem they are able to design comparative experiments to identify the most promising solution.

### Contents of module with emphasis on teaching content

***Introduction*** [5%]: importance of text analysis; layers of language analysis; basic text processing tools and notions of statistics; basic notions of information retrieval; data sources; evaluation methods; overview of the course.

***Part A. Text analysis using bags-of-words*** [40%]
**Motivating examples:** text classification and sentiment analysis, need for word representations accounting for meaning and similarity, distributional semantics.

**Methods** for learning low-rank word representations from data with illustration of resulting vectors: topic models from LSA to LDA; word embeddings; word sense disambiguation (statistical vs. knowledge-based).

**Apply** low-rank word representations to text classification, sentiment analysis, information retrieval and content-based text recommendation using bag-of-words models.

***Part B. Text analysis using sequences of words*** [20%]
**Motivating examples**: predict the next word in a sequence, POS tagging, named entity detection.

**Methods and their applications**: collocation extraction with mutual information, POS tagging with HMMs, NE detection with CRFs, language modeling with n-grams and neural networks.

***Part C. Text analysis using sentence structure*** [20%]
**Motivating example**: natural language inference (reasoning over sentences).

**Methods**: parsing, semantic role labeling, named entity linking, relationship and fact extraction, neural network models of sentence structure (e.g. CNNs or HANs).

**Applications**: solving logical entailment with deep neural networks, revisiting sentiment analysis with DNNs, question answering system; automatic information extraction from texts (entities, relationships, facts, events) and linking with ontologies (e.g. DBpedia).

***Part D. Special chapters*** [15%]
Perspectives on other text analysis tasks, on multilingual issues, question answering and dialogue, information retrieval and recommendation.

### Teaching and learning methods

Classroom teaching; programming exercises

### Literature

Foundations of Statistical Natural Language Processing, Christopher Manning & Hinrich Schütze, MIT Press, 1999.

Speech and Language Processing, 2nd edition, Daniel Jurafsky and James H. Martin, Prentice-Hall, 2008.

Introduction to Information Retrieval, Christopher Manning, Prabhakar Raghavan and Hinrich Schütze, 2008.

Natural Language Processing with Python, Steven Bird, Ewan Klein and Edward Loper, O'Reilly, 2009.

Neural Network Methods for Natural Language Processing, Yoav Goldberg, Morgan & Claypool, 2017.

Supplemental material (articles) will be indicated for each lesson.

## Assessment

**Certification requirements**

Module uses certification requirements

**Certification requirements for final examinations (conditions for attestation)**

75% of homework passed.

**Basic principle for exams**

**As a rule, all the standard final exams for modules and also all resit exams are to be in written form**

**Standard final exam for a module and written resit exam**

**Kind of exam**

written

**Duration of exam**

120 minutes

**Permissible aids**

*Aids permitted as specified below:*

**Permissible electronic aids**

No electronic aids permitted

**Other permissible aids**

One A4 page (front and back) of personal notes

**Special case: Resit exam as oral exam**

**Kind of exam**

oral

**Duration of exam**

30 minutes

**Permissible aids**

No aids permitted

MASTER OF SCIENCE
IN ENGINEERING

**Description du module, disponible en: EN, FR**

# *Analyse des Données Textuelles*

## Informations générales

**Nombre de crédits ECTS**

3

**Code du module**

TSM_AnTeDe

**Valable pour l'année académique**

2021-2022

**Dernière modification**

2018-11-02

**Coordinateur/coordinatrice du module**

Andrei Popescu-Belis (HES-SO, andrei.popescu-belis@heig-vd.ch)

**Explication des définitions de langue par lieu :**

- Les cours se dérouleront dans la langue définie ci-dessous par lieu/exécution.
- Les documents sont disponibles dans les langues définies ci-dessous. Pour le multilinguisme, voir la répartition en pourcentage (100% = documents complets)
- L'examen est disponible à 100% dans chaque langue sélectionnée pour chaque lieu/exécution.

| | Berne | 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**

TSM approfondissement technico-scientifique

**Leçons**

2 leçons et 1 leçon de pratique par semaine

## Compétences préalables

**Connaissances préalables, compétences initiales**

- Mathématiques: algèbre linéaire de base (p.ex. multiplication de matrices), notions de probabilités (p.ex. formule de Bayes)
- Statistiques: statistiques descriptives de base (p.ex. moyenne, variance, test d'hypothèse)
- Programmation: maitrise d'un langage de programmation structurée (p.ex. Python, C++, Java, etc.)
- Apprentissage automatique (machine learning) : principes des expérimentations, classifieurs élémentaires (p.ex. arbres de décision, classifieur bayésien naïf, machines à vecteur support)

## Brève description du contenu et des objectifs

Ce module présente les principales méthodes d'analyse des données textuelles, utilisant le traitement automatique des langues (TAL), dans la perspective de la science des données (data science). Les méthodes sont présentées en relation à des applications concrètes, pour extraire des connaissances sur plusieurs plans, à partir de grandes quantités de textes non-structurés. Ces connaissances et applications sont complémentaires à celles internenant dans le domaine de la recherche d'information (RI), avec toutefois plusieurs points communs (p.ex. la représentation des documents) ; des notions avancées de RI seront également présentées.

Ce module est divisé en trois parties, chacune commençant par la présentation d'un ou plusieurs problèmes d'analyse des données textuelles. Puis, les principales méthodes requises pour résoudre ces problèmes sont définies, en mettant l'accent sur leur généralité et leur réutilisabilité. Enfin, pour chaque partie, les méthodes sont mise en œuvre et combinées en vue d'applications concrètes.

Les trois parties sont organisées par ordre croissant de la complexité des analyses textuelles utilisées :

- Analyse de textes utilisant des « sacs de mots » (les textes sont considérés comme des ensembles de mots indépendants)
- Analyse de textes utilisant les séquences (ordonnées) de mots
- Analyse de textes utilisant la structure des propositions (i.e. les relations entre mots)

## Objectifs, contenus, méthodes

### Objectifs d'apprentissage, compétences à acquérir

- Les étudiants sont capables de classer un problème d'analyse de textes, d'identifier les analyses nécessaires et les traits à extraire, et de les relier à la gamme d'applications déjà étudiées.
- Les étudiants sont capables de choisir les méthodes de traitement automatique des langues à utiliser pour résoudre un problème nouveau.
- Les étudiants connaissent une gamme d'outils de TAL et peuvent adapter des systèmes génériques existants à leurs propres besoins.
- Les étudiants comprennent le rôle des données et des métriques d'évaluation. Etant donnée un problème d'analyse de textes, les étudiants

### Contenu des modules avec pondération du contenu des cours

***Introduction*** [5%]: importance de l'analyse des données textuelles ; niveaux d'analyse des langues ; outils fondamentaux ; rappels de statistiques et de recherche d'information ; sources de données ; méthodes d'évaluation ; vue d'ensemble du cours.

***Partie A. Analyse de textes comme ensemble de mots*** [40%]
**Motivation (exemples)**: classification de textes, analyse des sentiments ; nécessité de représenter les mots en tenant compte de leurs sens et leur similarité ; sémantique distributionnelle.

**Méthodes**: apprentissage de représentations de mots en dimensions réduites, illustration des vecteurs résultants : modèles de topics de la LSA à la LDA ; plongements de mots (embeddings) ; désambiguïsation du sens des mots (basée sur les statistiques ou sur les dictionnaires).

**Application** des représentations en dimensions réduites à la classification de textes, à l'analyse des sentiments, la recherche d'information, et la recommandation de textes basée sur le contenu (modèles « sacs de mots »).

***Partie B. Analyse de textes utilisant les séquences de mots*** [20%]
**Motivation (exemples)**: prédire le mot suivant dans une phrase, étiquetage morphosyntaxique, reconnaissance d'entités nommées.

**Méthodes et applications**: extraction de collocations un utilisant l'information mutuelle ; étiquetage morphosyntaxique avec des modèles de Markov cachés (HMM) ; reconnaissance d'entités nommées avec des CRFs ; modèles de langage à base de n-grammes ou de réseaux neuronaux.

***Part C. Analyse de textes utilisant les structures des propositions*** [20%]
**Motivation (exemples)**: capacité à faire des inférences à partir de phrases.

**Méthodes**: analyse syntaxique, étiquetage des rôles sémantiques, liage des entités nommées, extraction de faits et de relations, modèles neuronaux de la structure des propositions (p.ex. des réseaux de convolution, ou des réseaux hiérarchiques avec attention).

**Applications**: identification de l'implication logique ou analyse des sentiments avec des réseaux de neurones ; systèmes de question-réponse ; extraction d'information textuelle (entités, relations, faits, événements) et lien avec les ontologies (p.ex. DBpedia).

***Part D. Morceaux choisis*** [15%]
Perspectives sur les autres tâches d'analyse de textes, le cas des données multililingues, le dialogue humain-machine, la recherche et la recommandation d'information.

### Méthodes d'enseignement et d'apprentissage

Enseignement magistral, exercices utilisant la programmation

### Bibliographie

Foundations of Statistical Natural Language Processing, Christopher Manning & Hinrich Schütze, MIT Press, 1999.

Speech and Language Processing, 2nd edition, Daniel Jurafsky and James H. Martin, Prentice-Hall, 2008.

Introduction to Information Retrieval, Christopher Manning, Prabhakar Raghavan and Hinrich Schütze, 2008.

Natural Language Processing with Python, Steven Bird, Ewan Klein and Edward Loper, O'Reilly, 2009.

Neural Network Methods for Natural Language Processing, Yoav Goldberg, Morgan & Claypool, 2017.

Des articles supplémentaires seront indiqués pour chaque cours.

## Evaluation

**Conditions d'admission**

Le module utilise les conditions d'admission

**Conditions d'admission à l'examen de fin de module (exigences du certificat)**

75% des devoirs à la maison validés.

**Principe pour les examens**

**En règle générale, tous les examens de fin de module réguliers et les examens de rattrapage sont organisés sous la forme écrite**

**Examen de fin de module régulier et examen écrit de répétition**

**Type de l'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 personnelles sur une page A4 recto-verso.

**Cas spécial: examen de répétition oral**

**Type de l'examen**

oral

**Durée de l'examen**

30 minutes

**Aides autorisées**

Sans aides

MASTER OF SCIENCE
IN ENGINEERING

**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**

2021-2022

**Dernière modification**

2021-03-30

**Coordinateur/coordinatrice du module**

Christophe Besson (HES-SO, Christophe.Besson@heig-vd.ch)

**Explication des définitions de langue par lieu :**

- Les cours se dérouleront dans la langue définie ci-dessous par lieu/exécution.
- Les documents sont disponibles dans les langues définies ci-dessous. Pour le multilinguisme, voir la répartition en pourcentage (100% = documents complets)
- L'examen est disponible à 100% dans chaque langue sélectionnée pour chaque lieu/exécution.

| | Berne | 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

**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 methods.
- 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 und quasi-static analysis (dielectric design, computation of the electric capacitance and magnetic inductance, eddy currents, skin effect, proximity effect, and magnetic force)

- Emission, propagation and reception of electromagnetic waves
- Eigenvalue problems (waveguide, antenna, resonator, and optical fiber)

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 using Matlab
- 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. Practical applications (40%)

- Dielectric simulations of high voltage devices
- Eddy-current analysis
- Electromagnetic simulations of electrical machines
- Eigenvalue analysis of filters and waveguides
- Electromagnetic simulations of RF-antennas
- Electromagnetic analysis of microstrip structures
- Electromagnetic compatibility (EMC and EMI)
- MRI-applications
- 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

**Conditions d'admission**

Le module n'utilise pas de conditions d'admission.

**Principe pour les examens**

**En règle générale, tous les examens de fin de module réguliers et les examens de rattrapage sont organisés sous la forme écrite**

**Examen de fin de module régulier et examen écrit de répétition**

**Type de l'examen**

écrit

**Durée de l'examen**

120 minutes

**Aides autorisées**

*Les aides suivantes sont autorisées:*

**Aides électroniques autorisées**

Calculator, computer, no social network

**Autres aides autorisées**

To be defined between lecturers and students

**Cas spécial: examen de répétition oral**

**Type de l'examen**

oral

**Durée de l'examen**

30 minutes

**Aides autorisées**

*Les aides suivantes sont autorisées:*

**Aides électroniques autorisées**

Calculator, computer, no social network

**Autres aides**

Same as written exam

MASTER OF SCIENCE
IN ENGINEERING

**Module Description, available in: EN**

# *Applied micro & nano technologies*

## General Information

**Number of ECTS Credits**

3

**Module code**

TSM_AppMNT

**Valid for academic year**

2021-2022

**Last modification**

2021-02-12

**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 defined below for each location/each time the module is held.
- Documentation is available in the languages defined below. Where documents are in several languages, the percentage distribution is shown (100% = all the documentation).
- The examination is available 100% in the languages shown for each location/each time it is held.

| | Berne | Lausanne | | | Lugano | Zurich | | |
|---|---|---|---|---|---|---|---|---|
| **Instruction** | | | | | | **X** E 100% | | |
| **Documentation** | | | | | | **X** E 100% | | |
| **Examination** | | | | | | **X** E 100% | | |

**Module Category**

TSM Technical scientific module

**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 modul imparts the scientific and technological basics as well as the possibilities and the perspectives of the micro- and nanotechnologies. The students should become sensitve to the enormous potential of applications of this field and acquire a certain ability in handling it.

## Aims, content, methods

### Learning objectives and acquired competencies

- the students know the 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

### Contents of module with emphasis on teaching content

Introduction in the modern devcie fabrication

- scaling laws
- from photo- to nanolithography and self-assemling
- technologies for the material deposition and the surface structuring in order to result in certain electrical and other properties
- nanotools for the analysis and the modification of  surfaces
- surface topography on micro- and nanolevel: AFM, SEM/TEM, IOM

Future technologies

- From MEMS to NEMS
- fullerene-based nanosystems
- biomedical applications of the nanotachnolgy
- micro- and nanofluidics
- nanosafety and risks

### Teaching and learning methods

lectures and exercises

### Literature

.

## Assessment

### Certification requirements

Module does not use certification requirements

### Basic principle for exams

**As a rule, all the standard final exams for modules and also all resit exams are to be in written form**

### Standard final exam for a module and written resit exam

**Kind of exam**

written

**Duration of exam**

120 minutes

**Permissible aids**

No aids permitted

### Special case: Resit exam as oral exam

**Kind of exam**

oral

**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**

2021-2022

**Last modification**

2019-11-06

**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 defined below for each location/each time the module is held.
- Documentation is available in the languages defined below. Where documents are in several languages, the percentage distribution is shown (100% = all the documentation).
- The examination is available 100% in the languages shown for each location/each time it is held.

| | Berne | Lausanne | | | Lugano | Zurich | | |
|---|---|---|---|---|---|---|---|---|
| **Instruction** | | | | | | **X** E 100% | | |
| **Documentation** | | | | | | **X** E 100% | | |
| **Examination** | | | | | | **X** E 100% | | |

**Module Category**

TSM Technical scientific module

**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 acquired competencies

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

### Contents of module with emphasis on teaching content

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

### Certification requirements

Module does not use certification requirements

### Basic principle for exams

**As a rule, all the standard final exams for modules and also all resit exams are to be in written form**

### Standard final exam for a module and written resit exam

**Kind of exam**

written

**Duration of exam**

120 minutes

**Permissible aids**

*Aids permitted as specified below:*

**Permissible electronic aids**

none

**Other permissible aids**

Personal formulary: 4 A4 pages

**Special case: Resit exam as oral exam**

**Kind of exam**

oral

**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**

2021-2022

**Last modification**

2019-08-31

**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 defined below for each location/each time the module is held.
- Documentation is available in the languages defined below. Where documents are in several languages, the percentage distribution is shown (100% = all the documentation).
- The examination is available 100% in the languages shown for each location/each time it is held.

| | Berne | Lausanne | | | Lugano | Zurich | | |
|---|---|---|---|---|---|---|---|---|
| **Instruction** | | | | | | **X** E 100% | | |
| **Documentation** | | | | | | **X** E 100% | | |
| **Examination** | | | | | | **X** E 100% | | |

**Module Category**

TSM Technical scientific module

**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. The course combines theoretical foundations for coordinate transformations, sensor fusion, planning and control 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.

## Aims, content, methods

### Learning objectives and acquired competencies

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.

### Contents of module with emphasis on teaching content

- 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
    - Closing the loop
- Navigation
    - Planning
    - Obstacle avoidance
    - Trajectory follower
- Advanced Topics
    - Real-time systems & Robot operating system frameworks
    - Multi-robot systems
    - Modelling and 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

### Certification requirements

Module does not use certification requirements

### Basic principle for exams

**As a rule, all the standard final exams for modules and also all resit exams are to be in written form**

### Standard final exam for a module and written resit exam

**Kind of exam**

written

**Duration of exam**

120 minutes

**Permissible aids**

No aids permitted

### Special case: Resit exam as oral exam

**Kind of exam**

oral

**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**

2021-2022

**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 defined below for each location/each time the module is held.
- Documentation is available in the languages defined below. Where documents are in several languages, the percentage distribution is shown (100% = all the documentation).
- The examination is available 100% in the languages shown for each location/each time it is held.

| | Berne | Lausanne | | | Lugano | Zurich | | |
|---|---|---|---|---|---|---|---|---|
| **Instruction** | | | | | | **X** E 100% | | |
| **Documentation** | | | | | | **X** E 100% | | |
| **Examination** | | | | | | **X** E 100% | | |

**Module Category**

TSM Technical scientific module

**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 acquired competencies

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.

### Contents of module with emphasis on teaching content

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 |
|---|
| Presentations, description of module, organization<br><br>Introduction on drives<br><br>Evaluation: development of model on Matlab/Simulink for a drive, and simulation.<br><br>Variants on drive solutions. |
| Drive solutions with DC or BLDC motors<br><br>- dynamic description of movement<br><br>- modeling (*Matlab+Simulink*)<br><br>- transmitters and power electronics<br><br>- transmissions<br><br>- cascade regulation of drives. |
| - synchronous motor<br><br>- asynchronous motor<br><br>- stepper motor<br><br>- reluctance motor |
| 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

### Certification requirements

Module does not use certification requirements

### Basic principle for exams

**As a rule, all the standard final exams for modules and also all resit exams are to be in written form**

### Standard final exam for a module and written resit exam

**Kind of exam**

written

**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).

### Special case: Resit exam as oral exam

**Kind of exam**

oral

**Duration of exam**

30 minutes

**Permissible aids**

No aids permitted

MASTER OF SCIENCE
IN ENGINEERING

**Modulbeschreibung, verfügbar in: DE, FR**

# *Building Information Modelling (BIM)*

## Allgemeine Angaben

**Anzahl ECTS-Credits**

3

**Modulkürzel**

TSM_BIM

**Gültig für akademisches Jahr**

2021-2022

**Letzte Änderung**

2021-02-10

**Modul-Koordinator/in**

Manfred Huber (FHNW, manfred.huber@fhnw.ch)

**Erläuterungen zu den Sprachdefinitionen je Standort:**

- Der Unterricht findet in der unten definierten Sprache je Standort/Durchführung statt.
- Die Unterlagen sind in den unten definierten Sprachen verfügbar. Bei Mehrsprachigkeit, siehe prozentuale Verteilung (100% = komplette Unterlagen)
- Die Prüfung ist in jeder je Standort/Durchführung angekreuzten Sprache zu 100% verfügbar.

| | Berne | 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

**Lektionen**

2 Lektionen und 1 Übungslektion pro Woche

## Eintrittskompetenzen

**Vorkenntnisse, Eingangskompetenzen**

Bachelor-Abschluss in einer technischen Fachdisziplin, Business Engineering, Informatik o.ä. Erste Kontakte mit der BIM-Methode von Vorteil. Es sind keine CAD-Kenntnisse erforderlich.

## Kurzbeschreibung der Inhalte und Ziele

Die BIM-Methode (VDC) umfasst das digitale Planen, Bauen und Betreiben von Bauwerken mit digitalen Bauwerksmodellen in Kombination von geeigneten Organisationsformen und Prozessen.

Das digitale Bauwerksmodell wird dabei zielgerichtet und disziplinübergreifend erstellt. Es umfasst sowohl die geometrischen (3D) wie die nichtgeometrischen Informationen die es zur Nutzung der vereinbarten Anwendungsfälle braucht.

Die BIM-Methode findet sowohl im Bauwesen bei der Projektierung und Realisierung (z.B. Grundlagen [rechtlich, geologisch/geotechnisch], Architektur, Ingenieurwesen, Haustechnik), in der Geomatik für die Bauwerksgeometrieerfassung, -modellierung, -nachführung und -verwaltung als auch im Facility Management Anwendung.

## Ziele, Inhalte, Methoden

### Lernziele, zu erwerbende Kompetenzen

Im TSM_BIM lernen die Studierenden die wichtigsten Grundlagen der BIM-Methode kennen. Dabei werden sowohl bau- (BIM) wie geomatik-relevante (GeoBIM) Aspekte betrachtet.

Fokus des Moduls liegt in der disziplinübergreifenden Nutzung von digitalen Bauwerksmodellen.

Die Studierenden sind nach dem Besuch des TSM_BIM Moduls in der Lage Informationsanforderungen an einfache digitale Bauwerksmodelle zu formulieren und zu erfassen, deren Daten im offenen Datenaustauschformat IFC auszutauschen und anschliessend zielgerichtet zur Gewinnung von Informationen auszuwerten.

Der Unterricht erfolgt praxisnah unter der Nutzung von digitalen Bauwerksmodellen und geeigneten BIM-Werkzeugen.

### Modulinhalt mit Gewichtung der Lehrinhalte

**TEIL 1: BIM-Methode – Grundlagen und Blick in die Praxis**

**Einführung**: Definition und Grundidee. Planungs- und Bauprozess gestern, heute und morgen. Stand BIM CH-International. Terminologien. Herausforderungen.

**Anspruchsgruppen, Modelle und Rollen**: Vom Auftraggeber über die Planer bis hin zu Betreiber und Nutzer. Prinzip der Informationsanforderungen und -lieferung. Informationsbesteller / Informationssender.

**Blick in die Praxis**: Anforderungen, Strukturierung, Aufbau und Auswertung von digitalen Bauwerksmodellen.

**Daten und Digitale Bauwerksmodelle:** Lesen und beurteilen von Daten aus digitalen Bauwerksmodellen.

**TEIL 2: GeoBIM und Datenaustauschmodelle**

**BIM und Geodaten:** Unterschiede und Gemeinsamkeiten zwischen BIM und Geo, 3D-Modellierungsparadigmen.

**Datenaustauschmodell IFC**: IFC-Schema, IFC vs. CityGML.

**Software der BIM-Methode und Geodatenerfassung für BIM (Field2BIM)**: BIM-Software und -Webplattformen, BIM-Webdienste, 3D-Erfassungstechnologien und Points2BIM-Konzepte.

**TEIL 3: Digitale Bauwerksmodelle und Datenmanagement**

**Informationsanforderungen:** Formulierung von BIM-Zielen, Lastenheft (EIR). Beschreibung und Prüfung von Informationsanforderungen.

**Datenauswertung I:** Gewinnen von Informationen durch das vordefinierte Auswerten von digitalen Bauwerksmodellen. Prüfen der Datenqualität.

**Erweiterung Datenaustauschmodell I:** Nutzung eines Autorenwerkzeuges. Erweitern des nativen Datenmodelles.

**Erweiterung Datenaustauschmodell II :** Nutzung eines Autorenwerkzeuges. Mapping des nativen Datenmodelles auf das IFC-Datenaustauschmodell.

**Datenauswertung II:** Formulieren und Schreiben von Regeln zur Gewinnung von Informationen aus digitalen Bauwerksmodellen.

**Datenauswertung III:** Zielgerichtete Ausgabe von Informationen aus digitalen Bauwerksmodellen in Templates zur weiteren Verarbeitung.

**BIM-Projektabwicklungsplan:** Der BIM-Projektabwicklungsplan als Pflichtenheft das Aufbau, Struktur, Qualitätssicherung und Datenaustausch regelt.

### Lehr- und Lernmethoden

Vorlesung, Fallbeispiele, Übungen, ggf. Exkursion

Didaktisches Konzept: Blended Learning -Inverted Classroom

**Bibliografie**


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. Verfügbar unter: 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.


## Bewertung

**Zulassungsbedingungen**

Modul verwendet Zulassungsbedingungen

**Zulassungsbedingungen für die Modulabschlussprüfung (Testatbedingungen)**

Zur Modulschlussprüfung werden alle Modulteilnehmenden zugelassen, welche nicht mehr als drei Abwesenheiten aufweisen. Zudem müssen alle Modularbeiten pünktlich abgegeben, in ausreichendem Masse bearbeitet und dokumentiert und vom Modulverantwortlichen angenommen werden.

**Grundsatz Prüfungen**

**In der Regel werden alle regulären Modulabschlussprüfungen und Wiederholungsprüfungen in schriftlicher Form gehalten**

**Reguläre Modulschlussprüfung und schriftliche Wiederholungsprüfung**

**Art der Prüfung**

schriftlich

**Prüfungsdauer**

120 Minuten

**Erlaubte Hilfsmittel**

*Erlaubt sind die aufgeführten Hilfsmittel:*

**Zulässige elektronische Hilfsmittel**

Ausser der Hilfestellung von aussenstehenden Personen, Mitstudierenden oder deren Prüfungen sind alle Hilfsmittel zugelassen. Somit darf während der Prüfung keine Kommunikation (mündlich und schriftlich) stattfinden. Ebenfalls dürfen keine Aufnahme (Foto, Video oder dgl.) von der Prüfung erstellt werden.

**Weitere erlaubte Hilfsmittel**

in Papierform: Folien, Übungen, Literatur und Notizen.

**Spezialfall: Wiederholungsprüfung als mündliches Examen**

**Art der Prüfung**

mündlich

**Prüfungsdauer**

30 Minuten

**Erlaubte Hilfsmittel**

*Erlaubt sind die aufgeführten Hilfsmittel:*

**Zulässige elektronische Hilfsmittel**

Ausser der Hilfestellung von aussenstehenden Personen, Mitstudierenden oder deren Prüfungen sind alle Hilfsmittel zugelassen. Somit darf während der Prüfung keine Kommunikation (mündlich und schriftlich) stattfinden. Ebenfalls dürfen keine Aufnahme (Foto, Video oder dgl.) von der Prüfung erstellt werden.

**Andere zulässige Hilfsmittel**
in Papierform: Folien, Übungen, Literatur und Notizen.

**Description du module, disponible en: DE, FR**

# *Building Information Modelling (BIM)*

## Informations générales

**Nombre de crédits ECTS**

3

**Code du module**

TSM_BIM

**Valable pour l'année académique**

2021-2022

**Dernière modification**

2021-02-10

**Coordinateur/coordinatrice du module**

Manfred Huber (FHNW, manfred.huber@fhnw.ch)

**Explication des définitions de langue par lieu :**

- Les cours se dérouleront dans la langue définie ci-dessous par lieu/exécution.
- Les documents sont disponibles dans les langues définies ci-dessous. Pour le multilinguisme, voir la répartition en pourcentage (100% = documents complets)
- L'examen est disponible à 100% dans chaque langue sélectionnée pour chaque lieu/exécution.

| | Berne | 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

**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**

**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 et GeoBIM**

**BIM et géodonnées:** Différences et points communs entre les paradigmes de modélisation 3D BIM et Geo.

**Modèle d'échange de données IFC**: Schéma IFC, IFC vs. CityGML.

**Logiciels de la méthode BIM et saisie de géodonnées pour BIM (Field2BIM)**: Logiciels et plateforme internet BIM, services web BIM, technologies de saisie 3D et concepts Points2BIM.

**PARTIE 3: Maquettes d'ouvrages numérique et gestion des données**

**Exigences d'information:** Formulation d'objectifs BIM et cahier des charges (EIR). Description et vérification des exigences relatives à l'information.

**Evaluation des données I:** Acquisition d'informations par une évaluation prédéfinie de maquettes d'ouvrages numériques. Vérification de la qualité des données.

**Élargissement du modèle d'échange de données I:** Utilisation d'un outil auteur. Élargissement du modèle de données natif.

**Élargissement du modèle d'échange de données II:** Utilisation d'un outil auteur. Mapping du modèle de données natif sur le modèle d'échange de données.

**Évaluation des données II:** Formulation et rédaction de règles pour l'obtention d'informations à partir de maquettes d'ouvrages numériques.

**Évaluation des données III:** Édition ciblée d'informations à partir de maquettes d'ouvrages numériques dans des modèles en vue de leur traitement ultérieur.

**Plan de déroulement de projet BIM:** Le plan de déroulement de projet BIM en guise de cahier des charges qui régit le cadre, la structure et l'assurance qualité ainsi que l'échange des données.

### 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

### Conditions d'admission

Le module utilise les conditions d'admission

### Conditions d'admission à l'examen de fin de module (exigences du certificat)

Seuls les étudiant-e-s qui ne comptabilisent pas plus de trois absences sont autorisés à passer l'examen de fin de module. En outre, tous les travaux de module doivent être rendus dans les délais, avoir été estimés suffisamment documentés et travaillés et avoir été validés par le responsable du module.

### Principe pour les examens

**En règle générale, tous les examens de fin de module réguliers et les examens de rattrapage sont organisés sous la forme écrite**

### Examen de fin de module régulier et examen écrit de répétition

#### Type de l'examen

écrit

#### Durée de l'examen

120 minutes

#### Aides autorisées

*Les aides suivantes sont autorisées:*

#### Aides électroniques autorisées

A l'exception de l'aide d'autrui, tous les moyens auxiliaires sont autorisés. Il est ainsi interdit de communiquer pendant l'examen (à l'oral ou à l'écrit). Aucun enregistrement (photo, vidéo ou autre) de l'examen n'est autorisé.

#### Autres aides autorisées

Format papier : Slides et exercices, livres et notes

### Cas spécial: examen de répétition oral

**Type de l'examen**

oral

**Durée de l'examen**

30 minutes

**Aides autorisées**

*Les aides suivantes sont autorisées:*

**Aides électroniques autorisées**

Toutes les aides sont autorisées, à l'exception de l'aide de personnes extérieures, de camarades de classe ou de leurs examens. Par conséquent, aucune communication (orale ou écrite) n'est autorisée pendant l'examen. De même, aucun enregistrement (photos, vidéos, etc.) de l'examen ne peut être fait.

**Autres aides**

Format papier : Slides et exercices, livres et notes

MASTER OF SCIENCE
IN ENGINEERING

**Modulbeschreibung, verfügbar in: DE**

# *Baustatik*

## Allgemeine Angaben

**Anzahl ECTS-Credits**

3

**Modulkürzel**

TSM_BauStat

**Gültig für akademisches Jahr**

2021-2022

**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 unten definierten Sprache je Standort/Durchführung statt.
- Die Unterlagen sind in den unten definierten Sprachen verfügbar. Bei Mehrsprachigkeit, siehe prozentuale Verteilung (100% = komplette Unterlagen)
- Die Prüfung ist in jeder je Standort/Durchführung angekreuzten Sprache zu 100% verfügbar.

| | Berne | Lausanne | | | Lugano | Zurich | | |
|---|---|---|---|---|---|---|---|---|
| **Unterricht** | | | | | | | **X** D 100% | |
| **Dokumentation** | | | | | | | **X** D 100% | |
| **Prüfung** | | | | | | | **X** D 100% | |

**Modulkategorie**

TSM Technisch-wissenschaftliche Vertiefung

**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, 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

### Zulassungsbedingungen

Modul verwendet keine Zulassungsbedingungen

### Grundsatz Prüfungen

**In der Regel werden alle regulären Modulabschlussprüfungen und Wiederholungsprüfungen in schriftlicher Form gehalten**

### Reguläre Modulschlussprüfung und schriftliche Wiederholungsprüfung

**Art der Prüfung**

schriftlich

**Prüfungsdauer**

120 Minuten

**Erlaubte Hilfsmittel**

*Erlaubt sind die aufgeführten Hilfsmittel:*

**Zulässige elektronische Hilfsmittel**

- Taschenrechner

**Weitere erlaubte Hilfsmittel**

- selbstverfasste Zusammenfassung, 10 DIN A4 Seiten

### Spezialfall: Wiederholungsprüfung als mündliches Examen

**Art der Prüfung**

mündlich

**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**

# *Biomedical Engineering*

## General Information

**Number of ECTS Credits**

3

**Module code**

TSM_BioMedEng

**Valid for academic year**

2021-2022

**Last modification**

2019-08-31

**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 defined below for each location/each time the module is held.
- Documentation is available in the languages defined below. Where documents are in several languages, the percentage distribution is shown (100% = all the documentation).
- The examination is available 100% in the languages shown for each location/each time it is held.

| | Berne | Lausanne | | | Lugano | Zurich | | |
|---|---|---|---|---|---|---|---|---|
| **Instruction** | | | | | | **X** E 100% | | |
| **Documentation** | | | | | | **X** E 100% | | |
| **Examination** | | | | | | **X** E 100% | | |

**Module Category**

TSM Technical scientific module

**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, orthopaedics, osteosynthesis)

## Brief course description of module objectives and content

(1) The module's goal is to obtain a deeper understanding of biomedical engineering principles, the human musculoskeletal system, its function, and related biomechanical analysis, pathologies, possible treatment strategies in surgery and rehabilitation.

(2) Participants will obtain insight into basic requirements such as biology and physiology, materials used for implants and prostheses, and available biomaterials for skeletal tissue regeneration.

(3) Current clinical topics will be addressed, like osteoporosis, fracture fixation osteoarthritis, and neurorehabilitation. Treatment methods such as fracture fixation, primary stability, and joint replacements will be discussed besides.

(4) A more profound insight will be provided into technologies for human motion analysis (measurement technologies and performance analysis).

(5) The course will also discuss robot-assistive rehabilitation technologies in cases of neuropathology such as stroke, multiple sclerosis, and spinal cord injury.

## Aims, content, methods

### Learning objectives and acquired competencies

There will be lectures on the following main subjects: a) biomedical engineering) prosthetics as well as c) clinical topics. The students will learn more about these subjects and understand why these topics are significant in medical engineering.

### Contents of module with emphasis on teaching content

***Biomedical engineering***

- physiological systems
- biotechnology and tissue engineering
- bioelectric and neuro-engineering
- human sensory systems

***Prosthetics***

- human movement analysis, orthopedics, biomechanics, biomaterials
- biomechanical testing of implants/test development & lab accreditation

***Clinical topics***

- aging and geriatrics, degenerative diseases, osteoporosis, muscle atrophy, neuro-/endocrinological disorders (e.g., diabetes mellitus)
- bioreactors and tissue engineering in regenerative medicine

### Teaching and learning methods

There will be a mix of various teaching methods applied like classical teaching, group work, etc.

### Literature

Slides and lecture notes will be made available to the students. Furthermore, there will be a list provided with references to books or scientific articles relevant to the topics taught.

## Assessment

### Certification requirements

Module does not use certification requirements

### Basic principle for exams

**As a rule, all the standard final exams for modules and also all resit exams are to be in written form**

### Standard final exam for a module and written resit exam

**Kind of exam**

written

**Duration of exam**

120 minutes

**Permissible aids**

No aids permitted

### Special case: Resit exam as oral exam

**Kind of exam**

oral

**Duration of exam**

30 minutes

**Permissible aids**

No aids permitted

MSE MASTER OF SCIENCE IN ENGINEERING

**Modulbeschreibung, verfügbar in: DE**

# *Zustandserfassung von Bauwerken*

## Allgemeine Angaben

**Anzahl ECTS-Credits**

3

**Modulkürzel**

TSM_Build

**Gültig für akademisches Jahr**

2021-2022

**Letzte Änderung**

2019-11-25

**Modul-Koordinator/in**

Felix Wenk (OST, felix.wenk@ost.ch)

**Erläuterungen zu den Sprachdefinitionen je Standort:**

- Der Unterricht findet in der unten definierten Sprache je Standort/Durchführung statt.
- Die Unterlagen sind in den unten definierten Sprachen verfügbar. Bei Mehrsprachigkeit, siehe prozentuale Verteilung (100% = komplette Unterlagen)
- Die Prüfung ist in jeder je Standort/Durchführung angekreuzten Sprache zu 100% verfügbar.

| | Berne | Lausanne | | | Lugano | Zurich | | |
|---|---|---|---|---|---|---|---|---|
| **Unterricht** | | | | | | | **X** D 100% | |
| **Dokumentation** | | | | | | | **X** D 100% | |
| **Prüfung** | | | | | | | **X** D 100% | |

**Modulkategorie**

TSM Technisch-wissenschaftliche Vertiefung

**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, 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 Übungslektionen 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 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 weiteren Übungslektionen 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 / A. Müller / Dr. R. Wagner

## Bewertung

### Zulassungsbedingungen

Modul verwendet keine Zulassungsbedingungen

## Grundsatz Prüfungen

**In der Regel werden alle regulären Modulabschlussprüfungen und Wiederholungsprüfungen in schriftlicher Form gehalten**

## Reguläre Modulschlussprüfung und schriftliche Wiederholungsprüfung

**Art der Prüfung**

schriftlich

**Prüfungsdauer**

120 Minuten

**Erlaubte Hilfsmittel**

*Erlaubt sind die aufgeführten Hilfsmittel:*

**Zulässige elektronische Hilfsmittel**

Keine elektronischen Hilfsmittel zulässig

**Weitere erlaubte Hilfsmittel**

Open Book

## Spezialfall: Wiederholungsprüfung als mündliches Examen

**Art der Prüfung**

mündlich

**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**

2021-2022

**Last modification**

2019-07-18

**Coordinator of the module**

Marcel Dettling (ZHAW, dtli@zhaw.ch)

**Explanations regarding the language definitions for each location:**

- Instruction is given in the language defined below for each location/each time the module is held.
- Documentation is available in the languages defined below. Where documents are in several languages, the percentage distribution is shown (100% = all the documentation).
- The examination is available 100% in the languages shown for each location/each time it is held.

| | Berne | Lausanne | | | Lugano | Zurich | | |
|---|---|---|---|---|---|---|---|---|
| **Instruction** | | | | | | **X** E 100% | | |
| **Documentation** | | | | | | **X** E 100% | | |
| **Examination** | | | | | | **X** E 100% | | |

**Module Category**

TSM Technical scientific module

**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 acquired competencies

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.

### Contents of module with emphasis on teaching content

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

### Certification requirements

Module does not use certification requirements

### Basic principle for exams

**As a rule, all the standard final exams for modules and also all resit exams are to be in written form**

### Standard final exam for a module and written resit exam

**Kind of exam**

written

**Duration of exam**

120 minutes

**Permissible aids**

*Aids permitted as specified below:*

**Permissible electronic aids**

Scientific pocket calculator

**Other permissible aids**

Open book

### Special case: Resit exam as oral exam

**Kind of exam**

oral

**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**

2021-2022

**Last modification**

2020-02-10

**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 defined below for each location/each time the module is held.
- Documentation is available in the languages defined below. Where documents are in several languages, the percentage distribution is shown (100% = all the documentation).
- The examination is available 100% in the languages shown for each location/each time it is held.

| | Berne | Lausanne | | | Lugano | Zurich | | |
|---|---|---|---|---|---|---|---|---|
| **Instruction** | | | | | | **X** E 100% | | |
| **Documentation** | | | | | | **X** E 100% | | |
| **Examination** | | | | | | **X** E 100% | | |

**Module Category**

TSM Technical scientific module

**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 acquired competencies

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

### Contents of module with emphasis on teaching content

- **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

### Certification requirements

Module does not use certification requirements

### Basic principle for exams

**As a rule, all the standard final exams for modules and also all resit exams are to be in written form**

### Standard final exam for a module and written resit exam

**Kind of exam**

written

**Duration of exam**

120 minutes

**Permissible aids**

No aids permitted

### Special case: Resit exam as oral exam

**Kind of exam**

oral

**Duration of exam**

30 minutes

**Permissible aids**

No aids permitted

MASTER OF SCIENCE
IN ENGINEERING

**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**

2021-2022

**Last modification**

2021-01-11

**Coordinator of the module**

Jürg Küffer (FHNW, juerg.kueffer@fhnw.ch)

**Explanations regarding the language definitions for each location:**

- Instruction is given in the language defined below for each location/each time the module is held.
- Documentation is available in the languages defined below. Where documents are in several languages, the percentage distribution is shown (100% = all the documentation).
- The examination is available 100% in the languages shown for each location/each time it is held.

| | Berne | 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

**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 acquired competencies

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.

### Contents of module with emphasis on teaching content

- **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

### Certification requirements

Module does not use certification requirements

### Basic principle for exams

**As a rule, all the standard final exams for modules and also all resit exams are to be in written form**

### Standard final exam for a module and written resit exam

**Kind of exam**

written

**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

### Special case: Resit exam as oral exam

**Kind of exam**

oral

**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**

2021-2022

**Dernière modification**

2021-01-11

**Coordinateur/coordinatrice du module**

Jürg Küffer (FHNW, juerg.kueffer@fhnw.ch)

**Explication des définitions de langue par lieu :**

- Les cours se dérouleront dans la langue définie ci-dessous par lieu/exécution.
- Les documents sont disponibles dans les langues définies ci-dessous. Pour le multilinguisme, voir la répartition en pourcentage (100% = documents complets)
- L'examen est disponible à 100% dans chaque langue sélectionnée pour chaque lieu/exécution.

| | Berne | 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

**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

### Conditions d'admission

Le module n'utilise pas de conditions d'admission.

### Principe pour les examens

**En règle générale, tous les examens de fin de module réguliers et les examens de rattrapage sont organisés sous la forme écrite**

### Examen de fin de module régulier et examen écrit de répétition

**Type de l'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

### Cas spécial: examen de répétition oral

**Type de l'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**

# *Cloud Computing*

## General Information

**Number of ECTS Credits**

3

**Module code**

TSM_ClComp

**Valid for academic year**

2021-2022

**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 defined below for each location/each time the module is held.
- Documentation is available in the languages defined below. Where documents are in several languages, the percentage distribution is shown (100% = all the documentation).
- The examination is available 100% in the languages shown for each location/each time it is held.

| | Berne | Lausanne | | | Lugano | Zurich | | |
|---|---|---|---|---|---|---|---|---|
| **Instruction** | | | | | | **X** E 100% | | |
| **Documentation** | | | | | | **X** E 100% | | |
| **Examination** | | | | | | **X** E 100% | | |

**Module Category**

TSM Technical scientific module

**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 use, operations, development of and for IaaS and PaaS, as well as developing applications natively for the cloud.

## Aims, content, methods

### Learning objectives and acquired competencies

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 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.

### Contents of module with emphasis on teaching content

- Definition, Origin and Motivation, Principles, Services (IaaS, PaaS, SaaS) and Deployment Models (Public, Private, Hybrid)
- IaaS - Successful commercial example: Amazon Web Services (AWS)
- IaaS - OSS Alternative: Kubernetes, Architecture, Services, Usage
- IaaS - Compute Virtualization - Hypervisors and Containers
- IaaS - Storage Virtualization - Basic Concepts, Block, File and Object Storage Services
- IaaS - Network Virtualization - Software Defined Networking
- Cloud Security
- PaaS - OSS Alternative: CloudFoundry, Architecture, Services, Usage
- PaaS - Continuous Deployment
- PaaS - Cloud-native Application Design Principles
- FaaS - Function as a Service / Serverless Computing

### Teaching and learning methods

2 Lectures, 1 tutorial session per week
Self-study based on lecture material and literature (papers, books)

### Literature

## Assessment

### Certification requirements

Module does not use certification requirements

### Basic principle for exams

**As a rule, all the standard final exams for modules and also all resit exams are to be in written form**

### Standard final exam for a module and written resit exam

**Kind of exam**

written

**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

### Special case: Resit exam as oral exam

**Kind of exam**

oral

**Duration of exam**

30 minutes

**Permissible aids**

No aids permitted

MSE MASTER OF SCIENCE IN ENGINEERING

## 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**

2021-2022

**Dernière modification**

2020-03-04

**Coordinateur/coordinatrice du module**

Nabil Abdennadher (HES-SO, nabil.abdennadher@hesge.ch)

**Explication des définitions de langue par lieu :**

- Les cours se dérouleront dans la langue définie ci-dessous par lieu/exécution.
- Les documents sont disponibles dans les langues définies ci-dessous. Pour le multilinguisme, voir la répartition en pourcentage (100% = documents complets)
- L'examen est disponible à 100% dans chaque langue sélectionnée pour chaque lieu/exécution.

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

**Catégorie de module**

TSM approfondissement technico-scientifique

**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

- Understand the concepts, principles and architectures of IaaS, PaaS and FaaS services, as well as deployment and implementation environments.
- Be able to use and choose the appropriate IaaS, PaaS and FaaS Cloud environments
- Understand the APIs allowing access to IaaS and PaaS services.
- Be able to choose appropriate measures to secure a Cloud.
- Be able to design "cloud-native" services and applications.
- Be able to use the characteristics of the cloud: on-demand resources, elasticity, multi-user, metered services, broadband network access.
- Be able to evaluate the economic, legal and technological advantages/limits of the cloud as well as its intrinsic limitations.

### Contenu des modules avec pondération du contenu des cours

- Definition, principles, services and deployment models (1 session)
- Comparative study of different infrastructure services (IaaS), including storage (2 sessions)
- Comparative study of container technologies: Docker, SWARM, Kubernetes (2 sessions)
- Edge-Cloud technology (1 session)
- Cloud-based Function-as-a-Service, Serverless Computing (1 session)
- Network Resource Virtualization (1 session)
- Security for Cloud (1 session)
- Platform-as-a-Service (2 sessions)
- Continuous Delivery and Deployment in a Cloud environment (1 session)
- Persistence services and Database-as-a-Service (1 session)
- Cloud-Native applications (1 session)

### Méthodes d'enseignement et d'apprentissage

2 périodes de cours, 1 période d'exercice et travail pratique par semaine – 75% des exercices et travaux pratiques doivent être rendus à temps et validés pour pouvoir passer l'examen. En plus des 3 périodes du cours, l'équivalent de 3 périodes de travail personnel est demandé à chaque étudiant.

### Bibliographie

## Evaluation

### Conditions d'admission

Le module n'utilise pas de conditions d'admission.

### Principe pour les examens

**En règle générale, tous les examens de fin de module réguliers et les examens de rattrapage sont organisés sous la forme écrite**

### Examen de fin de module régulier et examen écrit de répétition

**Type de l'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

### Cas spécial: examen de répétition oral

**Type de l'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**

2021-2022

**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 defined below for each location/each time the module is held.
- Documentation is available in the languages defined below. Where documents are in several languages, the percentage distribution is shown (100% = all the documentation).
- The examination is available 100% in the languages shown for each location/each time it is held.

| | Winterthur | | | |
|---|---|---|---|---|
| **Instruction** | **X** E 100% | | | |
| **Documentation** | **X** E 100% | | | |
| **Examination** | **X** E 100% | | | |

**Module Category**

TSM Technical scientific module

**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 acquired competencies

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.

### Contents of module with emphasis on teaching content

- 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

### Certification requirements

Module uses certification requirements

### Certification requirements for final examinations (conditions for attestation)

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 the standard final exams for modules and also all resit exams are to be in written form**

## Standard final exam for a module and written resit exam

**Kind of exam**

written

**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

## Special case: Resit exam as oral exam

**Kind of exam**

oral

**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**

2021-2022

**Last modification**

2018-11-06

**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 defined below for each location/each time the module is held.
- Documentation is available in the languages defined below. Where documents are in several languages, the percentage distribution is shown (100% = all the documentation).
- The examination is available 100% in the languages shown for each location/each time it is held.

| | Berne | Lausanne | | | Lugano | Zurich | | |
|---|---|---|---|---|---|---|---|---|
| **Instruction** | | | | | | **X** E 100% | | |
| **Documentation** | | | | | | **X** E 100% | | |
| **Examination** | | | | | | **X** E 100% | | |

**Module Category**

TSM Technical scientific module

**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 very complex task that has many important real-world applications. This module presents powerful techniques to extract information from images and 3D data, based on machine learning and deep learning methods. These methods are mostly used as “black boxes” and their inner workings are not discussed in much detail. The module provides an overview of many image analysis applications such as document analysis, medical imaging and autonomous driving; examples of advanced uses of deep learning on images (generative networks for image synthesis, adversarial networks, neural style transfer) are also discussed.

## Aims, content, methods

### Learning objectives and acquired competencies

- 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 tracking
- 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

### Contents of module with emphasis on teaching content

- Introduction
- Basic image processing methods applied to document processing: binarization; 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: data augmentation techniques; one-shot learning; transfer learning and pre-trained models.
- 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
  - object tracking in videos.
- 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

### Certification requirements

Module uses certification requirements

### Certification requirements for final examinations (conditions for attestation)

75% of homework passed

### Basic principle for exams

**As a rule, all the standard final exams for modules and also all resit exams are to be in written form**

### Standard final exam for a module and written resit exam

#### Kind of exam

written

#### 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)

**Special case: Resit exam as oral exam**

**Kind of exam**

oral

**Duration of exam**

30 minutes

**Permissible aids**

No aids permitted

**Description du module, disponible en: FR**

# *Cyber Security*

## Informations générales

**Nombre de crédits ECTS**

3

**Code du module**

TSM_CyberSec

**Valable pour l'année académique**

2021-2022 DRAFT

**Dernière modification**

2021-03-19

**Coordinateur/coordinatrice du module**

Michael Mäder (HES-SO, michael.maeder@hefr.ch)

**Explication des définitions de langue par lieu :**

- Les cours se dérouleront dans la langue définie ci-dessous par lieu/exécution.
- Les documents sont disponibles dans les langues définies ci-dessous. Pour le multilinguisme, voir la répartition en pourcentage (100% = documents complets)
- L'examen est disponible à 100% dans chaque langue sélectionnée pour chaque lieu/exécution.

| | Berne | 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

**Leçons**

2 leçons et 1 leçon de pratique par semaine

## Compétences préalables

**Connaissances préalables, compétences initiales**

- Cryptography basics
- Knowledge of at least one programming language, such as C, Python, Java

## Brève description du contenu et des objectifs

The course will first give the necessary background knowledge in the field of cybersecurity such as CIA and availability as well as data security.

Thereby, the module will define a threat and risk assessment accompanied with main security standards and General Data Protection Regulation (GDPR).

Based on that, it will go in deep to permit the student to have a complete overview how identify and list threats and risks. Then, the student will be able to propose and implement a list of mitigation mechanisms. This will be applied in three security fields: software development, software security and web security based on tools.

The course covers the following core topics:

- Reminder of basic knowledge about security
- Security development
- Software security
- Web security

## Objectifs, contenus, méthodes

### Objectifs d'apprentissage, compétences à acquérir

- Understand and choose the appropriate cryptographic primitive(s)
- Identify and list the threats and risks of a system and propose different kind of mitigation mechanisms
- Understand, apply and use processes and tools towards secure development
- Understand, identify vulnerabilities in software and web applications then propose mitigations

### Contenu des modules avec pondération du contenu des cours

Basics (25%):

- Confidentiality, integrity, availability, authenticity, authorization, accounting
- Threat model, malwares, etc.
- Data Protection and GDPR
- Risk and threat analysis and standards

Secure development (25%):

- SDLC: fundamentals of DevOps and how DevOps teams can build and deliver secure software
- Secure DevOps: How to build security into Continuous Delivery and Continuous Deployment
- The tools, patterns, and techniques of security automation in DevOps

Software security (25%):

- Software vulnerability identification (SANS Top 25)
- Software exploitation techniques and tools
- Software protections and mitigations

Web application security (25%):

- Web vulnerabilities (OWASP top 10)
- Web exploitation techniques and tools
- Web protections and mitigations

### Méthodes d'enseignement et d'apprentissage

This course involves theoretical presentations and hands-on exercises.

**Bibliographie**

Lecture slides, references to internet resources and books are mentioned during the module introduction.

## Evaluation

**Conditions d'admission**

Le module n'utilise pas de conditions d'admission.

**Principe pour les examens**

**En règle générale, tous les examens de fin de module réguliers et les examens de rattrapage sont organisés sous la forme écrite**

**Examen de fin de module régulier et examen écrit de répétition**

**Type de l'examen**

écrit

**Durée de l'examen**

120 minutes

**Aides autorisées**

Sans aides

**Cas spécial: examen de répétition oral**

**Type de l'examen**

oral

**Durée de l'examen**

30 minutes

**Aides autorisées**

Sans aides

MASTER OF SCIENCE
IN ENGINEERING

**Module Description, available in: EN**

# *Data Analysis and Classification*

## General Information

**Number of ECTS Credits**

3

**Module code**

TSM_DataAnaCla

**Valid for academic year**

2021-2022

**Last modification**

2021-01-15

**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 defined below for each location/each time the module is held.
- Documentation is available in the languages defined below. Where documents are in several languages, the percentage distribution is shown (100% = all the documentation).
- The examination is available 100% in the languages shown for each location/each time it is held.

| | Berne | Lausanne | | | Lugano | Zurich | | |
|---|---|---|---|---|---|---|---|---|
| **Instruction** | | | | | **X** E 100% | | | |
| **Documentation** | | | | | **X** E 100% | | | |
| **Examination** | | | | | **X** E 100% | | | |

**Module Category**

TSM Technical scientific module

**Lessons**

2 lecture periods and 1 tutorial period per week

## Entry level competences

**Prerequisites, previous knowledge**

- basic python scripting and SQL
- basic calculus, linear algebra and statistics concepts

## Brief course description of module objectives and content

The module is organised around 4 core subject areas:

- Data Preprocessing
- Data Classification
- Clustering
- Complex Networks

## Aims, content, methods

### Learning objectives and acquired competencies

Students understand how to use data analysis tools to process large, structured and heterogeneous data collections.

- They learn the basics of the data analysis
- They know the main tools and techniques to address the analysis of large data sets
- They learn and use the most common classification techniques
- They learn how to exploit the networking structure of the data to handle the complexity and dynamicity of large set of data
- They learn the main tools for data and results visualization
- They learn methods for processing and clustering with the purpose of effective analysis
- 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 within these domains.

### Contents of module with emphasis on teaching content

The content of the module is the following:

- Introduction to data analysis
- Data Preprocessing (univariate and bivariate analysis, features selection, dimensionality reduction)
- Linear Regression, Logistic Regression
- Data Classification, Bagging and Boosting,  classifiers evaluation
- Clustering and clustering validation
- Recommendation Systems
- Complex Networks Theory
- Network measures and Models

### Teaching and learning methods

Problem based learning. During the lesson the lecturer will introduce real world problems and the class will try to solve them together.

The lecturer will support the problem solving process, introducing new concepts and tools, as required.

Practical work will complement the theory, so that students can put in practice the studied arguments.

### Literature

Lecture slides, references to internet resources and books

## Assessment

**Certification requirements**

Module uses certification requirements

**Certification requirements for final examinations (conditions for attestation)**

The successful delivery of a solved final project is a condition for entering the examination, and will contribute to the final mark.

**Basic principle for exams**

**As a rule, all the standard final exams for modules and also all resit exams are to be in written form**

**Standard final exam for a module and written resit exam**

**Kind of exam**

written

**Duration of exam**

120 minutes

**Permissible aids**

No aids permitted

**Special case: Resit exam as oral exam**

**Kind of exam**

oral

**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**

2021-2022

**Last modification**

2021-02-12

**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 defined below for each location/each time the module is held.
- Documentation is available in the languages defined below. Where documents are in several languages, the percentage distribution is shown (100% = all the documentation).
- The examination is available 100% in the languages shown for each location/each time it is held.

| | Berne | Lausanne | | | Lugano | Zurich | | |
|---|---|---|---|---|---|---|---|---|
| **Instruction** | | **X** E 100% | | **X** E 100% | | **X** E 100% | | |
| **Documentation** | | **X** E 100% | | | | **X** E 100% | | |
| **Examination** | | **X** E 100% | | **X** E 100% | | **X** E 100% | | |

**Module Category**

TSM Technical scientific module

**Lessons**

2 lecture periods and 1 tutorial period per week

## Entry level competences

**Prerequisites, previous knowledge**

- Basic data structures and algorithms
- Working level on basic relational databases
- Relational Models, Relational Algebra,
- Normalization
- RDBMS architectures
- Transactions
- SQL:92
- Query optimization, Indexes
- Security in RDBMS

## Brief course description of module objectives and content

This course is centered on the Data Engineering domain.

This course covers modern methods and technologies that are needed to manage and process potentially large, heterogeneous and distributed data collections. It includes diverse technologies frequently used in industrial contexts such as data warehouses, multi-model databases and NoSQL stores. A focus of the class is also given on Information Retrieval including techniques to efficiently retrieve data that are typically in unstructured form.

## Aims, content, methods

### Learning objectives and acquired competencies

Learning objectives and acquired competencies:

The learning objectives are directed towards Data Engineering:

- Students understand the modern ecosystems currently used in industries for data storage and data processing; including their respective adequations to application needs.
- Students understand the use of modern database and processing technologies for managing large, distributed and potentially heterogeneous data collections.
- Students are able to organize complex data structures, reaching beyond RDBMS and meeting the requirements of data availability and type, e.g. polyglot persistence and multi-model databases.
- Students are able to use selected advanced data technology stacks such as data warehouses, NoSQL stores and cloud data stores.
- Students are able to implement methods and tools to integrate, cleanse and synthesize data, such as the ones used to compose data pipelines.
- Students are able to integrate efficient Information Retrieval techniques typically used for unstructured and textual data, such as the ones used for search engines.
- Students can also apply the acquired knowledge in their own working environment.

### Contents of module with emphasis on teaching content

The module covers the following contents:

**1. Database Management (DM)**: overview of modern ecosystems currently used in industries for data management; new data structures and alternatives to RDBMS; non-relational aspects including NoSQL and cloud data stores; new ways to query data such as JSON paths, SQL extensions, graph query language, etc.

**2. Data Integration (DI)**: Data Warehousing for data aggregation and data preparation for analytics (e.g. business intelligence components); other methods and tools for data integration, data cleansing and data synthesizing.

**3. Information Retrieval (IR)**: Efficient methods for finding information, typically in the context of unstructured and textual data, such as the ones used for search engines; ways to query data in IR systems, such as Query DSL.

### Teaching and learning methods

Head-on teaching, exercises, case studies.

### Literature

Optional literature suggestion (books):

- DB: Lena Wiese: Advanced Data Management for SQL, NoSQL, Cloud and Distributed Databases. De Gruyter Textbook. 2015. ISBN 978-3-11-044140-6.
- IR: Introduction to Information Retrieval. C.D. Manning, P. Raghavan, H. Schütze. Cambridge UP, 2008. Classical and web information retrieval systems: algorithms, mathematical foundations and practical issues.
- IR: Information Retrieval in Practice. B. Croft, D. Metzler, T. Strohman. Pearson Education, 2009.

## Assessment

### Certification requirements

Module does not use certification requirements

### Basic principle for exams

**As a rule, all the standard final exams for modules and also all resit exams are to be in written form**

### Standard final exam for a module and written resit exam

**Kind of exam**

written

**Duration of exam**

120 minutes

**Permissible aids**

*Aids permitted as specified below:*

**Permissible electronic aids**

Scientific calculator (without communication functions).

**Other permissible aids**

Summary on one A4 page (possibly written on both sides).

### Special case: Resit exam as oral exam

**Kind of exam**

oral

**Duration of exam**

30 minutes

**Permissible aids**

No aids permitted

**Module Description, available in: EN**

# *Deep Learning*

## General Information

**Number of ECTS Credits**

3

**Module code**

TSM_DeLearn

**Valid for academic year**

2021-2022

**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 defined below for each location/each time the module is held.
- Documentation is available in the languages defined below. Where documents are in several languages, the percentage distribution is shown (100% = all the documentation).
- The examination is available 100% in the languages shown for each location/each time it is held.

| | Berne | 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

**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 acquired competencies

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.

### Contents of module with emphasis on teaching content

- **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

**Certification requirements**

Module uses certification requirements

**Certification requirements for final examinations (conditions for attestation)**

75% of handed-in homework passed

**Basic principle for exams**

**As a rule, all the standard final exams for modules and also all resit exams are to be in written form**

**Standard final exam for a module and written resit exam**

**Kind of exam**

written

**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

**Special case: Resit exam as oral exam**

**Kind of exam**

oral

**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**

2021-2022

**Letzte Änderung**

2018-11-02

**Modul-Koordinator/in**

Christian Wagner (FHGR, christian.wagner@fhgr.ch)

**Erläuterungen zu den Sprachdefinitionen je Standort:**

- Der Unterricht findet in der unten definierten Sprache je Standort/Durchführung statt.
- Die Unterlagen sind in den unten definierten Sprachen verfügbar. Bei Mehrsprachigkeit, siehe prozentuale Verteilung (100% = komplette Unterlagen)
- Die Prüfung ist in jeder je Standort/Durchführung angekreuzten Sprache zu 100% verfügbar.

| | Berne | Lausanne | | | Lugano | Zurich | | |
|---|---|---|---|---|---|---|---|---|
| **Unterricht** | | | | | | | **X** D 100% | |
| **Dokumentation** | | | | | | | **X** D 100% | |
| **Prüfung** | | | | | | | **X** D 100% | |

**Modulkategorie**

TSM Technisch-wissenschaftliche Vertiefung

**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, 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

### Zulassungsbedingungen

Modul verwendet Zulassungsbedingungen

### Zulassungsbedingungen für die Modulabschlussprüfung (Testatbedingungen)

vollständige Abgabe Übungen, Teilnahme an den Seminaren

### Grundsatz Prüfungen

**In der Regel werden alle regulären Modulabschlussprüfungen und Wiederholungsprüfungen in schriftlicher Form gehalten**

### Reguläre Modulschlussprüfung und schriftliche Wiederholungsprüfung

**Art der Prüfung**

schriftlich

**Prüfungsdauer**

120 Minuten

**Erlaubte Hilfsmittel**

*Erlaubt sind die aufgeführten Hilfsmittel:*

**Zulässige elektronische Hilfsmittel**

Keine elektronischen Hilfsmittel zulässig

**Weitere erlaubte Hilfsmittel**

Skizzenbuch

### Spezialfall: Wiederholungsprüfung als mündliches Examen

**Art der Prüfung**

mündlich

**Prüfungsdauer**

30 Minuten

**Erlaubte Hilfsmittel**

Ohne Hilfsmittel

MASTER OF SCIENCE
IN ENGINEERING

**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**

2021-2022

**Last modification**

2019-10-30

**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 defined below for each location/each time the module is held.
- Documentation is available in the languages defined below. Where documents are in several languages, the percentage distribution is shown (100% = all the documentation).
- The examination is available 100% in the languages shown for each location/each time it is held.

| | Berne | Lausanne | | | Lugano | Zurich | | |
|---|---|---|---|---|---|---|---|---|
| **Instruction** | | | | | **X** E 100% | | | |
| **Documentation** | | | | | **X** E 100% | | | |
| **Examination** | | | | | **X** E 100% | | | |

**Module Category**

TSM Technical scientific module

**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 acquired competencies

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.

### Contents of module with emphasis on teaching content

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)
- Tools and methodologies for DevOps and CI/CD
- Container technologies (Docker)
- Infrastructures for container orchestration (Kubernetes)
- Frameworks for REST APIs development (Spring Boot)
- Software architectures and design patterns for microservices
- Protocols and technologies for message queuing (AMQP) and for inter-process communication (gRPC)
- Serverless computing technologies (FaaS and lambdas)
- GraphQL (with Spring Boot)
- Techniques for infrastructure as a code (Terraform)
- Service mesh technologies (Istio, Linkerd)
- Tools and frameworks for monitoring and logging (Prometheus, Fluentd)
- Storage orchestrators for kubernetes (Etcd, Rook)
- Tools and frameworks for testing: unit, integration, component, contract, end-to-end

### Teaching and learning methods

Frontal theoretical lessons, demonstrations, examples, exercises

### Literature

## Assessment

### Certification requirements

Module does not use certification requirements

### Basic principle for exams

**As a rule, all the standard final exams for modules and also all resit exams are to be in written form**

### Standard final exam for a module and written resit exam

**Kind of exam**

written

**Duration of exam**

120 minutes

**Permissible aids**

No aids permitted

### Special case: Resit exam as oral exam

**Kind of exam**

oral

**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**

2021-2022

**Last modification**

2019-11-20

**Coordinator of the module**

Jürgen Holm (BFH, juergen.holm@bfh.ch)

**Explanations regarding the language definitions for each location:**

- Instruction is given in the language defined below for each location/each time the module is held.
- Documentation is available in the languages defined below. Where documents are in several languages, the percentage distribution is shown (100% = all the documentation).
- The examination is available 100% in the languages shown for each location/each time it is held.

| | Berne | Lausanne | | | Lugano | Zurich | | |
|---|---|---|---|---|---|---|---|---|
| **Instruction** | | | | | | **X** E 100% | | |
| **Documentation** | | | | | | **X** E 100% | | |
| **Examination** | | | | | | **X** E 100% | | |

**Module Category**

TSM Technical scientific module

**Lessons**

2 lecture periods and 1 tutorial period per week

## Entry level competences

**Prerequisites, previous knowledge**

This course requires knowledge about

- the electronic - also sensor-based - structured data acquisition,
- user Centered design,
- a good understanding of database-concepts,
- information systems and
- general data analysis.

## Brief course description of module objectives and content

This course provides an in-depth overview of data management in digital healthcare.

First, the special features and challenges of medical documentation will be discussed followed by the underlying ontologies, classifications and scoring systems. Particular emphasis will be placed on a deeper understanding of different dimensions of interoperability. This knowledge will then be used to address exemplary specific medical information systems.

BigData technologies will then open the next section which deals with the particular challenges of digital transformation in healthcare. In particular, the inclusion of patients in future data collection 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 issus within the emerging Data Science Centers is also the subject of this module. Finally, the new challenges for software development in the context of the Medical Device Regulation ("MDR") are presented.

## Aims, content, methods

### Learning objectives and acquired competencies

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.

### Contents of module with emphasis on teaching content

First Part (6 weeks):

- Medical & Health Data Documentation (1 week)
- Medical Ontologies and Classification (2 weeks)
- Dimensions of Interoperability in Health Care Systems (2 weeks)
- - Hospital & Health Care Information Management Systems (1 week)

Second Part (8 weeks):

- BigData Technologies (1 week)
- Digitalization & Transformation in Treatment Pathways (1 week)
- eHealth & EPD (1 week)
- mHealth & App – Ecosystems (1 week)
- Privacy & IAM in cybersecurity (1 week)
- pHealth and Data Science Center (1 week)
- Home Monitoring (1 week)
- MDR (1 week)

### Teaching and learning methods

Lectures and practical work on computer.

### Literature

Slides and lecture notes will be available in addition to recommended book chapters.

## Assessment

### Certification requirements

Module does not use certification requirements

### Basic principle for exams

**As a rule, all the standard final exams for modules and also all resit exams are to be in written form**

### Standard final exam for a module and written resit exam

#### Kind of exam

written

#### Duration of exam

120 minutes

#### Permissible aids

*Aids permitted as specified below:*

#### Permissible electronic aids

examination on laptop, Moodle

**Other permissible aids**

No further aids permitted

**Special case: Resit exam as oral exam**

**Kind of exam**

oral

**Duration of exam**

30 minutes

**Permissible aids**

No aids permitted

MSE MASTER OF SCIENCE IN ENGINEERING

**Module Description, available in: EN**

# *Digitalisation in industry*

## General Information

**Number of ECTS Credits**

3

**Module code**

TSM_DigInd

**Valid for academic year**

2021-2022

**Last modification**

2019-08-31

**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 defined below for each location/each time the module is held.
- Documentation is available in the languages defined below. Where documents are in several languages, the percentage distribution is shown (100% = all the documentation).
- The examination is available 100% in the languages shown for each location/each time it is held.

| | Berne | Lausanne | | | Lugano | Zurich | | |
|---|---|---|---|---|---|---|---|---|
| **Instruction** | | | | | | **X** E 100% | | |
| **Documentation** | | | | | | **X** E 100% | | |
| **Examination** | | | | | | **X** E 100% | | |

**Module Category**

TSM Technical scientific module

**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 module offers an overview of digitization in industry from several perspectives.

**Content**

**Section 1: Product Lifecycle Management**

- Introduction of end-to-end process (As-Required, As-Design, As-Built, As Maintained)
- Product lifecycle and closed loop lifecycle management

- Development of mechatronic products (HW/SW Co-Development)
- Generating master data for mechatronic products
- Customizable products and modularization
- Engineering Change management

**Section 2: Digitization in Production**
- Introduction to Production Management
- Prozessleitsysteme, Bussysteme und Protokolle, MES
- Optimization of production based on digital tools
- Examples and Use Cases of digitization in production
- Lean Management and digitization

**Section 3: Digitalization of Products**
- Digitization driven new Business Models
- Sensor to information: communication and aggregation of data
- Reliability, security and accessablity
- Digital Twins
- Discussion of specific Use Cases - Market & Operational Excellence

## Aims, content, methods

### Learning objectives and acquired competencies

- 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 (Internet of Things) and how these are linked to the processes and data streams of the original company in oder to increase the range of product related services or business models.
- They can rationally decide between "digital" and "non-digital" solution concepts.

### Contents of module with emphasis on teaching content

### Teaching and learning methods

### Literature

## Assessment

### Certification requirements

Module does not use certification requirements

### Basic principle for exams

**As a rule, all the standard final exams for modules and also all resit exams are to be in written form**

### Standard final exam for a module and written resit exam

**Kind of exam**

written

**Duration of exam**

120 minutes

**Permissible aids**

No aids permitted

**Special case: Resit exam as oral exam**

**Kind of exam**

oral

**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**

2021-2022

**Dernière modification**

2020-01-31

**Coordinateur/coordinatrice du module**

Marcello Righi (ZHAW, rigm@zhaw.ch)

**Explication des définitions de langue par lieu :**

- Les cours se dérouleront dans la langue définie ci-dessous par lieu/exécution.
- Les documents sont disponibles dans les langues définies ci-dessous. Pour le multilinguisme, voir la répartition en pourcentage (100% = documents complets)
- L'examen est disponible à 100% dans chaque langue sélectionnée pour chaque lieu/exécution.

| | Berne | Lausanne | | | Lugano | Zurich | | |
|---|---|---|---|---|---|---|---|---|
| **Leçons** | | | **X** F 100% | | | | | |
| **Documentation** | | | **X** F 100% | | | | | |
| **Examen** | | | **X** F 100% | | | | | |

**Catégorie de module**

TSM approfondissement technico-scientifique

**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
Les connaissances de base de Matlab sont un avantage
Connaissance de base des transformations de Fourier et de Laplace

## 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,
- 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
- Dynamique du rotor
  - Etablissement des équations de mouvement pour un modèle mono-disque à effet gyroscopique et arbre élastique
  - Valeurs propres en fonction de la vitesse de rotation (diagramme de Campbell),
  - Excitation par équilibrage statique et dynamique, vibration stable et contre-rotative
- Introduction à la simulation multi-corps :
  - Etablissement d'équations de mouvement pour un modèle multi-corps non linéaire, cinématique, cinétique, espace d'état
  - Elimination des forces de liaison via des matrices jacobiennes,
  - Solution numérique d'équations mécaniques non linéaires du mouvement

### 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

### Conditions d'admission

Le module n'utilise pas de conditions d'admission.

### Principe pour les examens

**En règle générale, tous les examens de fin de module réguliers et les examens de rattrapage sont organisés sous la forme écrite**

### Examen de fin de module régulier et examen écrit de répétition

**Type de l'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 : Notes sur 2 pages A4 (max)

**Cas spécial: examen de répétition oral**

**Type de l'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**

2021-2022

**Dernière modification**

2021-09-20

**Coordinateur/coordinatrice du module**

Jacques Richard (HES-SO, jacques.richard@hesge.ch)

**Explication des définitions de langue par lieu :**

- Les cours se dérouleront dans la langue définie ci-dessous par lieu/exécution.
- Les documents sont disponibles dans les langues définies ci-dessous. Pour le multilinguisme, voir la répartition en pourcentage (100% = documents complets)
- L'examen est disponible à 100% dans chaque langue sélectionnée pour chaque lieu/exécution.

| | Berne | 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

**Leçons**

2 leçons et 1 leçon de pratique par semaine

## Compétences préalables

**Connaissances préalables, compétences initiales**

Culture générale, bases scientifiques principalement physique avec notion de chimie

## 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. Il s'agit notamment de savoir concevoir de nouveaux produits (ou procédés industriels) en y intégrant la notion du cycle de vie et de durabilité. A ce titre, l'analyse de cycle de vie est un outil précieux permettant une démarche rationnelle d'écoconception, et cet outil constitue un élément central de ce module.

Au terme de ce module l'étudiant(e) sera capable de :

- Élargir le champ des paramètres influents d’un CDC et évaluer différentes approches pluridisciplinaires pour réaliser une conception performante, efficiente et efficace.
- Appliquer une méthode d’écoconception dans un contexte industriel pour le développement de produits ou procédés.
- Développer un sens critique permettant de réaliser en autonomie un projet de développement industriel en intégrant de multiples connaissances

## Objectifs, contenus, méthodes

### Objectifs d'apprentissage, compétences à acquérir

Comprendre l’approche cycle de vie d’un produit et être capable d’analyser son impact sur l’environnement.

Acquérir une compétence logicielle pour réaliser une ACV dans un contexte industriel.

Etre capable de mettre en perspective un produit donné dans un contexte général en lien avec la fonction ou le service effectué.

Savoir identifier les aspects environnementaux significatifs pour en minimiser les conséquences dès la conception d’un produit.

Savoir élaborer un cahier des charges de projets transversaux en mécanique incluant les aspects environnementaux en identifiant le juste besoin.

Savoir engager une démarche d’éco-conception, et de mettre en œuvre une méthodologie efficace menant à une conception durable et performante.

### Contenu des modules avec pondération du contenu des cours

Les étapes principales du cycle de vie d’un produit (de l’extraction des matières premières, au recyclage ou élimination).

Impacts environnementaux – qualification et quantification.

Analyse du Cycle de Vie (ACV) - Définitions et normes, Unité Fonctionnelle, Limites du Système et Etude des impacts.

Pratique de l’ACV: Exemples - Critères de classification de produits.

Eco Conception appliquée – exemples pratiques.

Méthodologie appliquée d’Eco Conception

### Méthodes d'enseignement et d'apprentissage

1. Base théorique

2. Etude de cas

3. Initiation à un outil logiciel (p.ex Simapro & Ecoinvent)

4. Applications pratiques (micromachine, transformateurs, systèmes de stockage d’énergie, mobilité, etc)

### 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

## Evaluation

### Conditions d'admission

Le module utilise les conditions d'admission

### Conditions d'admission à l'examen de fin de module (exigences du certificat)

Avoir réussi le TP (note 4.0 au minimum) sur sujet écoconception dont le rendu est une présentation orale accompagnée de son support type fichier ppt

### Principe pour les examens

**En règle générale, tous les examens de fin de module réguliers et les examens de rattrapage sont organisés sous la forme écrite**

### Examen de fin de module régulier et examen écrit de répétition

**Type de l'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**

support de cours + 2 feuillets A4 de prises de notes personnelles

### Cas spécial: examen de répétition oral

**Type de l'examen**

oral

**Durée de l'examen**

30 minutes

**Aides autorisées**

*Les aides suivantes sont autorisées:*

**Aides électroniques autorisées**

Aucune aide électronique autorisée

**Autres aides**

support 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**

2021-2022

**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 defined below for each location/each time the module is held.
- Documentation is available in the languages defined below. Where documents are in several languages, the percentage distribution is shown (100% = all the documentation).
- The examination is available 100% in the languages shown for each location/each time it is held.

| | Berne | 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

**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 acquired competencies

- 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.

### Contents of module with emphasis on teaching content

- 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

### Certification requirements

Module uses certification requirements

### Certification requirements for final examinations (conditions for attestation)

Part 1: Voluntary test or presentation of Practical Work - SoC Implementation (20%)

Part 2: Voluntary test or presentation of Practical Work - Formal Processes and Methods (20%)

### Basic principle for exams

**As a rule, all the standard final exams for modules and also all resit exams are to be in written form**

### Standard final exam for a module and written resit exam

**Kind of exam**

written

**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

**Special case: Resit exam as oral exam**

**Kind of exam**

oral

**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

MSE MASTER OF SCIENCE IN ENGINEERING

**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**

2021-2022

**Dernière modification**

2019-07-22

**Coordinateur/coordinatrice du module**

Hans Dermot Doran (ZHAW, hans.doran@zhaw.ch)

**Explication des définitions de langue par lieu :**

- Les cours se dérouleront dans la langue définie ci-dessous par lieu/exécution.
- Les documents sont disponibles dans les langues définies ci-dessous. Pour le multilinguisme, voir la répartition en pourcentage (100% = documents complets)
- L'examen est disponible à 100% dans chaque langue sélectionnée pour chaque lieu/exécution.

| | Berne | 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

**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

### Conditions d'admission

Le module utilise les conditions d'admission

### Conditions d'admission à l'examen de fin de module (exigences du certificat)

Test volontaire partie 1: Implémentation SoC (20%)
Test volontaire partie 2: Processus et méthodologie formels (20%)

### Principe pour les examens

**En règle générale, tous les examens de fin de module réguliers et les examens de rattrapage sont organisés sous la forme écrite**

### Examen de fin de module régulier et examen écrit de répétition

#### Type de l'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

### Cas spécial: examen de répétition oral

**Type de l'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

MSE MASTER OF SCIENCE IN ENGINEERING

**Module Description, available in: EN**

# *Embedded Real-time Software*

## General Information

**Number of ECTS Credits**

3

**Module code**

TSM_EmbReal

**Valid for academic year**

2021-2022

**Last modification**

2021-02-11

**Coordinator of the module**

Hans Buchmann (FHNW, hans.buchmann@fhnw.ch)

**Explanations regarding the language definitions for each location:**

- Instruction is given in the language defined below for each location/each time the module is held.
- Documentation is available in the languages defined below. Where documents are in several languages, the percentage distribution is shown (100% = all the documentation).
- The examination is available 100% in the languages shown for each location/each time it is held.

| | Berne | Lausanne | | | Lugano | Zurich | | |
|---|---|---|---|---|---|---|---|---|
| **Instruction** | | | | | | **X** E 100% | | |
| **Documentation** | | | | | | **X** E 100% | | |
| **Examination** | | | | | | **X** E 100% | | |

**Module Category**

TSM Technical scientific module

**Lessons**

2 lecture periods and 1 tutorial period per week

## Entry level competences

**Prerequisites, previous knowledge**

- Programming language C++/C
- Computer architectures
- Fundamentals of Operating Systems

## Brief course description of module objectives and content

Embedded Systems, although they are not visible, they have become integral parts of this world. Embedded Systems essentially consist of two components, hardware and software. In contrast to information systems 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 Embedded System Software and deals with the following two complementary aspects:

- Embedded Programming, Programming close to hardware
- Abstract Modeling Concepts.

Both parts are based on Object-Oriented Concepts.

## Aims, content, methods

### Learning objectives and acquired competencies

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++,
- on application layer using modeling methods.

### Contents of module with emphasis on teaching content

In the first part, the focus is on Near-Hardware-Programming. We use a typical (small) System on Chip (SoC) equipped with a RISC V.

The programming language is C++, the programming environment is Linux.

- Using C++: showing the huge advantages of C++ for a small SoC
- ISA Instruction Set Architecture
- Hardware-Access
- Concurrency
    - for a SoC
    - for a Linux based System

In the second part, the focus is on modeling, a model driven approach: from requirements, over modeling to the running system

- Introduction
    - Development Process
    - Generic Software-Architecture
- Modeling functional requirements
    - System of cooperating state machines
    - CIRO (Communicating Interacting Reactive Objects)
- Modeling connection software
    - Connection between hardware and reactive system
- Code Generation
    - Generated Code
    - Strategies
    - Tools?
- Testing executable Models
- Real-Time Scheduling
    - Multi-Tasking
    - Distribution
    - Task and Event Scheduling
- Exercises and laboratories using concrete tool-chain and microcontroller

### Teaching and learning methods

- Ex-cathedra teaching
- Exercises
- Self-study (study of papers, case studies)

### Literature

## Assessment

### Certification requirements

Module does not use certification requirements

### Basic principle for exams

**As a rule, all the standard final exams for modules and also all resit exams are to be in written form**

**Standard final exam for a module and written resit exam**

**Kind of exam**

written

**Duration of exam**

120 minutes

**Permissible aids**

No aids permitted

**Special case: Resit exam as oral exam**

**Kind of exam**

oral

**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**

2021-2022

**Last modification**

2021-02-10

**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 defined below for each location/each time the module is held.
- Documentation is available in the languages defined below. Where documents are in several languages, the percentage distribution is shown (100% = all the documentation).
- The examination is available 100% in the languages shown for each location/each time it is held.

| | Berne | 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

**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 groundwater and atmosphere.

## Aims, content, methods

### Learning objectives and acquired competencies

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

### Contents of module with emphasis on teaching content

PART 1 general concepts of:

- environment, ecosystem, pollution, remediation.
- contaminants and emerging contaminants characteristics.
- representative sampling and monitoring.

PART 2 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.

PART 3 remediation:

- containment technologies;
- removal technologies;
- treatment technologies.

### Teaching and learning methods

front lecturing theory lessons and student active involvement

### Literature

- Slides given at the course from the Lecturers
- Reference books details will be given at the beginning of the course

## Assessment

### Certification requirements

Module does not use certification requirements

### Basic principle for exams

**As a rule, all the standard final exams for modules and also all resit exams are to be in written form**

### Standard final exam for a module and written resit exam

**Kind of exam**

written

**Duration of exam**

120 minutes

**Permissible aids**

No aids permitted

### Special case: Resit exam as oral exam

**Kind of exam**

oral

**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**

2021-2022

**Dernière modification**

2021-02-10

**Coordinateur/coordinatrice du module**

Pamela Principi (SUPSI, pamela.principi@supsi.ch)

**Explication des définitions de langue par lieu :**

- Les cours se dérouleront dans la langue définie ci-dessous par lieu/exécution.
- Les documents sont disponibles dans les langues définies ci-dessous. Pour le multilinguisme, voir la répartition en pourcentage (100% = documents complets)
- L'examen est disponible à 100% dans chaque langue sélectionnée pour chaque lieu/exécution.

| | Berne | 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

**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

PARTIE 1 : 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.

PARTIE 2: 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, l'eau et l'atmosphère.

PARTIE 3: 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 étudiant-e-s

### Bibliographie

Diapositives données lors du cours par les enseignant-e-s

Les détails des ouvrages de référence seront donnés au début du cours

## Evaluation

### Conditions d'admission

Le module n'utilise pas de conditions d'admission.

### Principe pour les examens

**En règle générale, tous les examens de fin de module réguliers et les examens de rattrapage sont organisés sous la forme écrite**

### Examen de fin de module régulier et examen écrit de répétition

**Type de l'examen**

écrit

**Durée de l'examen**

120 minutes

**Aides autorisées**

Sans aides

**Cas spécial: examen de répétition oral**

**Type de l'examen**

oral

**Durée de l'examen**

30 minutes

**Aides autorisées**

Sans aides

**Module Description, available in: EN**

# *Fluid Mechanics and Heat Transfer*

## General Information

**Number of ECTS Credits**

3

**Module code**

TSM_FMechHeat

**Valid for academic year**

2021-2022

**Last modification**

2021-04-07

**Coordinator of the module**

Roberto Putzu (HES-SO, roberto.putzu@hesge.ch)

**Explanations regarding the language definitions for each location:**

- Instruction is given in the language defined below for each location/each time the module is held.
- Documentation is available in the languages defined below. Where documents are in several languages, the percentage distribution is shown (100% = all the documentation).
- The examination is available 100% in the languages shown for each location/each time it is held.

| | Berne | Lausanne | | | Lugano | Zurich | | |
|---|---|---|---|---|---|---|---|---|
| **Instruction** | | **X** E 100% | | | | | | |
| **Documentation** | | **X** E 100% | | | | | | |
| **Examination** | | **X** E 100% | | | | | | |

**Module Category**

TSM Technical scientific module

**Lessons**

2 lecture periods and 1 tutorial period per week

## Entry level competences

**Prerequisites, previous knowledge**

## Brief course description of module objectives and content

At the beginning of the course, we will give the students an insight on the basics of fluid dynamics and heat transfer.

Subsequently, the course will focus on more complex thermal and fluid phenomena occuring in mechanical engineering applications.

## Aims, content, methods

### Learning objectives and acquired competencies

The objectives of the course are the following:

- To give students a solid knowledge of fluid mechanics and thermal phenomena in order to be able to develop a critical approach with respect to complex mechanical and energetic systems
- To train students at the development of fluid and energetic systems
- To enable students to understand, analyse and realise complex thermal and fluid systems

### Contents of module with emphasis on teaching content

- Navier-Stokes and Bernoulli equations: Starting from mass, energy and momentum conservation laws, the basic fluid mechanics equations are presented
- Vaschy-Buckingham theorem: Different applications will be presented, with the aim of introducing fundamental adimensional numbers (Reynolds, Strouhal, Mach number, etc.) for basic phenomena in both gas and liquid phases (e.g. tip speed ratio for wind mills, pressure drops in pipes, hydraulic machines)
- Basic fluid phenomena
    - Turbulent and laminar flows
    - Wall flows (boundary layers and duct flows); head losses (generalization of Bernoulli theorem)
    - Flow-induced forces (lift, drag and moments) for different geometries (wing profiles and 3D wings; blunt bodies)
    - Laminar or turbulent separation
- Basic thermal phenomena
    - Conduction, convection and radiation
    - Heat exchange (Nusselt, Reynolds and Prandtl correlations)
- Heat exchangers (performance evaluations, geometries)
- Basics of fluid and thermal systems simulations (e.g. heat exchangers and simple heating networks)
- Advanced phenomenological analysis
    - Unsteady phenomena
    - Compressible flows

### Teaching and learning methods

### Literature

## Assessment

### Certification requirements

Module does not use certification requirements

### Basic principle for exams

**As a rule, all the standard final exams for modules and also all resit exams are to be in written form**

### Standard final exam for a module and written resit exam

**Kind of exam**

written

**Duration of exam**

120 minutes

**Permissible aids**

No aids permitted

**Special case: Resit exam as oral exam**

**Kind of exam**

oral

**Duration of exam**

30 minutes

**Permissible aids**

No aids permitted

MSE MASTER OF SCIENCE IN ENGINEERING

**Module Description, available in: EN**

# *Factory Planning*

## General Information

**Number of ECTS Credits**

3

**Module code**

TSM_FactPlan

**Valid for academic year**

2021-2022

**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 defined below for each location/each time the module is held.
- Documentation is available in the languages defined below. Where documents are in several languages, the percentage distribution is shown (100% = all the documentation).
- The examination is available 100% in the languages shown for each location/each time it is held.

| | Berne | Lausanne | | | Lugano | Zurich | | |
|---|---|---|---|---|---|---|---|---|
| **Instruction** | | | | | **X** E 100% | | | |
| **Documentation** | | | | | **X** E 100% | | | |
| **Examination** | | | | | **X** E 100% | | | |

**Module Category**

TSM Technical scientific module

**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 acquired competencies

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

### Contents of module with emphasis on teaching content

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

### Certification requirements

Module does not use certification requirements

### Basic principle for exams

**As a rule, all the standard final exams for modules and also all resit exams are to be in written form**

### Standard final exam for a module and written resit exam

**Kind of exam**

written

**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

**Special case: Resit exam as oral exam**

**Kind of exam**

oral

**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**

2021-2022

**Dernière modification**

2021-3-05

**Coordinateur/coordinatrice du module**

Nikos Zarkadis (HES-SO, nikos.zarkadis@hes-so.ch)

**Explication des définitions de langue par lieu :**

- Les cours se dérouleront dans la langue définie ci-dessous par lieu/exécution.
- Les documents sont disponibles dans les langues définies ci-dessous. Pour le multilinguisme, voir la répartition en pourcentage (100% = documents complets)
- L'examen est disponible à 100% dans chaque langue sélectionnée pour chaque lieu/exécution.

| | Berne | 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

**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

### Conditions d'admission

Le module n'utilise pas de conditions d'admission.

### Principe pour les examens

**En règle générale, tous les examens de fin de module réguliers et les examens de rattrapage sont organisés sous la forme écrite**

### Examen de fin de module régulier et examen écrit de répétition

**Type de l'examen**

écrit

**Durée de l'examen**

120 minutes

**Aides autorisées**

Sans aides

**Cas spécial: examen de répétition oral**

**Type de l'examen**

oral

**Durée de l'examen**

30 minutes

**Aides autorisées**

Sans aides

**Module Description, available in: EN**

# Geoprocessing

## General Information

**Number of ECTS Credits**

3

**Module code**

TSM_GeoProc

**Valid for academic year**

2021-2022

**Last modification**

2019-09-22

**Coordinator of the module**

Martin Christen (FHNW, martin.christen@fhnw.ch)

**Explanations regarding the language definitions for each location:**

- Instruction is given in the language defined below for each location/each time the module is held.
- Documentation is available in the languages defined below. Where documents are in several languages, the percentage distribution is shown (100% = all the documentation).
- The examination is available 100% in the languages shown for each location/each time it is held.

| | Berne | Lausanne | | | Lugano | Zurich | | |
|---|---|---|---|---|---|---|---|---|
| **Instruction** | | | | | | **X** E 100% | | |
| **Documentation** | | | | | | **X** E 100% | | |
| **Examination** | | | | | | **X** E 100% | | |

**Module Category**

TSM Technical scientific module

**Lessons**

2 lecture periods and 1 tutorial period per week

## Entry level competences

**Prerequisites, previous knowledge**

Basic IT knowledge
Interest in dealing with geodata
Interest in cloud environments and processing of very large data sets

## Brief course description of module objectives and content

After studies had shown that 80% of all decisions in business and private life are based on geodata, this now also applies increasingly to Big Data. Modern programming languages such as Python have developed into an easy-to-learn and powerful tool for processing this data. Python is the most frequently used programming language for processing geographical data, especially because of its simplicity, the extensive standard library and the large number of extensions.

Python was used, for example, for Space Shuttle Mission Design or for processing images from the Hubble Space Telescope. Python is also used for highly scalable web applications such as YouTube or the internal Google infrastructure.

At the same time, the availability of (geospatial) data has changed drastically in the last decade. There are more and more data sources - especially thanks to Open Data initiatives. In addition, there is an increasing number of mobile, Internet-enabled devices that make it possible to access data from anywhere and at any time. The availability of storage and computing capacity through cloud computing services has helped to make new data-centric services possible, especially on mobile devices and in web browsers.

A major challenge today, however, is the explosion of data volumes. Traditional methods for data storage, data processing and data evaluation using relational databases and SQL have been the way to work with large amounts of data for decades. For some years, however, there have been alternatives such as Hadoop, NoSQL or Map-Reduce, which can handle this much more efficiently within their area of application.
This module shows the possible uses of Python for (geo)data processing, for handling big data, for data handling and analysis and in cloud computing.
This module shows the application possibilities of Python for (geo) data processing, for handling big data, for data handling and analysis and in cloud computing, as well as the combinability of the individual building blocks to an entire workflow.

In the first part, the programming language Python is introduced, and Python modules for handling and processing data are discussed.

The second part deals with big data, data analysis, and cloud computing.

## Aims, content, methods

### Learning objectives and acquired competencies

Technical goals:

- Learning the programming language Python and the Jupyter Notebook
- Using Tools & Python modules from the field of geo data processing
- Dealing with Python modules in the area of Big Data, NoSQL and Map-Reduce
- Gain the ability to develop your own programs to analyze data sets
- Processing of data records in the cloud

Methodological objectives:

- Develop, compare and present solution concepts, structure and document developed solutions, find online forums and use them to solve problems.

### Contents of module with emphasis on teaching content

Part 1: Python & (geo-)data & geo-libraries

- Introduction to the programming language Python with the Jupyter Notebook
- Introduction to Numpy and Pandas
- Introduction to spatial reference and geographical data (reference systems, projections, transformations etc.)
- Processing of spatial data (reading, creating and modifying raster and vector data)
- Analysis and visualization of spatial data
- Working with spatial databases (import, export, data manipulation)
- Processing of (spatial / OGC) web services

Part 2: Big Data Processing & Cloud Computing

- Introduction Big Data
- Big Data data model (compute, modeling, storage)
- Data storage of very large data sets
- Hadoop (Python API, HDFS, Map-Reduce, Cluster processing)
- NoSQL database systems (application-oriented, focus on geodata)
- Scaling using cloud computing and parallel computing

### Teaching and learning methods

Lectures (2 lessons per week)
Exercises (1 lesson per week)

### Literature


- Wes McKinney, 2012. Python for Data Analysis: Data Wrangling with Pandas, Numpy and IPython.
- Erik Westra, 2013. Python Geospatial Development. Second Edition. Packt Publishing, Birmingham
- Joel Lawhead, 2013. Learning Geospatial Analysis with Python. Packt Publishing
- Chris Garrard, 2015. Geoprocessing with Python, Manning, ISBN: 9781617292149.

## Assessment

**Certification requirements**

Module uses certification requirements

**Certification requirements for final examinations (conditions for attestation)**

Active participation in lessons (min. 80% attendance) and solving exercises.

**Basic principle for exams**

**As a rule, all the standard final exams for modules and also all resit exams are to be in written form**

**Standard final exam for a module and written resit exam**

**Kind of exam**

written

**Duration of exam**

120 minutes

**Permissible aids**

*Aids permitted as specified below:*

**Permissible electronic aids**

No electronic aids permitted

**Other permissible aids**

Teaching materials (Script/Jupyternotebook) printed out

**Special case: Resit exam as oral exam**

**Kind of exam**

oral

**Duration of exam**

30 minutes

**Permissible aids**

*Aids permitted as specified below:*

**Permissible electronic aids**

Teaching materials (Script/Jupyternotebook) printed out

**Other permissible aids**

No other aids permitted

**Module Description, available in: EN**

# *Heat Transfer*

## General Information

**Number of ECTS Credits**

3

**Module code**

TSM_Heat

**Valid for academic year**

2021-2022

**Last modification**

2019-09-07

**Coordinator of the module**

Heinrich Manz (HSLU, heinrich.manz@hslu.ch)

**Explanations regarding the language definitions for each location:**

- Instruction is given in the language defined below for each location/each time the module is held.
- Documentation is available in the languages defined below. Where documents are in several languages, the percentage distribution is shown (100% = all the documentation).
- The examination is available 100% in the languages shown for each location/each time it is held.

| | Berne | Lausanne | | | Lugano | Zurich | | |
|---|---|---|---|---|---|---|---|---|
| **Instruction** | | | | | | **X** E 100% | | |
| **Documentation** | | | | | | **X** E 100% | | |
| **Examination** | | | | | | **X** E 100% | | |

**Module Category**

TSM Technical scientific module

**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 acquired competencies

Students shall learn how to solve engineering problems in the field of heat transfer.

### Contents of module with emphasis on teaching content

- 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

### Certification requirements

Module does not use certification requirements

### Basic principle for exams

**As a rule, all the standard final exams for modules and also all resit exams are to be in written form**

### Standard final exam for a module and written resit exam

**Kind of exam**

written

**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 textbook (F. Incropera, D. DeWitt, T. L. Bergman, A. S. Lavine. Incropera's Principles of Heat and Mass Transfer: Global Edition. Wiley, 2017-11-01)

### Special case: Resit exam as oral exam

**Kind of exam**

oral

**Duration of exam**

30 minutes

**Permissible aids**

No aids permitted

**Module Description, available in: EN**

# *Thermal Hydraulic Methods for Energy Systems in Buildings*

## General Information

**Number of ECTS Credits**

3

**Module code**

TSM_HydMeth

**Valid for academic year**

2021-2022

**Last modification**

2019-10-11

**Coordinator of the module**

Ralph Eismann (FHNW, ralph.eismann@fhnw.ch)

**Explanations regarding the language definitions for each location:**

- Instruction is given in the language defined below for each location/each time the module is held.
- Documentation is available in the languages defined below. Where documents are in several languages, the percentage distribution is shown (100% = all the documentation).
- The examination is available 100% in the languages shown for each location/each time it is held.

| | Berne | Lausanne | | | Lugano | Zurich | | |
|---|---|---|---|---|---|---|---|---|
| **Instruction** | | | | | | **X** E 100% | | |
| **Documentation** | | | | | | **X** E 100% | | |
| **Examination** | | | | | | **X** E 100% | | |

**Module Category**

TSM Technical scientific module

**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 systems such as heating and cooling circuits, solar thermal systems and district networks.  Special emphasis is placed on the conditions for safe operation. The design and integration of storage tanks and heat pumps into thermal networks is also covered. Furthermore, building physical aspects and practical rules regarding pipe routing, building integration, and maintenance are discussed as well.

## Aims, content, methods

### Learning objectives and acquired competencies

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”.

The students will learn how to solve thermal hydraulic engineering problems in the fields of building technology, solar thermal energy and thermal network design.

The aim of these methods is to enable the design of energetically and economically efficient as well as maintenance friendly technical components and systems, and, to prove their functionality by way of simulation.

### Contents of module with emphasis on teaching content

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 the ventability of pipe networks and the stagnation safety of solar thermal plants.

Dedicated code snippets and open source simulation tools allow the students to apply the methods to real cases.

### Teaching and learning methods

The content is taught in frontal lessons.
Numerous examples are motivated and illustrated by story-telling.

Homework exercises are solved using the provided VBA codes running under Excel.

### Literature

The script is provided in the form of ppt-presentations.

Further reading:

Massoud, M., 2005, "Engineering Thermofluids", Springer-Verlag, Berlin, Heidelberg, New York. https://doi.org/10.1007/b138870

Eismann, R., 2017, "Thermohydraulische Dimensionierung von Solaranlagen : Theorie und Praxis der kostenoptimierenden Anlagenplanung", Springer Vieweg, Wiesbaden. ISBN: 978-3-658-07124-0. https://doi.org/10.1007/978-3-658-07125-7

## Assessment

### Certification requirements

Module does not use certification requirements

### Basic principle for exams

**As a rule, all the standard final exams for modules and also all resit exams are to be in written form**

### Standard final exam for a module and written resit exam

**Kind of exam**

written

**Duration of exam**

120 minutes

**Permissible aids**

*Aids permitted as specified below:*

**Permissible electronic aids**

Own Laptop

**Other permissible aids**

Open book (Slides, Lecture notes, Exercises)

### Special case: Resit exam as oral exam

**Kind of exam**

oral

**Duration of exam**

30 minutes

**Permissible aids**

No aids permitted

**Module Description, available in: EN**

# *IT-Security*

## General Information

**Number of ECTS Credits**

3

**Module code**

TSM_ITSec

**Valid for academic year**

2021-2022

**Last modification**

2019-10-09

**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 defined below for each location/each time the module is held.
- Documentation is available in the languages defined below. Where documents are in several languages, the percentage distribution is shown (100% = all the documentation).
- The examination is available 100% in the languages shown for each location/each time it is held.

| | Berne | Lausanne | | | Lugano | Zurich | | |
|---|---|---|---|---|---|---|---|---|
| **Instruction** | | | | | | **X** E 100% | | |
| **Documentation** | | | | | | **X** E 100% | | |
| **Examination** | | | | | | **X** E 100% | | |

**Module Category**

TSM Technical scientific module

**Lessons**

2 lecture periods and 1 tutorial period per week

## Entry level competences

**Prerequisites, previous knowledge**

This module assumes that students have a working knowledge of basic security technologies such as cryptology, secure communication protocols, and access control mechanisms (which amounts to approx. a 4 ECTS bachelor module). See e.g.: William Stallings, Network Security Essentials: Applications and Standards. We also assume that students have a working knowledge in a general purpose programming language such as Java, C, or similar and are familiar with modern software development processes.

## Brief course description of module objectives and content

This module teaches two aspects of IT security. The first part deals with secure software, focusing on developing secure software and exploiting defects in software. The second part deals with several advanced security technologies, which includes authentication, access control, network security devices, and operating system security.

## Aims, content, methods

### Learning objectives and acquired competencies

- The students know and understand the secure development lifecycle and are capable of developing secure software.
- The students can analyze software with respect to security and can exploit vulnerabilities.
- The students can employ threat modeling to identify threats and use this to define security requirements.
- The students know and understand advanced authentication and access control methods including identity federations.
- The students understand the underlying principles of application layer firewalls and intrusion detection/prevention systems.
- The students are able to apply the current network access control standards to establish trust in client platforms.

### Contents of module with emphasis on teaching content

The module consists of 2 main topics, Software Security and Security Technologies. Each covers 6-8 weeks.

- Main topic 1: Software Security. The skills taught here are applicable to any software project and therefore include web applications, web services, and mobile applications.
  - Introduction to software security (motivation, secure development lifecycle)
  - Finding and exploiting vulnerabilities in software (e.g. web applications) by combining manual methods and tools
  - Developing secure software (e.g. web applications and web services)
  - Security requirements engineering and threat modeling
- Main topic 2: Security Technologies. The skills taught here are applicable to a wide range of scenarios, and include Internet and operating system security.
  - Advanced access control and authentication methods and federated identities
  - Application level firewalls and intrusion detection/prevention systems
  - Internet security, e.g., network access control
  - Operating system security and trusted platforms

### Teaching and learning methods

- Lecture: Ex cathedra teaching
- Exercises/self-study: reading texts about security topics, some self-study, mainly about web application development frameworks; practical exercises (computer-based); theoretical exercises

### Literature

Lecture slides, references to Internet sources and textbooks

## Assessment

### Certification requirements

Module does not use certification requirements

### Basic principle for exams

**As a rule, all the standard final exams for modules and also all resit exams are to be in written form**

### Standard final exam for a module and written resit exam

#### Kind of exam

written

#### Duration of exam

120 minutes

#### Permissible aids

No aids permitted

### Special case: Resit exam as oral exam

#### Kind of exam

oral

**Duration of exam**

30 minutes

**Permissible aids**

No aids permitted

MASTER OF SCIENCE
IN ENGINEERING

**Module Description, available in: EN**

# *Industrial Control*

## General Information

**Number of ECTS Credits**

3

**Module code**

TSM_IndContr

**Valid for academic year**

2021-2022

**Last modification**

2020-12-22

**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 defined below for each location/each time the module is held.
- Documentation is available in the languages defined below. Where documents are in several languages, the percentage distribution is shown (100% = all the documentation).
- The examination is available 100% in the languages shown for each location/each time it is held.

| | Berne | Lausanne | | | Lugano | Zurich | | |
|---|---|---|---|---|---|---|---|---|
| **Instruction** | | | | | **X** E 100% | | | |
| **Documentation** | | | | | **X** E 100% | | | |
| **Examination** | | | | | **X** E 100% | | | |

**Module Category**

TSM Technical scientific module

**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 logic and numerical control of industrial systems. Practical laboratory activities are developed for both CNC and PLC programming.

## Aims, content, methods

### Learning objectives and acquired competencies

- to understand tasks and generic architecture of a machine and production operations control system
- to learn which are the functions of a generic PLC and CNC necessary to control manufacturing plants

- to learn configuring and programming PLC and CNC systems through standard IEC and ISO languages
- to develop practical exercises on industrial PLC and CNC targets

### Contents of module with emphasis on teaching content

The PLC and CNC roles and functions in production systems. 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.

### Teaching and learning methods

Frontal theoretical lessons and practical lab activities.

### Literature

## Assessment

### Certification requirements

Module does not use certification requirements

### Basic principle for exams

**As a rule, all the standard final exams for modules and also all resit exams are to be in written form**

### Standard final exam for a module and written resit exam

**Kind of exam**

written

**Duration of exam**

120 minutes

**Permissible aids**

No aids permitted

### Special case: Resit exam as oral exam

**Kind of exam**

oral

**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**

2021-2022

**Last modification**

2020-12-22

**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 defined below for each location/each time the module is held.
- Documentation is available in the languages defined below. Where documents are in several languages, the percentage distribution is shown (100% = all the documentation).
- The examination is available 100% in the languages shown for each location/each time it is held.

| | Berne | Lausanne | | | Lugano | Zurich | | |
|---|---|---|---|---|---|---|---|---|
| **Instruction** | | | | | | **X** E 100% | | |
| **Documentation** | | | | | | **X** E 100% | | |
| **Examination** | | | | | | **X** E 100% | | |

**Module Category**

TSM Technical scientific module

**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 of information visualization as well as the options and techniques for the design of static and dynamic visual user interfaces. 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. R, D3.js or Python Bokeh) or otherwise to select one and use it for (almost) all exercises.

## Aims, content, methods

### Learning objectives and acquired competencies

- 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.

### Contents of module with emphasis on teaching content

- 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

### Certification requirements

Module uses certification requirements

### Certification requirements for final examinations (conditions for attestation)

Submitted and accepted homework (visualization project module task)

**Basic principle for exams**

**As a rule, all the standard final exams for modules and also all resit exams are to be in written form**

**Standard final exam for a module and written resit exam**

**Kind of exam**

written

**Duration of exam**

120 minutes

**Permissible aids**

*Aids permitted as specified below:*

**Permissible electronic aids**

Open book, all materials and documents

**Other permissible aids**

Open book, all materials and documents

**Special case: Resit exam as oral exam**

**Kind of exam**

oral

**Duration of exam**

30 minutes

**Permissible aids**

No aids permitted

MASTER OF SCIENCE
IN ENGINEERING

**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**

2021-2022

**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 defined below for each location/each time the module is held.
- Documentation is available in the languages defined below. Where documents are in several languages, the percentage distribution is shown (100% = all the documentation).
- The examination is available 100% in the languages shown for each location/each time it is held.

| | Berne | Lausanne | | | Lugano | Zurich | | |
|---|---|---|---|---|---|---|---|---|
| **Instruction** | | | | | | **X** E 100% | | |
| **Documentation** | | | | | | **X** E 100% | | |
| **Examination** | | | | | | **X** E 100% | | |

**Module Category**

TSM Technical scientific module

**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 acquired competencies

- 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

### Contents of module with emphasis on teaching content

| 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.

### 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 (2029): Das Design Thinking Toolbook, Vahlen Verlag.

## Assessment

### Certification requirements

Module uses certification requirements

### Certification requirements for final examinations (conditions for attestation)

Active participation at the team work (real case Innovation challenge):

10 methods selected, applied and handed in

Concept Maps created

Intermediate and final presentation of the team work

### Basic principle for exams

**As a rule, all the standard final exams for modules and also all resit exams are to be in written form**

### Standard final exam for a module and written resit exam

**Kind of exam**

written

**Duration of exam**

120 minutes

**Permissible aids**

*Aids permitted as specified below:*

**Permissible electronic aids**

Created 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.

**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.

### Special case: Resit exam as oral exam

**Kind of exam**

oral

**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**

2021-2022

**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 defined below for each location/each time the module is held.
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- The examination is available 100% in the languages shown for each location/each time it is held.

| | Berne | Lausanne | | | Lugano | Zurich | | |
|---|---|---|---|---|---|---|---|---|
| **Instruction** | | | | | | **X** E 100% | | |
| **Documentation** | | | | | | **X** E 100% | | |
| **Examination** | | | | | | **X** E 100% | | |

**Module Category**

TSM Technical scientific module

**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 acquired competencies

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

### Contents of module with emphasis on teaching content

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

### Certification requirements

Module does not use certification requirements

### Basic principle for exams

**As a rule, all the standard final exams for modules and also all resit exams are to be in written form**

### Standard final exam for a module and written resit exam

#### Kind of exam

written

#### 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

**Special case: Resit exam as oral exam**

**Kind of exam**

oral

**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**

2021-2022

**Last modification**

2019-08-31

**Coordinator of the module**

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**Explanations regarding the language definitions for each location:**

- Instruction is given in the language defined below for each location/each time the module is held.
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| | Berne | Lausanne | | | Lugano | Zurich | | |
|---|---|---|---|---|---|---|---|---|
| **Instruction** | | | | | **X** E 100% | | | |
| **Documentation** | | | | | **X** E 100% | | | |
| **Examination** | | | | | **X** E 100% | | | |

**Module Category**

TSM Technical scientific module

**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 acquired competencies

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

### Contents of module with emphasis on teaching content

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

### Certification requirements

Module does not use certification requirements

### Basic principle for exams

**As a rule, all the standard final exams for modules and also all resit exams are to be in written form**

### Standard final exam for a module and written resit exam

#### Kind of exam

written

#### 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

**Special case: Resit exam as oral exam**

**Kind of exam**

oral

**Duration of exam**

30 minutes

**Permissible aids**

No aids permitted

MSE MASTER OF SCIENCE IN ENGINEERING

**Module Description, available in: EN**

# *Laser and laser applications*

## General Information

**Number of ECTS Credits**

3

**Module code**

TSM_Laser

**Valid for academic year**

2021-2022

**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 defined below for each location/each time the module is held.
- Documentation is available in the languages defined below. Where documents are in several languages, the percentage distribution is shown (100% = all the documentation).
- The examination is available 100% in the languages shown for each location/each time it is held.

| | Berne | Lausanne | | | Lugano | Zurich | | |
|---|---|---|---|---|---|---|---|---|
| **Instruction** | | | | | | **X** E 100% | | |
| **Documentation** | | | | | | **X** E 100% | | |
| **Examination** | | | | | | **X** E 100% | | |

**Module Category**

TSM Technical scientific module

**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 acquired competencies

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

### Contents of module with emphasis on teaching content

**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

### Certification requirements

Module does not use certification requirements

### Basic principle for exams

**As a rule, all the standard final exams for modules and also all resit exams are to be in written form**

### Standard final exam for a module and written resit exam

**Kind of exam**

written

**Duration of exam**

120 minutes

**Permissible aids**

*Aids permitted as specified below:*

**Permissible electronic aids**

- calculator

**Other permissible aids**

- personal formulary 4 A4 pages

### Special case: Resit exam as oral exam

**Kind of exam**

oral

**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**

2021-2022

**Last modification**

2021-01-15

**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 defined below for each location/each time the module is held.
- Documentation is available in the languages defined below. Where documents are in several languages, the percentage distribution is shown (100% = all the documentation).
- The examination is available 100% in the languages shown for each location/each time it is held.

| | Berne | Lausanne | | | Lugano | Zurich | | |
|---|---|---|---|---|---|---|---|---|
| **Instruction** | | | | | | **X** E 100% | | |
| **Documentation** | | | | | | **X** E 100% | | |
| **Examination** | | | | | | **X** E 100% | | |

**Module Category**

TSM Technical scientific module

**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 acquired competencies

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.

### Contents of module with emphasis on teaching content

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

### Certification requirements

Module uses certification requirements

### Certification requirements for final examinations (conditions for attestation)

### Basic principle for exams

**As a rule, all the standard final exams for modules and also all resit exams are to be in written form**

### Standard final exam for a module and written resit exam

**Kind of exam**

written

**Duration of exam**

120 minutes

**Permissible aids**

*Aids permitted as specified below:*

**Permissible electronic aids**

None

**Other permissible aids**

Open book. Printed documents (all lectures).

### Special case: Resit exam as oral exam

**Kind of exam**

oral

**Duration of exam**

30 minutes

**Permissible aids**

*Aids permitted as specified below:*

**Permissible electronic aids**

None

**Other permissible aids**

Open book. Printed documents (all lectures).

**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**

2021-2022

**Last modification**

2021-01-29

**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 defined below for each location/each time the module is held.
- Documentation is available in the languages defined below. Where documents are in several languages, the percentage distribution is shown (100% = all the documentation).
- The examination is available 100% in the languages shown for each location/each time it is held.

| | Berne | Lausanne | | | Lugano | Zurich | | |
|---|---|---|---|---|---|---|---|---|
| **Instruction** | | **X** E 100% | | | | | | |
| **Documentation** | | **X** E 100% | | | | | | |
| **Examination** | | **X** E 100% | | | | | | |

**Module Category**

TSM Technical scientific module

**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 acquired competencies

- Know how to apply design methods (writing functional specifications, functional analysis, FMECA, FRDPARRC...) 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, multiphysics simulation software.
- 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.

### Contents of module with emphasis on teaching content

- *(a+b) a theoretical periods + b practical exercises/application periods*
- (3+2) Design methods (e.g., FRDPARRC)
  - writing functional specifications
  - functional analysis
  - FMECA
  - 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+1) Specificities of microengineering products (change of scale and change of physics)
  - multi-physics simulation software
- (3+1) Microengineering interactions for production and maintenance
  - prototype vs. series products (traceability, documentation, manufacturing environment (design master file), standards)
- Health and safety aspects, environmental and economic constraints (review of projects that have more or less successfully taken these aspects into account)

### 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


- Fabrication additive - 2e édition, Du prototypage rapide à l'impression 3D - Claude Barlier, Alain Bernard, Editions Dunod

- Reference books selected by the instructor

## Assessment

### Certification requirements

Module uses certification requirements

### Certification requirements for final examinations (conditions for attestation)

The usual participation conditions apply.

We would like to extend the duration of the exam to 180 minutes. In the medium term, we are considering extending the examination to one full day in order to increase quality.

### Basic principle for exams

**As a rule, all the standard final exams for modules and also all resit exams are to be in written form**

### Standard final exam for a module and written resit exam

**Kind of exam**

written

**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

### Special case: Resit exam as oral exam

**Kind of exam**

oral

**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

MASTER OF SCIENCE
IN ENGINEERING

**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**

2021-2022

**Dernière modification**

2020-02-06

**Coordinateur/coordinatrice du module**

Daia Zwicky (HES-SO, Daia.Zwicky@hefr.ch)

**Explication des définitions de langue par lieu :**

- Les cours se dérouleront dans la langue définie ci-dessous par lieu/exécution.
- Les documents sont disponibles dans les langues définies ci-dessous. Pour le multilinguisme, voir la répartition en pourcentage (100% = documents complets)
- L'examen est disponible à 100% dans chaque langue sélectionnée pour chaque lieu/exécution.

| | Berne | 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

**Leçons**

2 leçons et 1 leçon de pratique par semaine

## Compétences préalables

**Connaissances préalables, compétences initiales**

Bonnes connaissances en analyse structurale, technologie des matériaux.

## 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 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

### Conditions d'admission

Le module n'utilise pas de conditions d'admission.

### Principe pour les examens

**En règle générale, tous les examens de fin de module réguliers et les examens de rattrapage sont organisés sous la forme écrite**

### Examen de fin de module régulier et examen écrit de répétition

**Type de l'examen**

écrit

**Durée de l'examen**

120 minutes

**Aides autorisées**

*Les aides suivantes sont autorisées:*

**Aides électroniques autorisées**

Au contraire de l'indication ci-haut, l'examen sera en oral selon la formule 30' de préparation, suivi de 30' d'examen.

Examen "Open Book" (tout support admis sous forme papier).

Pas d'outils électroniques au-delà d'une calculatrice (pas de laptop, mobile etc.).

**Autres aides autorisées**

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**Cas spécial: examen de répétition oral**

**Type de l'examen**

oral

**Durée de l'examen**

30 minutes

**Aides autorisées**

*Les aides suivantes sont autorisées:*

**Aides électroniques autorisées**

Même principe que pour examen final

**Autres aides**

Examen oral de 30', précédé de 30' de préparation

Open Book

**Module Description, available in: EN**

# Manufacturing Technologies

## General Information

**Number of ECTS Credits**

3

**Module code**

TSM_ManTech

**Valid for academic year**

2021-2022

**Last modification**

2019-10-21

**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 defined below for each location/each time the module is held.
- Documentation is available in the languages defined below. Where documents are in several languages, the percentage distribution is shown (100% = all the documentation).
- The examination is available 100% in the languages shown for each location/each time it is held.

| | Berne | Lausanne | | | Lugano | Zurich | | |
|---|---|---|---|---|---|---|---|---|
| **Instruction** | | | | | | **X** E 100% | | |
| **Documentation** | | | | | | **X** E 100% | | |
| **Examination** | | | | | | **X** E 100% | | |

**Module Category**

TSM Technical scientific module

**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 acquired competencies

To learn about and to understand modern manufacturing methods and systems used to improve productivity and quality.

### Contents of module with emphasis on teaching content

| | |
|---|---|
| **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 | 2 lecture periods |
| • Tools and coating: Trends | 2 lecture periods |
| • Multiaxis machining: Trends | 2 lecture periods |
| **Sheet metal forming** | 4 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

### Certification requirements

Module does not use certification requirements

### Basic principle for exams

**As a rule, all the standard final exams for modules and also all resit exams are to be in written form**

### Standard final exam for a module and written resit exam

**Kind of exam**

written

**Duration of exam**

120 minutes

**Permissible aids**

No aids permitted

### Special case: Resit exam as oral exam

**Kind of exam**

oral

**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**

2021-2022

**Last modification**

2021-01-15

**Coordinator of the module**

Christoph Imboden (HSLU, christoph.imboden@hslu.ch)

**Explanations regarding the language definitions for each location:**

- Instruction is given in the language defined below for each location/each time the module is held.
- Documentation is available in the languages defined below. Where documents are in several languages, the percentage distribution is shown (100% = all the documentation).
- The examination is available 100% in the languages shown for each location/each time it is held.

| | Berne | Lausanne | | | Lugano | Zurich | | |
|---|---|---|---|---|---|---|---|---|
| **Instruction** | | | | | | **X** E 100% | | |
| **Documentation** | | | | | | **X** E 100% | | |
| **Examination** | | | | | | **X** E 100% | | |

**Module Category**

TSM Technical scientific module

**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 acquired competencies

Students have the knowledge and the ability to understand and analyze a market as a complex socio-economic system. They are able to identify the most relevant factors determining the market behavior, to identify the causal relation between these factors and to describe socio-economic systems by means of qualitative 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 their impacts on the overall system behavior. Students apply qualitative and quantitative methods for model validation, including basic behavior analysis and statistics. In practical examples they learn to analyze, predict and steer such systems. Finally students are able to present the analysis results in terms of descriptive scenarios using different visualization techniques.

### Contents of module with emphasis on teaching content

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
- 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. Case studies that cover topics in market analysis such as

- Customer segmentation for marketing campaign planning
- Customer feedback analysis for service improvement planning
- Demand prediction for electricity production planning and agricultural planning
- Credit card default prediction
- Applicant rating for HR decision making

using basic quantitative methods such as

- Data structuring and cleaning
- k-Means clustering
- rfm segmentation
- Linear-multiple and non-linear regression
- Time series forecasting

The use and benefits of each discussed topic will be explained, methods for solving the analysis tasks will be presented in an accessible and non-technical manner. The focus will be on the validity and generalizability of the results/conclusions and how they will be included in 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

### Certification requirements

Module uses certification requirements

### Certification requirements for final examinations (conditions for attestation)

A project ('case study') to be compiled through independent study.

The case study report accounts for 1/3 of the final assessment.

### Basic principle for exams

**As a rule, all the standard final exams for modules and also all resit exams are to be in written form**

### Standard final exam for a module and written resit exam

**Kind of exam**

written

**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.

### Special case: Resit exam as oral exam

**Kind of exam**

oral

**Duration of exam**

30 minutes

**Permissible aids**

No aids permitted

MASTER OF SCIENCE
IN ENGINEERING

**Modulbeschreibung, verfügbar in: DE**

# *Werkstoffmechanik und Plastizitätstheorie*

## Allgemeine Angaben

**Anzahl ECTS-Credits**

3

**Modulkürzel**

TSM_MatPla

**Gültig für akademisches Jahr**

2021-2022

**Letzte Änderung**

2019-12-02

**Modul-Koordinator/in**

Ivan Markovic (OST, ivan.markovic@ost.ch)

**Erläuterungen zu den Sprachdefinitionen je Standort:**

- Der Unterricht findet in der unten definierten Sprache je Standort/Durchführung statt.
- Die Unterlagen sind in den unten definierten Sprachen verfügbar. Bei Mehrsprachigkeit, siehe prozentuale Verteilung (100% = komplette Unterlagen)
- Die Prüfung ist in jeder je Standort/Durchführung angekreuzten Sprache zu 100% verfügbar.

| | Berne | Lausanne | | | Lugano | Zurich | | |
|---|---|---|---|---|---|---|---|---|
| **Unterricht** | | | | | | | **X** D 100% | |
| **Dokumentation** | | | | | | | **X** D 100% | |
| **Prüfung** | | | | | | | **X** D 100% | |

**Modulkategorie**

TSM Technisch-wissenschaftliche Vertiefung

**Lektionen**

2 Lektionen und 1 Übungslektion pro Woche

## Eintrittskompetenzen

**Vorkenntnisse, Eingangskompetenzen**

- Kenntnisse der Baustatik von Stabtragwerken und Flächentragwerken sowie Kenntnisse der Bemessung und Konstruktion von Tragwerken aus Stahlbeton und Stahl.

- Kenntnisse von Bodenmechanik sowie von Berechnung und Dimensionierung geotechnischer Tragwerke.

- Kenntnisse der Matrixalgebra und der Differentialgleichungen.

## Kurzbeschreibung der Inhalte und Ziele

1. Inhalte: Einführung in Kontinuum-Mechanik und in Plastizitätstheorie, Analyse der Stoffgesetze für Boden und Baustoffe im Bereich des konstruktiven Ingenieurbaus; Anwendung der Plastizitätstheorie für Traglastberechnungen in der Geotechnik sowie im konstruktiven Ingenieurbau
2. Ziele: Nach diesem Modul sollen die Studierenden ein vertieftes Verständnis über die Stoffgesetze von Boden sowie von Baustoffen im konstruktiven Ingenieurbau entwickeln und fähig sein, diese Stoffgesetze korrekt in der Berechnung der Traglast für konkrete Bauwerke anzuwenden. Zudem sollen die Studierenen die Methoden für Berechnung des Tragvermögens mittels Plastizitätstheorie in der Geotechnik sowie im konstruktiven Ingenieurbau verstehen und in geeigneten praktischen Aufgaben anwenden können.

## Ziele, Inhalte, Methoden

### Lernziele, zu erwerbende Kompetenzen

Lernziele und zu erwerbende Kompetenzen:

Nach diesem Modul sollen die Studierenden:

a) ein vertieftes Verständnis über die Stoffgesetze von Boden sowie von Baustoffen im konstruktiven Ingenieurbau entwickeln

b) korrekt einschätzen können, welcher Stoffgesetz in welcher Situation in der Praxis anzuwenden ist

c) Sinn und Zweck des Traglastverfahrens und der Grenzwertsätze in der Plastizitätstheorie verstehen

d) Methoden für Berechnung des Tragvermögens mittels Traglastverfahrens in Geotechnik sowie im konstruktiven Ingenieurbau verstehen und anwenden können

e) Stoffgesetze für Berechnung des realitätsnahen Tragvermögens für geotechnische Bauwerke sowie für Bauwerke im konstruktiven Ingenieurbau anwenden können

f) Resultate der Berechnungen des Tragvermögens verstehen und plausibilisieren können

### Modulinhalt mit Gewichtung der Lehrinhalte

1. Einführung in Kontinuum-Mechanik und Werkstoffmechanik (insgesamt ca. 35%):

- Einführung in statische und kinematische Beziehungen; Einführung in Werkstoffbeziehungen (linear-elastisches, ideal-plastisches Verhalten, plastisches Potential, Fliessbedingungen) (ca. 10%)

- Stoffgesetze für Boden (Elastizität; Versagenskriterien und plastisches Fliessen, Verfestigung, Critical State) (ca. 15%)

- Stoffgesetze für Baustoffe im konstruktiven Ingenieurbau (Stahl, Stahlbeton, Faserbeton, UHFB, Glass) (ca. 10%)

2. Anwendung der Plastizitätstheorie im konstruktiven Ingenieurbau (insgesamt ca. 40%):

- Grenzwertsätze der Plastizitätstheorie

- Elastisch-plastische Systeme

- Traglastverfahren für Stabtragwerke inkl. konkrete Beispiele: statische und kinematische Methode

- Traglastverfahren für Flächentragwerke inkl. konkrete Beispiele: einfache Momentenfelder, Fliessgelenklinien und Streifenmethode

3. Anwendung der Plastizitätstheorie und des nicht-linearen Materialverhaltens in der Geotechnik (insgesamt ca. 25%):

- Ausgewählte Fallbeispiele geotechnischer Problemstellungen aus der Praxis (Stützmauern, Hangstabilität, Flachgründungen, tiefe Ausgrabungen)

### Lehr- und Lernmethoden

- Frontalunterricht und seminaristischer Unterricht

- selbstständige Übungen

### Bibliografie

Vorlesungsunterlagen:

- P. Marti: Baustatik, Ernst u. Sohn, 2. Auflage, 2014

- P. Marti et al.: Tragverhalten von Stahlbeton: Fortbildungskurs für Bauingenieure, ETH Zürich, 1999

- C. Rabaiotti: Untererichts-Skript "Stoffgesetzte für Boden", HSR Hochschule für Technik Rapperswil, 2017

- weitere Unterlagen gemäss Hinweis des zuständigen Dozierenden

## Bewertung

### Zulassungsbedingungen

Modul verwendet keine Zulassungsbedingungen

### Grundsatz Prüfungen

**In der Regel werden alle regulären Modulabschlussprüfungen und Wiederholungsprüfungen in schriftlicher Form gehalten**

### Reguläre Modulschlussprüfung und schriftliche Wiederholungsprüfung

**Art der Prüfung**

schriftlich

**Prüfungsdauer**

120 Minuten

**Erlaubte Hilfsmittel**

*Erlaubt sind die aufgeführten Hilfsmittel:*

**Zulässige elektronische Hilfsmittel**

Keine elektronischen Hilfsmittel zulässig

**Weitere erlaubte Hilfsmittel**

Zusammenfassung des Lehrstoffs mit sechs A4-Seiten für Kurs Werkstoffe und sechs A4-Seiten für Kurs Plastizität.

Weitere Hilfsmittel in Absprache mit dem Dozierenden.

### Spezialfall: Wiederholungsprüfung als mündliches Examen

**Art der Prüfung**

mündlich

**Prüfungsdauer**

30 Minuten

**Erlaubte Hilfsmittel**

*Erlaubt sind die aufgeführten Hilfsmittel:*

**Zulässige elektronische Hilfsmittel**

Keine elektronischen Hilfsmittel zulässig

**Andere zulässige Hilfsmittel**

Zulässige Hilfsmittel in Absprache mit dem Dozierenden.

**Module Description, available in: EN**

# *Materials Selection and Design*

## General Information

**Number of ECTS Credits**

3

**Module code**

TSM_MatSelDes

**Valid for academic year**

2021-2022

**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 defined below for each location/each time the module is held.
- Documentation is available in the languages defined below. Where documents are in several languages, the percentage distribution is shown (100% = all the documentation).
- The examination is available 100% in the languages shown for each location/each time it is held.

| | Berne | Lausanne | | | Lugano | Zurich | | |
|---|---|---|---|---|---|---|---|---|
| **Instruction** | | | | | **X** E 100% | | | |
| **Documentation** | | | | | **X** E 100% | | | |
| **Examination** | | | | | **X** E 100% | | | |

**Module Category**

TSM Technical scientific module

**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 acquired competencies

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.

### Contents of module with emphasis on teaching content

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 CES 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

### Certification requirements

Module does not use certification requirements

### Basic principle for exams

**As a rule, all the standard final exams for modules and also all resit exams are to be in written form**

### Standard final exam for a module and written resit exam

**Kind of exam**

written

**Duration of exam**

120 minutes

**Permissible aids**

No aids permitted

### Special case: Resit exam as oral exam

**Kind of exam**

oral

**Duration of exam**

30 minutes

**Permissible aids**

No aids permitted

MASTER OF SCIENCE
IN ENGINEERING

**Module Description, available in: EN, FR**

# *Materials and Surfaces*

## General Information

**Number of ECTS Credits**

3

**Module code**

TSM_MatSurf

**Valid for academic year**

2021-2022

**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 defined below for each location/each time the module is held.
- Documentation is available in the languages defined below. Where documents are in several languages, the percentage distribution is shown (100% = all the documentation).
- The examination is available 100% in the languages shown for each location/each time it is held.

| | Berne | 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

**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 acquired competencies

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

### Contents of module with emphasis on teaching content

- 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

### Certification requirements

Module does not use certification requirements

### Basic principle for exams

**As a rule, all the standard final exams for modules and also all resit exams are to be in written form**

### Standard final exam for a module and written resit exam

**Kind of exam**

written

**Duration of exam**

120 minutes

**Permissible aids**

*Aids permitted as specified below:*

**Permissible electronic aids**

no electronical aids allowed

**Other permissible aids**

Lecture notes (Paper version), personal notes of lessons and Exercises, textbooks

**Special case: Resit exam as oral exam**

**Kind of exam**

oral

**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**

2021-2022

**Dernière modification**

2020-12-22

**Coordinateur/coordinatrice du module**

Arnd Jung (ZHAW, arnd.jung@zhaw.ch)

**Explication des définitions de langue par lieu :**

- Les cours se dérouleront dans la langue définie ci-dessous par lieu/exécution.
- Les documents sont disponibles dans les langues définies ci-dessous. Pour le multilinguisme, voir la répartition en pourcentage (100% = documents complets)
- L'examen est disponible à 100% dans chaque langue sélectionnée pour chaque lieu/exécution.

| | Berne | 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

**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

### Conditions d'admission

Le module n'utilise pas de conditions d'admission.

### Principe pour les examens

**En règle générale, tous les examens de fin de module réguliers et les examens de rattrapage sont organisés sous la forme écrite**

### Examen de fin de module régulier et examen écrit de répétition

**Type de l'examen**

écrit

**Durée de l'examen**

120 minutes

**Aides autorisées**

*Les aides suivantes sont autorisées:*

**Aides électroniques autorisées**

Aucune aide électronique n'est autorisée

**Autres aides autorisées**

Documents de cours (version papier), notes personnelles, exercices, manuels

**Cas spécial: examen de répétition oral**

**Type de l'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**

2021-2022

**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 defined below for each location/each time the module is held.
- Documentation is available in the languages defined below. Where documents are in several languages, the percentage distribution is shown (100% = all the documentation).
- The examination is available 100% in the languages shown for each location/each time it is held.

| | Berne | Lausanne | | | Lugano | Zurich | | |
|---|---|---|---|---|---|---|---|---|
| **Instruction** | | | | | | **X** E 100% | | |
| **Documentation** | | | | | | **X** E 100% | | |
| **Examination** | | | | | | **X** E 100% | | |

**Module Category**

TSM Technical scientific module

**Lessons**

2 lecture periods and 1 tutorial period per week

## Entry level competences

**Prerequisites, previous knowledge**

Basics in maths, physics, electricity of BSc engineering programs or similar

## Brief course description of module objectives and content

This module gives an introduction to the physical and technical principles and applications of important diagnostic modalities. Starting with an overview of 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 acquired competencies

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
- achieve basic knowledge of the most important clinical application of medical imaging modalities
- describe approaches and methods for image quality assessment

### Contents of module with emphasis on teaching content

Part 1 Devices & Sensors: Overview of diagnostic instrumentation and modalities:

Generation of X-ray, X-ray detectors, technology and application of Fluoroscopy, CT, PET / SPECTMRI, diagnostic ultra sound; image-guided therapy (interventional radiology, IGRT, theranostics);

Image quality, radiation protection and QA for diagnostic devices,

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.)

Part 2 Signal processing

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

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

### Certification requirements

Module does not use certification requirements

### Basic principle for exams

**As a rule, all the standard final exams for modules and also all resit exams are to be in written form**

### Standard final exam for a module and written resit exam

#### Kind of exam

written

#### Duration of exam

120 minutes

#### Permissible aids

No aids permitted

**Special case: Resit exam as oral exam**

**Kind of exam**

oral

**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**

2021-2022

**Last modification**

2019-10-11

**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 defined below for each location/each time the module is held.
- Documentation is available in the languages defined below. Where documents are in several languages, the percentage distribution is shown (100% = all the documentation).
- The examination is available 100% in the languages shown for each location/each time it is held.

| | Berne | Lausanne | | | Lugano | Zurich | | |
|---|---|---|---|---|---|---|---|---|
| **Instruction** | | | | | | **X** E 100% | | |
| **Documentation** | | | | | | **X** E 100% | | |
| **Examination** | | | | | | **X** E 100% | | |

**Module Category**

TSM Technical scientific module

**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 organic chemistry

## Brief course description of module objectives and content

The course provides an in-depth overview on all relevant aspects for successfully introducing a medical device into the market. The corresponding topics include the important tasks during the development of a medical device (prior market access) as well as after its placement on the market.

## Aims, content, methods

### Learning objectives and acquired competencies

The aim of this lecture is to

- know the important medical device design principles
- know all relevant aspects for the development of a medical device with respect to a successful market placement
- understand the regulation for medical devices in Europe (MDR) and USA (FDA)
- apply current standards for (software) design, risk management, usability and/or biological aspects

### Contents of module with emphasis on teaching content

14 different topics related to the market access of a medical device will be presented each week as follows:

(1) From lab bench to bed side: medical device design principles.

(2) Understanding compatibility of materials according ISO 10993.

(3) Basic knowledge in microorganisms and pathogens (including ISO14644/clean room).

(4) Knowledge of cleaning and disinfection processes of medical products as well as sterilization procedures and methods. In addition, overview on the packaging of sterile products.

(5) Understanding the scientific language of medicine, the research culture as well as the ethical aspects in the context of medical devices.

(6) Knowledge of the classification of medical products and the requirements of EU-MDR and US-FDA.

(7) Insights into the quality management system EN ISO 13485:2016.

(8) Knowledge of the CE-labelling in Europe and registration procedure in the USA. Product labelling (ISO 15233) and UDI.

(9) Overview on the legal requirements on the design and construction of medical products. This includes the requirement management as well as the verification and validation of development results including the Software Life Cycle (ISO 62304).

(10) Knowledge of the legal requirements on producers of medical products in Europe and elsewhere.

(11) Introduction into the clinical testing of medical devices and basic knowledge of "good clinical practice" (including ISO 2859 and ISO 3951).

(12) Understanding the basics in the usability according EN 62366, validation of the usability.

(13) Understanding the risk management according ISO 14971 and having insights into the risk analysis.

(14) Overview on the markets, health systems and the decision makers when it comes to acquiring new medical products.

### Teaching and learning methods

Lectures and practical work on computer

### Literature

- Slides and lecture notes will be available in addition of recommended book chapters
- MDR
- EN ISO 13485:2016
- ISO 14971, 10993, 14644, 15233, 62304, 2859, 3951
- EN 62366

## Assessment

### Certification requirements

Module does not use certification requirements

### Basic principle for exams

**As a rule, all the standard final exams for modules and also all resit exams are to be in written form**

### Standard final exam for a module and written resit exam

#### Kind of exam

written

**Duration of exam**

120 minutes

**Permissible aids**

*Aids permitted as specified below:*

**Permissible electronic aids**

Principally none - if required, regulations will be handed out

**Other permissible aids**

One A4 page (double side), hand written

**Special case: Resit exam as oral exam**

**Kind of exam**

oral

**Duration of exam**

30 minutes

**Permissible aids**

No aids permitted

MASTER OF SCIENCE
IN ENGINEERING

**Module Description, available in: EN**

# Micromachining and Fabrication Processes in Microengineering

## General Information

**Number of ECTS Credits**

3

**Module code**

TSM_MicroFab

**Valid for academic year**

2021-2022

**Last modification**

2021-02-11

**Coordinator of the module**

Florian Serex (HES-SO, florian.serex@he-arc.ch)

**Explanations regarding the language definitions for each location:**

- Instruction is given in the language defined below for each location/each time the module is held.
- Documentation is available in the languages defined below. Where documents are in several languages, the percentage distribution is shown (100% = all the documentation).
- The examination is available 100% in the languages shown for each location/each time it is held.

| | Berne | Lausanne | | | Lugano | Zurich | | |
|---|---|---|---|---|---|---|---|---|
| **Instruction** | | **X** E 100% | | | | | | |
| **Documentation** | | **X** E 100% | | | | | | |
| **Examination** | | **X** E 100% | | | | | | |

**Module Category**

TSM Technical scientific module

**Lessons**

2 lecture periods and 1 tutorial period per week

## Entry level competences

**Prerequisites, previous knowledge**

Physics, Materials, Mechanics : Basics for Engineers (bachelor level)

## Brief course description of module objectives and content

The goal of the module is to give an overview on the existing micromachining and micromanufacturing processes commonly used in microengineering. The module covers the working principles and technical aspects of modern industrial micromachining equipment as well as photolithography-, engraving- and etching-based microfabrication techniques.

## Aims, content, methods

### Learning objectives and acquired competencies

After completion of the module participants will be able to

- explain the working principles of modern micromachining and micromanufacturing techniques and to discuss application examples from different industrial sectors;
- discuss the possibilities and limitations of different micromanufacturing techniques for various materials such as metals, ceramics, polymers, silicon;
- choose suitable micromachining and manufacturing techniques for given contexts of industrial need, taking into account parameters such as precision, speed and manufacturing costs from prototyping to small- and large-scale production.

### Contents of module with emphasis on teaching content

- Conventional machines for micro-engineering, such as milling, grinding, and five-axis machines (20%)
- Electrical Discharge Machining (EDM) (20%)
- Laser machining (20%)
- Measurement techniques for micromachining and microfabrication and in-line or in-process quality and precision control (20%)
- Further machining and fabrication techniques derived from the micro- and nanotechnology sector (20%)

### Teaching and learning methods

Lectures, case studies, and exercises.

### Literature

## Assessment

### Certification requirements

Module uses certification requirements

### Certification requirements for final examinations (conditions for attestation)

Evaluation mode: Exercises and case study reports during the semester (33.3%), written final exam (66.7%).

### Basic principle for exams

**As a rule, all the standard final exams for modules and also all resit exams are to be in written form**

### Standard final exam for a module and written resit exam

**Kind of exam**

written

**Duration of exam**

120 minutes

**Permissible aids**

*Aids permitted as specified below:*

**Permissible electronic aids**

- calculator (without telecommunication functionality)

**Other permissible aids**

- personal summary of two pages A4

### Special case: Resit exam as oral exam

**Kind of exam**

oral

**Duration of exam**

30 minutes

**Permissible aids**

*Aids permitted as specified below:*

**Permissible electronic aids**

- calculator (without telecommunication functionality)

**Other permissible aids**

- personal summary of two pages A4

**Module Description, available in: EN**

# *Mobile Computing*

## General Information

**Number of ECTS Credits**

3

**Module code**

TSM_MobCom

**Valid for academic year**

2021-2022

**Last modification**

2019-10-10

**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 defined below for each location/each time the module is held.
- Documentation is available in the languages defined below. Where documents are in several languages, the percentage distribution is shown (100% = all the documentation).
- The examination is available 100% in the languages shown for each location/each time it is held.

| | Berne | Lausanne | | | Lugano | Zurich | | |
|---|---|---|---|---|---|---|---|---|
| **Instruction** | | | | | | **X** E 100% | | |
| **Documentation** | | | | | | **X** E 100% | | |
| **Examination** | | | | | | **X** E 100% | | |

**Module Category**

TSM Technical scientific module

**Lessons**

2 lecture periods and 1 tutorial period per week

## Entry level competences

**Prerequisites, previous knowledge**

Students have working knowledge in:
• Programming in Java
• 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 acquired competencies

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 Arduino-compatible hardware platform, sensors and actuators.

### Contents of module with emphasis on teaching content

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
• Mini-projects
• Exercises
• Self-Study

### Literature

Android
• IDE https://developer.android.com/studio
• Docs https://developer.android.com/docs
• Source Code https://source.android.com/

Arduino
• IDE https://www.arduino.cc/en/Main/Software#download

## Assessment

### Certification requirements

Module uses certification requirements

### Certification requirements for final examinations (conditions for attestation)

Mini-projects count 30% for final examination mark.

### Basic principle for exams

**As a rule, all the standard final exams for modules and also all resit exams are to be in written form**

### Standard final exam for a module and written resit exam

**Kind of exam**

written

**Duration of exam**

120 minutes

**Permissible aids**

*Aids permitted as specified below:*

**Permissible electronic aids**

No electronic aids permitted

**Other permissible aids**

- Closed book examination
- Personal 1-page summary allowed

**Special case: Resit exam as oral exam**

**Kind of exam**

oral

**Duration of exam**

30 minutes

**Permissible aids**

No aids permitted

MSE MASTER OF SCIENCE IN ENGINEERING

**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**

2021-2022

**Last modification**

2021-01-12

**Coordinator of the module**

Manuel Renold (ZHAW, manuel.renold@zhaw.ch)

**Explanations regarding the language definitions for each location:**

- Instruction is given in the language defined below for each location/each time the module is held.
- Documentation is available in the languages defined below. Where documents are in several languages, the percentage distribution is shown (100% = all the documentation).
- The examination is available 100% in the languages shown for each location/each time it is held.

| | Winterthur | | | |
|---|---|---|---|---|
| **Instruction** | **X** E 100% | | | |
| **Documentation** | **X** E 100% | | | |
| **Examination** | **X** E 100% | | | |

**Module Category**

TSM Technical scientific module

**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 acquired competencies

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.

### Contents of module with emphasis on teaching content

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

### Certification requirements

Module does not use certification requirements

### Basic principle for exams

**As a rule, all the standard final exams for modules and also all resit exams are to be in written form**

### Standard final exam for a module and written resit exam

**Kind of exam**

written

**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)

**Special case: Resit exam as oral exam**

**Kind of exam**

oral

**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 der Umsetzung von Planungs- und Entwurfsprojekten

## Allgemeine Angaben

**Anzahl ECTS-Credits**

3

**Modulkürzel**

TSM_NPlanPro

**Gültig für akademisches Jahr**

2021-2022

**Letzte Änderung**

2018-11-12

**Modul-Koordinator/in**

Dominik Siegrist (OST, dominik.siegrist@ost.ch)

**Erläuterungen zu den Sprachdefinitionen je Standort:**

- Der Unterricht findet in der unten definierten Sprache je Standort/Durchführung statt.
- Die Unterlagen sind in den unten definierten Sprachen verfügbar. Bei Mehrsprachigkeit, siehe prozentuale Verteilung (100% = komplette Unterlagen)
- Die Prüfung ist in jeder je Standort/Durchführung angekreuzten Sprache zu 100% verfügbar.

| | Berne | Lausanne | | | Lugano | Zurich | | |
|---|---|---|---|---|---|---|---|---|
| **Unterricht** | | | | | | | **X** D 100% | |
| **Dokumentation** | | | | | | | **X** D 100% | |
| **Prüfung** | | | | | | | **X** D 100% | |

**Modulkategorie**

TSM Technisch-wissenschaftliche Vertiefung

**Lektionen**

2 Lektionen und 1 Übungslektion pro Woche

## Eintrittskompetenzen

**Vorkenntnisse, Eingangskompetenzen**

- Grundlegende Kenntnisse / Basiskenntnisse in Landschaftsarchitektur und Raumplanung
- Grundlegende Kenntnisse in den Problemstellungen der Nachhaltigkeit

## Kurzbeschreibung der Inhalte und Ziele

Ressourcenknappheit, Klimawandel, aber auch neue Strategien des Bundes (z.B. Biodiversitätsstrategie) verlangen zukünftig verstärkt den Einbezug der Nachhaltigkeit bei Planungs- und Entwurfsprozessen.
Im Modul wird mittels Beispielen aus der Praxis die Berücksichtigung der Nachhaltigkeit bei der Planung und Realisierung von Projekten der Landschaftsarchitektur (Landschaftsplanung, Freiraumentwurf) und der Raumplanung erörtert.

Mit den Studierenden werden wirksame Ansätze, die zu nachhaltigeren Projekten führen, behandelt und im Rahmen der Übungen anhand von ausgewählten, konkreten Vorhaben angewendet.

## Ziele, Inhalte, Methoden

### Lernziele, zu erwerbende Kompetenzen

Fachliche Ziele:

- Kenntnisse von Methoden, Instrumenten und Massnahmen, die zur systematischen Berücksichtigung der Nachhaltigkeit in Projekten in der Landschaftsarchitektur und in der Raumplanung führen. Damit haben Sie die Kompetenz, die Bearbeitung neuer Aufgabenstellungen mit den dafür geeigneten Mitteln anzugehen.
- Kenntnisse über die aktuelle Praxis sowie die Kompetenz, neue Aufgabenstellungen an Best-Practice zu messen und dementsprechend anspruchsvolle Prozesse in die Wege zu leiten.
- Kompetenz, gegenüber Spezialisten in Teilgebieten der Nachhaltigkeit kommunizieren zu können.

Methodische Ziele:

- Fähigkeit, unterschiedliche Anforderungen beteiligter Akteure zu systematisieren und in einem übergeordneten
- Planungsprozess einzubinden und wirksam zu machen.
- Fähigkeit, in komplexen Aufgaben zum Thema Nachhaltigkeit, zielführende Aufgaben (oder Teilaufgaben) und konkrete Massnahmen an spezialisierte Beteiligte zu delegieren.

### Modulinhalt mit Gewichtung der Lehrinhalte

- Einführung
- Teil 1: Theorien und Methoden des nachhaltigen Vorgehens in den Bereichen Landschaftsarchitektur und Raumplanung
- Teil 2: Praxisnahe Instrumente und Massnahmen zur Optimierung von Projekten der Landschaftsarchitektur und Raumplanung bezüglich der Nachhaltigkeit

- Einführung / Theorien und Methoden der Nachhaltigkeit in Planungs- und Entwurfprozessen: 3 Wochen
- Instrumente und Massnahmen zur Nachhaltigkeit in der Raumplanung: ca. 3 Wochen
- Instrumente und Massnahmen zur Nachhaltigkeit in der Landschaftsarchitektur: ca. 6 Wochen
- Kennenlernen von Best Practice im Rahmen von Exkursionen: 2 Wochen

### Lehr- und Lernmethoden

- Vorlesungen (2 Lektionen pro Woche)
- Übungen (1 Lektion pro Woche)

### Bibliografie

Checklisten / Richtlinien / Empfehlungen von Organisationen wie SIA, KBOB, eco-bau, Netzwerk Nachhaltiges Bauen NNBS, usw.; Unterlagen von Best Practice - Beispielen

## Bewertung

### Zulassungsbedingungen

Modul verwendet Zulassungsbedingungen

### Zulassungsbedingungen für die Modulabschlussprüfung (Testatbedingungen)

Besuch der Vorlesungen und der Exkursionen, Abgabe der Übungen.
Die Übungsresultate können bei fehlender Qualität vom Dozent abgelehnt werden und müssen für die Zulassung nachbearbeitet werden.

### Grundsatz Prüfungen

**In der Regel werden alle regulären Modulabschlussprüfungen und Wiederholungsprüfungen in schriftlicher Form gehalten**

### Reguläre Modulschlussprüfung und schriftliche Wiederholungsprüfung

**Art der Prüfung**

schriftlich

**Prüfungsdauer**

120 Minuten

**Erlaubte Hilfsmittel**

Ohne Hilfsmittel

**Spezialfall: Wiederholungsprüfung als mündliches Examen**

**Art der Prüfung**

mündlich

**Prüfungsdauer**

30 Minuten

**Erlaubte Hilfsmittel**

Ohne Hilfsmittel

MASTER OF SCIENCE
IN ENGINEERING

**Modulbeschreibung, verfügbar in: DE, FR**

# *Naturgefahren*

## Allgemeine Angaben

**Anzahl ECTS-Credits**

3

**Modulkürzel**

TSM_NatHaz

**Gültig für akademisches Jahr**

2021-2022

**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 unten definierten Sprache je Standort/Durchführung statt.
- Die Unterlagen sind in den unten definierten Sprachen verfügbar. Bei Mehrsprachigkeit, siehe prozentuale Verteilung (100% = komplette Unterlagen)
- Die Prüfung ist in jeder je Standort/Durchführung angekreuzten Sprache zu 100% verfügbar.

| | Berne | 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

**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, 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

**Zulassungsbedingungen**

Modul verwendet Zulassungsbedingungen

**Zulassungsbedingungen für die Modulabschlussprüfung (Testatbedingungen)**

Testat

**Grundsatz Prüfungen**

**In der Regel werden alle regulären Modulabschlussprüfungen und Wiederholungsprüfungen in schriftlicher Form gehalten**

**Reguläre Modulschlussprüfung und schriftliche Wiederholungsprüfung**

**Art der Prüfung**

schriftlich

**Prüfungsdauer**

120 Minuten

**Erlaubte Hilfsmittel**

*Erlaubt sind die aufgeführten Hilfsmittel:*

**Zulässige elektronische Hilfsmittel**

- Taschenrechner
- Notebook mit ausgeschaltetem WiFi

**Weitere erlaubte Hilfsmittel**

- Vorlesungsunterlagen
- Bücher

**Spezialfall: Wiederholungsprüfung als mündliches Examen**

**Art der Prüfung**

mündlich

**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**

2021-2022

**Dernière modification**

2020-03-04

**Coordinateur/coordinatrice du module**

Davood Farshi (OST, davood.farshi@ost.ch)

**Explication des définitions de langue par lieu :**

- Les cours se dérouleront dans la langue définie ci-dessous par lieu/exécution.
- Les documents sont disponibles dans les langues définies ci-dessous. Pour le multilinguisme, voir la répartition en pourcentage (100% = documents complets)
- L'examen est disponible à 100% dans chaque langue sélectionnée pour chaque lieu/exécution.

| | Berne | 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

**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

### Conditions d'admission

Le module utilise les conditions d'admission

### Conditions d'admission à l'examen de fin de module (exigences du certificat)

Suivi de cours et, le cas échéant, réalisation des travaux personnels demandés.

### Principe pour les examens

**En règle générale, tous les examens de fin de module réguliers et les examens de rattrapage sont organisés sous la forme écrite**

### Examen de fin de module régulier et examen écrit de répétition

**Type de l'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

### Cas spécial: examen de répétition oral

**Type de l'examen**

oral

**Durée de l'examen**

30 minutes

**Aides autorisées**

Sans aides

MSE MASTER OF SCIENCE IN ENGINEERING

**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**

2021-2022

**Last modification**

2019-10-09

**Coordinator of the module**

Axel Seerig (HSLU, axel.seerig@hslu.ch)

**Explanations regarding the language definitions for each location:**

- Instruction is given in the language defined below for each location/each time the module is held.
- Documentation is available in the languages defined below. Where documents are in several languages, the percentage distribution is shown (100% = all the documentation).
- The examination is available 100% in the languages shown for each location/each time it is held.

| | Berne | Lausanne | | | Lugano | Zurich | | |
|---|---|---|---|---|---|---|---|---|
| **Instruction** | | | | | | **X** E 100% | | |
| **Documentation** | | | | | | **X** E 100% | | **X** E 50% |
| **Examination** | | | | | | **X** E 100% | | |

**Module Category**

TSM Technical scientific module

**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 acquired competencies

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.

### Contents of module with emphasis on teaching content

**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

### Certification requirements

Module does not use certification requirements

### Basic principle for exams

**As a rule, all the standard final exams for modules and also all resit exams are to be in written form**

### Standard final exam for a module and written resit exam

**Kind of exam**

written

**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

### Special case: Resit exam as oral exam

**Kind of exam**

oral

**Duration of exam**

30 minutes

**Permissible aids**

No aids permitted

MASTER OF SCIENCE
IN ENGINEERING

**Module Description, available in: EN**

# *Optical engineering and metrology*

## General Information

**Number of ECTS Credits**

3

**Module code**

TSM_OpEngMe

**Valid for academic year**

2021-2022

**Last modification**

2021-01-07

**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 defined below for each location/each time the module is held.
- Documentation is available in the languages defined below. Where documents are in several languages, the percentage distribution is shown (100% = all the documentation).
- The examination is available 100% in the languages shown for each location/each time it is held.

| | Berne | Lausanne | | | Lugano | Zurich | | |
|---|---|---|---|---|---|---|---|---|
| **Instruction** | | | | | | **X** E 100% | | |
| **Documentation** | | | | | | **X** E 100% | | |
| **Examination** | | | | | | **X** E 100% | | |

**Module Category**

TSM Technical scientific module

**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 acquired competencies

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.

### Contents of module with emphasis on teaching content

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, and practical home work.

### Literature

1) Lecturers' scripts with references to current literature,

2) Saleh, Tech: Fundamentals of optics

3) Hecht: Optics

## Assessment

### Certification requirements

Module does not use certification requirements

### Basic principle for exams

**As a rule, all the standard final exams for modules and also all resit exams are to be in written form**

### Standard final exam for a module and written resit exam

**Kind of exam**

written

**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.

**Special case: Resit exam as oral exam**

**Kind of exam**

oral

**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**

2021-2022

**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 defined below for each location/each time the module is held.
- Documentation is available in the languages defined below. Where documents are in several languages, the percentage distribution is shown (100% = all the documentation).
- The examination is available 100% in the languages shown for each location/each time it is held.

| | Berne | Lausanne | | | Lugano | Zurich | | |
|---|---|---|---|---|---|---|---|---|
| **Instruction** | | | | | | **X** E 100% | | |
| **Documentation** | | | | | | **X** E 100% | | |
| **Examination** | | | | | | **X** E 100% | | |

**Module Category**

TSM Technical scientific module

**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 acquired competencies

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

### Contents of module with emphasis on teaching content

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
- Excursion

### 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

### Certification requirements

Module does not use certification requirements

### Basic principle for exams

**As a rule, all the standard final exams for modules and also all resit exams are to be in written form**

### Standard final exam for a module and written resit exam

#### Kind of exam

written

#### Duration of exam

120 minutes

#### Permissible aids

*Aids permitted as specified below:*

#### Permissible electronic aids

No electronic aids permitted

#### Other permissible aids

Open book

**Special case: Resit exam as oral exam**

**Kind of exam**

oral

**Duration of exam**

30 minutes

**Permissible aids**

No aids permitted

MSE MASTER OF SCIENCE IN ENGINEERING

**Module Description, available in: EN**

# *Photovoltaic & storage*

## General Information

**Number of ECTS Credits**

3

**Module code**

TSM_PhotoStor

**Valid for academic year**

2021-2022

**Last modification**

2019-10-11

**Coordinator of the module**

Franz Baumgartner (ZHAW, bauf@zhaw.ch)

**Explanations regarding the language definitions for each location:**

- Instruction is given in the language defined below for each location/each time the module is held.
- Documentation is available in the languages defined below. Where documents are in several languages, the percentage distribution is shown (100% = all the documentation).
- The examination is available 100% in the languages shown for each location/each time it is held.

| | Berne | Lausanne | | | Lugano | Zurich | | |
|---|---|---|---|---|---|---|---|---|
| **Instruction** | | | | | | **X** E 100% | | |
| **Documentation** | | | | | | **X** E 100% | | |
| **Examination** | | | | | | **X** E 100% | | |

**Module Category**

TSM Technical scientific module

**Lessons**

2 lecture periods and 1 tutorial period per week

## Entry level competences

**Prerequisites, previous knowledge**

Basics in Physics, Electronics

## Brief course description of module objectives and content

This course focuses on the advanced understanding of the main components of Photovoltaic PV power generation systems including storage options. The goal goes beyond the competence to design a PV System, like the installer business is used to do, but also to understand how the components are working in detail, either for different PV module technologies as well as for different inverters power electronic topologies ore battery types. Due to the fact, that in Switzerland some employees in the PV sector are not installing any PV system, but working for companies supplying components of turn-key PV module production lines for the world market as well others produce batteries, the main concepts of processes and different concepts of production lines of such components are included in the course  Analysis of the economic parameter of state of art PV systems and batteries, together with environmental key factors like energy pay back times will complete this course. Today the numbers of PV systems including a battery system to use PV electricity at night is growing in Switzerland with an increasing trend. The power electronic concepts, energy flows and control strategies in these grid connected PV and storage systems are discussed as well es levelized cost of electricity.

## Aims, content, methods

### Learning objectives and acquired competencies

The students will be able not only to know the different type of Photovoltaic components, like cell types, module types and inverters as well as battery types on the market, but they should be able to work for companies to develop improved products and system designs on the technology level. Several exercises are performed on applied aspects of solar cells, power electronic components, PV plant system design including batteries as well es levelised cost of electricity.

### Contents of module with emphasis on teaching content

**Chapter 1: Optoelectronic basics of different solar cell technologies 3×3 lectures**

- Introduction: Overview of renewable electricity generation and storage
- Physics of solar irradiation, power and spectra, optical absorption coefficient of several solar cell materials
- Band gap, PN junction, diffusion and drift, diode current voltage characteristics
- Basics of solar cell STC IV curve, equivalent circuit of a solar cell and equations
- Spectral Photocurrent, diffusion length, surface recombination, homo-heterojunctions, tandem solar cell
- State of the art silicon cell, high efficiency silicon cells and loss mechanism as well as other competing technologies

**Chapter 2: Industrial production of standard crystalline silicon, performance and testing 3×3 lectures**

- Cross section of standard crystalline silicon and thin film module, current flow, junction boxes
- Production process standard cryst. Si module: poly Silicon, wafering, cell production, stringing, lamination, testing
- Production technology of thin film solar module technologies
- Requirements on PV modules (IEC standards), quality control in the production line and failure mechanisms of PV modules
- Quality testing
- Outdoor performance, temperature coefficients, collected solar energy versus collector orientation, one and two axis tracking gains, relevant losses like shading, soiling and degradation
- PV system test methods in the field

**Chapter 3: Storage 3×3 lectures**

- Overview storage technologies – power, capacity, storing period
- Lithium standard batterie cell and their components, resources
- Performance, charging, discharging, decrease of capacity, life time, recycling
- Production processes of lithium batteries
- Power electronics and control of batteries

**Chapter 4: PV power electronics – AC/DC inverters and battery storage 2×3 lectures**

- Principles of DC/DC converter and MPP tracking
- PV battery charger, topologies, costs
- DC/AC PV inverter topologies: transformer less concepts and transformer types, DC earth potential
- Control circuits, anti-islanding techniques, power electronic components, efficiency and life time
- Key figures of the PV Inverter; average efficiency calculation methods incl. DC-voltage and partly load condition
- PV inverters on the market, efficiency, costs, regulations and grid code, power optimizer versus string inverter
- PV AC and battery backup system, peak shift power electronic topologies and frequency control
- Integration of fluctuating PV generation into the grid, active and reactive power voltage control, storage and PV forecast

**Chapter 5: PV power plant and storage design and system engineering 3×3 lectures**

- Grid connected AC System design; components, inverter MPP voltage window matching
- Electrical and mechanical installation and system components, residential roof top, utility scale MW plants, grid code
- Software based PV System design, uncertainties of annual PV electricity predictions including storage
- System performance ratio, yield, best practice results, examples of PV system monitoring, annual battery cycles
- Overall cost of photovoltaic electricity generation including storage
- Energy pay-back scenarios, LCA life cycle analysis results including PV plant and battery storage
- Trends of PV and battery market and jobs in Switzerland, global markets, incentives, net present value calculations and politics.

### Teaching and learning methods

- Lecture, discussion and tutorials, exercises, case studies
- Exercises using basic mathematics and several public software tools

### Literature

## Assessment

### Certification requirements

Module does not use certification requirements

### Basic principle for exams

**As a rule, all the standard final exams for modules and also all resit exams are to be in written form**

### Standard final exam for a module and written resit exam

**Kind of exam**

written

**Duration of exam**

120 minutes

**Permissible aids**

*Aids permitted as specified below:*

**Permissible electronic aids**

No electronic aids permitted

**Other permissible aids**

Course documents, lecture notes

### Special case: Resit exam as oral exam

**Kind of exam**

oral

**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**

2021-2022

**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 defined below for each location/each time the module is held.
- Documentation is available in the languages defined below. Where documents are in several languages, the percentage distribution is shown (100% = all the documentation).
- The examination is available 100% in the languages shown for each location/each time it is held.

| | Berne | Lausanne | | | Lugano | Zurich | | |
|---|---|---|---|---|---|---|---|---|
| **Instruction** | | | | | **X** E 100% | | | |
| **Documentation** | | | | | **X** E 100% | | | |
| **Examination** | | | | | **X** E 100% | | | |

**Module Category**

TSM Technical scientific module

**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 acquired competencies

Understand the chemical-physical processes of degradation of polymeric materials.
Master the possible approaches to protect polymeric materials from uncontrolled degradation.

### Contents of module with emphasis on teaching content

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

### Certification requirements

Module does not use certification requirements

### Basic principle for exams

**As a rule, all the standard final exams for modules and also all resit exams are to be in written form**

### Standard final exam for a module and written resit exam

**Kind of exam**

written

**Duration of exam**

120 minutes

**Permissible aids**

No aids permitted

### Special case: Resit exam as oral exam

**Kind of exam**

oral

**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**

2021-2022

**Last modification**

2021-02-10

**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 defined below for each location/each time the module is held.
- Documentation is available in the languages defined below. Where documents are in several languages, the percentage distribution is shown (100% = all the documentation).
- The examination is available 100% in the languages shown for each location/each time it is held.

| | Berne | Lausanne | | | Lugano | Zurich | | |
|---|---|---|---|---|---|---|---|---|
| **Instruction** | | | | | | **X** E 100% | | |
| **Documentation** | | | | | | **X** E 100% | | |
| **Examination** | | | | | | **X** E 100% | | |

**Module Category**

TSM Technical scientific module

**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 acquired competencies

The students are taught modelling methods, structure and control of power electronics circuits based on selected practical and realistic examples.

### Contents of module with emphasis on teaching content

**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

### Certification requirements

Module uses certification requirements

### Certification requirements for final examinations (conditions for attestation)

Two accepted exercises.

### Basic principle for exams

**As a rule, all the standard final exams for modules and also all resit exams are to be in written form**

### Standard final exam for a module and written resit exam

**Kind of exam**

written

**Duration of exam**

120 minutes

**Permissible aids**

*Aids permitted as specified below:*

**Permissible electronic aids**

Personal calculator (no PC)

**Other permissible aids**

Course documents and personal notes

**Special case: Resit exam as oral exam**

**Kind of exam**

oral

**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**

2021-2022

**Last modification**

2021-01-08

**Coordinator of the module**

Adriano Nasciuti (SUPSI, adriano.nasciuti@supsi.ch)

**Explanations regarding the language definitions for each location:**

- Instruction is given in the language defined below for each location/each time the module is held.
- Documentation is available in the languages defined below. Where documents are in several languages, the percentage distribution is shown (100% = all the documentation).
- The examination is available 100% in the languages shown for each location/each time it is held.

| | Berne | 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

**Lessons**

2 lecture periods and 1 tutorial period per week

## Entry level competences

**Prerequisites, previous knowledge**

Basics of electrical laws, circuitries, three-phase systems, components in power grids, energy conversion, electric charge, electric field theory.

## 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 and relevant design rules

- Breakdown theory
- High voltage testing equipment
- 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 acquired competencies

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

### Contents of module with emphasis on teaching content

| Course | Designation | Week |
|---|---|---|
| 0 | **Introduction: Evolution of the power grid**<br>History of power grids / technological milestones, DC and AC Systems, components and devices, market and regulations | 1 |
| 1 | **Fundamentals and devices in high voltage engineering**<br>• Tasks of HVE, Overvoltages origin and control, insulation Coordination (w2)<br>• Properties of insulating materials (w2)<br>• Electric fields and field stress control, (w3)<br>• Break down in gases (homogeneous field – Paschen; inhomogeneous field – Streamer/Leader (w4)<br>• Beakdown in liquids and in solids (w5) | 2,3,4,5 |
| 2 | **HV-testing**<br>• Generation of testing high voltages (DC, AC and impulse)<br>• Partial Discharge measurement | 6,7 |
| 3 | **Interconnected Grids**<br>• Design of T&D Grids<br>• Static load flow analysis, fault analysis<br>• Frequency & active power exchange under control of the TSO<br>• Combined voltage and reactive power control in the T&D Grid<br>• **Excursion Swissgrid Control Center, Aarau / W. Sattinger** | 8,9,10,11 |
| 4 | **Special Chapters on T&D (Transmission and Distribution)**<br>• Grid Dynamics and Stability | |

| | | |
|---|---|---|
| | • Optimized Grid use by “Smart Grid” Applications<br>• Energy storage | 12,13,14 |

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### 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

### Certification requirements

Module uses certification requirements

### Certification requirements for final examinations (conditions for attestation)

### Basic principle for exams

**As a rule, all the standard final exams for modules and also all resit exams are to be in written form**

### Standard final exam for a module and written resit exam

**Kind of exam**

written

**Duration of exam**

120 minutes

**Permissible aids**

*Aids permitted as specified below:*

**Permissible electronic aids**

- Electronical aids: calculator

**Other permissible aids**

access to any resource

### Special case: Resit exam as oral exam

**Kind of exam**

oral

**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**

2021-2022

**Dernière modification**

2021-01-08

**Coordinateur/coordinatrice du module**

Adriano Nasciuti (SUPSI, adriano.nasciuti@supsi.ch)

**Explication des définitions de langue par lieu :**

- Les cours se dérouleront dans la langue définie ci-dessous par lieu/exécution.
- Les documents sont disponibles dans les langues définies ci-dessous. Pour le multilinguisme, voir la répartition en pourcentage (100% = documents complets)
- L'examen est disponible à 100% dans chaque langue sélectionnée pour chaque lieu/exécution.

| | Berne | 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

**Leçons**

2 leçons et 1 leçon de pratique par semaine

## Compétences préalables

**Connaissances préalables, compétences initiales**

Bases des lois électriques, circuits, systèmes triphasés, composants des réseaux électriques, conversion de l'énergie, charge électrique, théorie des champs électriques.

## 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

- Théorie des pannes
- 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 grilles 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**<br><br>Histoire des réseaux électriques / étapes technologiques, systèmes c.a./c.c, composants et dispositifs, marché et réglementation | 1 |
| 1 | **Principes fondamentaux et dispositifs de l'ingénierie de la haute tension**<br>• tâches de haute tension, origine et contrôle des surtensions, coordination de l'isolation (s2)<br>• Propriétés des matériaux isolants (s2)<br>• Champs électriques et contrôle des contraintes de champ, (s3)<br>• Claquage dans le gaz (champ homogène – Paschen; champ non homogène – Streamer/Leader (s4)<br>• Claquage dans les liquides et solides (s5) | 2,3,4,5 |
| 2 | **HV Testing**<br>• Mise en place de tests de hautes tensions  (c.c, c.a. et impulsion)<br>• Mesure de la décharge partielle | 6,7 |
| 3 | **Reseaux interconnectés**<br>• Conception de reseaux T&D<br><br>• Analyse de charge statique, analyse de défaut<br>• Frequency & active power exchange under control of the TSO<br>• Combined voltage and reactive power control in the T&D Grid<br>• **Excursion Swissgrid Control Center, Aarau / W. Sattinger** | 8,9,10,11 |
| 4 | **Chapitres spécifiques sur T&D (Transmission et Distribution)**<br>• Réseaux dynamiques et stabilité<br>• Réseaux optimisés par des applications “Smart Grid”<br>• 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

### Conditions d'admission

Le module utilise les conditions d'admission

### Conditions d'admission à l'examen de fin de module (exigences du certificat)

### Principe pour les examens

**En règle générale, tous les examens de fin de module réguliers et les examens de rattrapage sont organisés sous la forme écrite**

### Examen de fin de module régulier et examen écrit de répétition

**Type de l'examen**

écrit

**Durée de l'examen**

120 minutes

**Aides autorisées**

*Les aides suivantes sont autorisées:*

**Aides électroniques autorisées**

- Electronical aids: calculator

**Autres aides autorisées**

access to any resource

### Cas spécial: examen de répétition oral

**Type de l'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**

2021-2022

**Last modification**

2021-01-12

**Coordinator of the module**

Konrad Stadler (ZHAW, stdl@zhaw.ch)

**Explanations regarding the language definitions for each location:**

- Instruction is given in the language defined below for each location/each time the module is held.
- Documentation is available in the languages defined below. Where documents are in several languages, the percentage distribution is shown (100% = all the documentation).
- The examination is available 100% in the languages shown for each location/each time it is held.

| | Berne | Lausanne | | | Lugano | Zurich | | |
|---|---|---|---|---|---|---|---|---|
| **Instruction** | | | | | | **X** E 100% | | |
| **Documentation** | | | | | | **X** E 100% | | |
| **Examination** | | | | | | **X** E 100% | | |

**Module Category**

TSM Technical scientific module

**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 acquired competencies

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

### Contents of module with emphasis on teaching content

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

## Assessment

### Certification requirements

Module uses certification requirements

### Certification requirements for final examinations (conditions for attestation)

Attendance of at least 9 tutorials.

### Basic principle for exams

**As a rule, all the standard final exams for modules and also all resit exams are to be in written form**

**Standard final exam for a module and written resit exam**

**Kind of exam**

written

**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

**Special case: Resit exam as oral exam**

**Kind of exam**

oral

**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**

2021-2022

**Last modification**

2021-01-22

**Coordinator of the module**

Beat Wellig (HSLU, beat.wellig@hslu.ch)

**Explanations regarding the language definitions for each location:**

- Instruction is given in the language defined below for each location/each time the module is held.
- Documentation is available in the languages defined below. Where documents are in several languages, the percentage distribution is shown (100% = all the documentation).
- The examination is available 100% in the languages shown for each location/each time it is held.

| | Berne | Lausanne | | | Lugano | Zurich | | |
|---|---|---|---|---|---|---|---|---|
| **Instruction** | | | | | | **X** E 100% | | |
| **Documentation** | | | | | | **X** E 100% | | |
| **Examination** | | | | | | **X** E 100% | | |

**Module Category**

TSM Technical scientific module

**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 acquired competencies

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.

### Contents of module with emphasis on teaching content

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

### Certification requirements

Module does not use certification requirements

### Basic principle for exams

**As a rule, all the standard final exams for modules and also all resit exams are to be in written form**

### Standard final exam for a module and written resit exam

**Kind of exam**

written

**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)

### Special case: Resit exam as oral exam

**Kind of exam**

oral

**Duration of exam**

30 minutes

**Permissible aids**

No aids permitted

MSE MASTER OF SCIENCE IN ENGINEERING

**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**

2021-2022

**Last modification**

2021-01-03

**Coordinator of the module**

Wilfried Elspass (ZHAW, wilfried.elspass@zhaw.ch)

**Explanations regarding the language definitions for each location:**

- Instruction is given in the language defined below for each location/each time the module is held.
- Documentation is available in the languages defined below. Where documents are in several languages, the percentage distribution is shown (100% = all the documentation).
- The examination is available 100% in the languages shown for each location/each time it is held.

| | Berne | Lausanne | | | Lugano | Zurich | | |
|---|---|---|---|---|---|---|---|---|
| **Instruction** | | | | | | **X** E 100% | | |
| **Documentation** | | | | | | **X** E 100% | | |
| **Examination** | | | | | | **X** E 100% | | |

**Module Category**

TSM Technical scientific module

**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 Mechanical Engineering from a Swiss University of Applied Sciences. Depending on the specific nature of the course, a Bachelor's degree in Electrical Engineering from a Swiss University of Applied Sciences may also be acceptable, providing that the student has successfully completed modules covering methodological product development in the field of consumer and/or investment goods.

**Development methods and Product innovation**

The students:

- know the purpose and content of project specifications and requirements with respect to user needs,
- know several methods of finding solutions (such as, for example, functional structures active principles, morphological box)
- know the evaluation methods (value benefit analysis, SWOT analysis, etc.)
- have worked in a team on at least one small development project

**Product Lifecycle Management**

The students:

- know the product conception process (in the consumption and/or investment goods sectors)

- know the meaning and purpose of product structures
- have experience in the application of a 3D CAX system (Master Model Approach) or have worked with complex-structured data in other applications

## Brief course description of module objectives and content

Students become acquainted with the product innovation process and its strategic importance for enterprises. They recognize the relationship between the **product innovation** process and the **product development** process. Students will get to know and train typical methods of both processes and will gain deeper knowledge of the subject by doing “hands-on”-project work.

In ***Product Lifecycle Management** (PLM)*, product innovation and development deal with in the context of the entire product lifecycle. The course will focus on the information flow across an industrial enterprise from data considering its organization (local, global), the processes (engineering, sales, manufacturing, purchasing, service), the product characteristics and the different IT tools (CAX, PLM, ERP). Aspects such as product structures, product variants, and release and change processes are important components of PLM. In team and project work, students will solve real life problems in a “laboratory environment”.

## Aims, content, methods

### Learning objectives and acquired competencies

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,
- understand the role of product information and its relationship with industry 4.0,
- can define the most important workflows in concrete application in the product conception stage (as an essential condition for the operation of a PLM system).

### Contents of module with emphasis on teaching content

The module comprises the two main subject areas: “Development methods and product innovation” and “Product lifecycle management”.
The two areas have been divided up into a total of 14 courses, which are listed below. The individual courses all have roughly the same weighting. A “convergence phase” of approximately two lessons is provided for in each area.

**Development Methods and Product Innovation**
- TRIZ/ TIPS (Theory of inventive problem solving): The importance of task formulation, the ideal machine, matrix of contradiction matrix, procedural principles, substance-field analysis, the evolution of technical systems
- Innovation strength
- Classical methods VDI 2221, 2222, 2206
- Product innovation process
- Strategic product planning: potential planning, product planning, business planning, strategic control
- Integrative product development
- Virtual product development tools for components, machines, and manufacturing plants: 3D CAX systems, digital mock-up, model building, model analysis, production (process) planning, product data technology

**Product Lifecycle Management**
- Basic principles: Product model, Product Data Management (PDM), Product Lifecycle Management (PLM)
- Product conception process: Business processes, data-process relationship, from the idea to waste disposal
- Product structures: Variant management, product configuration, material master data, product description data
- Lifecycle: Lifecycles of individual data objects, status of objects
- Release processes and change management
- Data models and authorizations
- Advanced topics of product lifecycle management (industry 4.0)

### Teaching and learning methods

- Ex-cathedra teaching
- Project-oriented work in the form of group work during the students’ self-study hours (students will be assisted through Moodle, presentations, etc.)

### 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

### Certification requirements

Module uses certification requirements

### Certification requirements for final examinations (conditions for attestation)

Two "mini projects" done in groups as the condition for attestation (requirement fulfilled).

### Basic principle for exams

**As a rule, all the standard final exams for modules and also all resit exams are to be in written form**

### Standard final exam for a module and written resit exam

**Kind of exam**

written

**Duration of exam**

120 minutes

**Permissible aids**

No aids permitted

### Special case: Resit exam as oral exam

**Kind of exam**

oral

**Duration of exam**

30 minutes

**Permissible aids**

No aids permitted

MASTER OF SCIENCE
IN ENGINEERING

**Module Description, available in: EN**

# *Parallel and distributed computing*

## General Information

**Number of ECTS Credits**

3

**Module code**

TSM_ProgAlg

**Valid for academic year**

2021-2022

**Last modification**

2021-02-12

**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 defined below for each location/each time the module is held.
- Documentation is available in the languages defined below. Where documents are in several languages, the percentage distribution is shown (100% = all the documentation).
- The examination is available 100% in the languages shown for each location/each time it is held.

| | Berne | Lausanne | | | Lugano | Zurich | | |
|---|---|---|---|---|---|---|---|---|
| **Instruction** | | | | | | **X** E 100% | | |
| **Documentation** | | | | | | **X** E 100% | | |
| **Examination** | | | | | | **X** E 100% | | |

**Module Category**

TSM Technical scientific module

**Lessons**

2 lecture periods and 1 tutorial period per week

## Entry level competences

**Prerequisites, previous knowledge**

- Procedural and object oriented programming
- Software engineering (UML or other)
- Basic notions of algorithms and complexity
- Basic notions of concurrent programming (Threads)

## Brief course description of module objectives and content

The objective of this module is to present an overview of parallel and distributed computing and related algorithms. The first part of the course will be dedicated to the architectures of parallel and distributed infrastructures, the different theoretical models for these architectures and the different programming models and tools for programming such architectures. The second part will be dedicated to the study of a number of classical parallel and distributed algorithms. This course includes practical work to train the student in the use of parallel and distributed computing.

## Aims, content, methods

### Learning objectives and acquired competencies

At the end of the course the student knows:

- The most common parallel and distributed hardware infrastructures
- The different ways to model and efficiently program these architectures
- How to choose the proper parallel or distributed algorithm to write an application for solving a specific problem on a specific architecture
- How to efficiently program this application
- How to assess the performance of this application

### Contents of module with emphasis on teaching content

Introduction

- Different architectures of parallel and distributed infrastructures
- Communications models and communication costs
- Performance metrics for parallel and distributed systems
- Scalability of parallel and distributed systems

Heterogeneous shared memory systems

- Architecture of widely used multi-core systems
- Parallel programming models (OpenMP)

Distributed memory systems

- Communication operations and their costs
- Message passing paradigm (MPI)
- Distributed object paradigm

Parallel and distributed algorithms

- Asymptotic analysis of parallel programs
- Decomposition techniques
- Mapping techniques for load balancing
- Matrix-vector and matrix-matrix multiplication
- Parallel and distributed sorting algorithms
- Parallel and distributed Graph algorithms

### Teaching and learning methods

This course involves theoretical presentations and practical exercises or laboratories. Some of the exercises or laboratories are programming exercises that can be done at home by accessing a parallel and distributed infrastructure made available through the internet.

### Literature

A. Introduction to Parallel Computing, Zbigniew J. Czech, Cambridge University Press, 2017
B. An Introduction to Parallel Programming, 1st edition, Peter Pacheco , Morgan Kaufmann Publishers Inc, 2011

## Assessment

### Certification requirements

Module uses certification requirements

### Certification requirements for final examinations (conditions for attestation)

Some exercises or laboratories could be mandatory.

### Basic principle for exams

**As a rule, all the standard final exams for modules and also all resit exams are to be in written form**

### Standard final exam for a module and written resit exam

#### Kind of exam

written

**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.

**Special case: Resit exam as oral exam**

**Kind of exam**

oral

**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**

2021-2022

**Last modification**

2020-12-14

**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 defined below for each location/each time the module is held.
- Documentation is available in the languages defined below. Where documents are in several languages, the percentage distribution is shown (100% = all the documentation).
- The examination is available 100% in the languages shown for each location/each time it is held.

| | Berne | Lausanne | | | Lugano | Zurich | | |
|---|---|---|---|---|---|---|---|---|
| **Instruction** | | **X** E 100% | | | | | | |
| **Documentation** | | **X** E 100% | | | | | | |
| **Examination** | | **X** E 100% | | | | | | |

**Module Category**

TSM Technical scientific module

**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 reproductibility. Basic knowledge of ISO9001 standards. Knowledge of design/mechanical drawing reading/tolerancing

## Brief course description of module objectives and content

Introduction to quality management

- The quality approach

Problem solving methodology:

- Overview of the most commonly used tools
- Introduction to design of experiments
- Case studies

Introduction to Statistical Process Control

- Fundamentals
- Control charts
- Key parameter identification
- Capability concepts
- Automated process control

Incoming quality control

- Basics
- Formalization of incoming items requirements
- Customer and supplier risk
- Acceptable Quality Level
- 100% quality control vs random sampling quality control

Metrologic performances and measurement capability

- Uncertainty estimation
- Gage repeatability and reproducibility
- Measurement capability index
- Conformity decision

Examples of quality inspection techniques (commonly used in the field of Microengineering)

- Vision-based devices
- Microscopic techniques
- ... other techniques.

## Aims, content, methods

### Learning objectives and acquired competencies

At the end of the module, the students should

- Understand the quality management approach
- Understand and apply the principles of statistical process control
- Able to estimate the capability of a measuring device for the quality control

- Able to make a conformity decision
- Able to evaluate the resulting customer/supplier risks
- Able to set up a sampling plan for a given Acceptable Quality Level
- Know the most commonly used inspection techniques and understand their main limitations.
- Understand the different methods for problem solving
- Understand the main quality wordings.

### Contents of module with emphasis on teaching content

- Introduction to quality management: 10%
- Problem solving methodology: 20%
- Introduction to Statistical Process Control: 20%
- Incoming quality control: 20%
- Metrologic performances and measurement capability: 20%
- Examples of quality inspection techniques: 10%

### Teaching and learning methods

- Lectures
- Exercises
- Case studies
- Self-study of inspection techniques

### Literature

Duret, D. and M. Pillet. « Qualité en Production : De l'ISO 9000 à Six Sigma », Ed. Eyrolles (2005)

## Assessment

### Certification requirements

Module uses certification requirements

### Certification requirements for final examinations (conditions for attestation)

Evaluation mode: 33.3% exercises during the semester, 66.7% written examination

### Basic principle for exams

**As a rule, all the standard final exams for modules and also all resit exams are to be in written form**

### Standard final exam for a module and written resit exam

#### Kind of exam

written

#### Duration of exam

120 minutes

#### Permissible aids

*Aids permitted as specified below:*

#### Permissible electronic aids

- calculator (without telecommunication functionality)
- Two pages personal summary

**Other permissible aids**

No other aids permitted

**Special case: Resit exam as oral exam**

**Kind of exam**

oral

**Duration of exam**

30 minutes

**Permissible aids**

*Aids permitted as specified below:*

**Permissible electronic aids**

- calculator (without telecommunication functionality)
- Two pages personal summary

**Other permissible aids**

No other aids permitted

MASTER OF SCIENCE
IN ENGINEERING

**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**

2021-2022

**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 defined below for each location/each time the module is held.
- Documentation is available in the languages defined below. Where documents are in several languages, the percentage distribution is shown (100% = all the documentation).
- The examination is available 100% in the languages shown for each location/each time it is held.

| | Berne | Lausanne | | | Lugano | Zurich | | |
|---|---|---|---|---|---|---|---|---|
| **Instruction** | | | | | | **X** E 100% | | |
| **Documentation** | | | | | | **X** E 100% | | |
| **Examination** | | | | | | **X** E 100% | | |

**Module Category**

TSM Technical scientific module

**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 acquired competencies

- 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.

### Contents of module with emphasis on teaching content

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

### Certification requirements

Module does not use certification requirements

### Basic principle for exams

**As a rule, all the standard final exams for modules and also all resit exams are to be in written form**

### Standard final exam for a module and written resit exam

**Kind of exam**

written

**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.

**Special case: Resit exam as oral exam**

**Kind of exam**

oral

**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**

2021-2022

**Letzte Änderung**

2018-10-28

**Modul-Koordinator/in**

Stefan Lüthi (HSLU, stefan.luethi@hslu.ch)

**Erläuterungen zu den Sprachdefinitionen je Standort:**

- Der Unterricht findet in der unten definierten Sprache je Standort/Durchführung statt.
- Die Unterlagen sind in den unten definierten Sprachen verfügbar. Bei Mehrsprachigkeit, siehe prozentuale Verteilung (100% = komplette Unterlagen)
- Die Prüfung ist in jeder je Standort/Durchführung angekreuzten Sprache zu 100% verfügbar.

| | Berne | Lausanne | | | Lugano | Zurich | | |
|---|---|---|---|---|---|---|---|---|
| **Unterricht** | | | | | | | **X** D 100% | |
| **Dokumentation** | | | | | | | **X** D 100% | |
| **Prüfung** | | | | | | | **X** D 100% | |

**Modulkategorie**

TSM Technisch-wissenschaftliche Vertiefung

**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, zu erwerbende Kompetenzen

**Übergeordnetes Lernziel:** Die Studierenden sind in der Lage, auf Basis regionalwissenschaftlicher Analysen und Theorien ein Managementkonzept für eine Region zu entwickeln.

**Detaillierte Lernziele:** Die Studierenden sind in der Lage…

- die Bedeutung von Empirie, Theorie und Politik in der Raumentwicklung zu erläutern.
- Kriterien zur Abgrenzung von Regionen zu nennen und anhand von konkreten Beispielen zu illustrieren.
- die Bedeutungsvielfalt des Raumbegriffs zu beschreiben.
- die Komplexitätsebenen des Raumes anhand von Beispielen zu erläutern.
- wichtige Erklärungsgrundlagen (Theorien) für räumliche Entwicklung zu überblicken.
- Lesarten von Metropolregionen zu nennen und deren Bedeutung für die Raumentwicklung darzulegen.
- die Wirkungsweise des Standortwettbewerbs zu erklären.
- die Herausforderungen im Zusammenhang mit dem Fiskalföderalismus zu erläutern.
- den Stakeholder-Begriff zu erklären und eine Stakeholder-Analyse durchzuführen.
- Zentrale Herausforderungen von „Regional Governance“ zu erläutern.
- Ein Management-Konzept 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 Disparitätenausgleich 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 der seit 2008 in Kraft stehenden „Neue Regionalpolitik“ (NRP) sowie dem aktuellen „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

### Zulassungsbedingungen

Modul verwendet Zulassungsbedingungen

### Zulassungsbedingungen für die Modulabschlussprüfung (Testatbedingungen)

Besuch der Vorlesungen und der Übungen

### Grundsatz Prüfungen

**In der Regel werden alle regulären Modulabschlussprüfungen und Wiederholungsprüfungen in schriftlicher Form gehalten**

### Reguläre Modulschlussprüfung und schriftliche Wiederholungsprüfung

**Art der Prüfung**

schriftlich

**Prüfungsdauer**

120 Minuten

**Erlaubte Hilfsmittel**

Ohne Hilfsmittel

### Spezialfall: Wiederholungsprüfung als mündliches Examen

**Art der Prüfung**

mündlich

**Prüfungsdauer**

30 Minuten

**Erlaubte Hilfsmittel**

Ohne Hilfsmittel

MASTER OF SCIENCE
IN ENGINEERING

**Module Description, available in: EN**

# *Systems engineering of safety critical systems*

## General Information

**Number of ECTS Credits**

3

**Module code**

TSM_SafeSys

**Valid for academic year**

2021-2022

**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 defined below for each location/each time the module is held.
- Documentation is available in the languages defined below. Where documents are in several languages, the percentage distribution is shown (100% = all the documentation).
- The examination is available 100% in the languages shown for each location/each time it is held.

| | Winterthur | | | |
|---|---|---|---|---|
| **Instruction** | **X** E 100% | | | |
| **Documentation** | **X** E 100% | | | |
| **Examination** | **X** E 100% | | | |

**Module Category**

TSM Technical scientific module

**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 system 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
- Coordination of 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 acquired competencies

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
- Understanding of system engineering principles
- Understanding of system components qualification
- Understanding of aircraft certification process
- System Thinking

### Contents of module with emphasis on teaching content

Syllabus:

1. Introduction to Safety Critical Systems (SCS): General Concepts, Examples of SCS
2. Introduction to SCS: Complexity, Byzantine Problems, Multidisciplinarity
3. Requirement Engineering
4. Robustness, Redundancy, Dissimilarity and Integrity
5. Manned vs. Unmanned Systems
6. Manned Aircraft: Safety, DAL, Airworthiness
7. Unmanned Aircraft: Concept of Operations, Holistic Approach/SORA, Integration with Manned Aviation
8. System Modeling and Simulation
9. System Testing of SCS
10. Design and Development of Complex HW
11. Design and Development of SW
12. System Thinking
13. Risk Management
14. Team Management
15. Time Management

### 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-4754A - *Guidelines For Development Of Civil Aircraft and Systems*

- Aircraft Design - A Systems Engineering Approach M. H. Sadraey, Wiley Aerospace Engineering

- SAE-ARP4761 - Guidelines And Methods For Conducting The Safety Assessment Process On Civil Airborne Systems And Equipment

- DO-178B, Software Considerations in Airborne Systems and Equipment Certification

## Assessment

### Certification requirements

Module does not use certification requirements

### Basic principle for exams

**As a rule, all the standard final exams for modules and also all resit exams are to be in written form**

### Standard final exam for a module and written resit exam

**Kind of exam**

written

**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

### Special case: Resit exam as oral exam

**Kind of exam**

oral

**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**

2021-2022

**Last modification**

2019-11-07

**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 defined below for each location/each time the module is held.
- Documentation is available in the languages defined below. Where documents are in several languages, the percentage distribution is shown (100% = all the documentation).
- The examination is available 100% in the languages shown for each location/each time it is held.

| | Berne | Lausanne | | | Lugano | Zurich | | |
|---|---|---|---|---|---|---|---|---|
| **Instruction** | | | | | | **X** E 100% | | |
| **Documentation** | | | | | | **X** E 100% | | |
| **Examination** | | | | | | **X** E 100% | | |

**Module Category**

TSM Technical scientific module

**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

West S., Gaiardelli, P., & Saccani, N. (2021). Managing Industrial Services: A Cookbook for Design and Delivery. Springer. Cham.

## 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 acquired competencies

- 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

### Contents of module with emphasis on teaching content

**Lecture 1 Part 1 Introduction to the services for product firms**

- 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 2-7 Part 2 - 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

**Lectures 8-14 Part 3 - Service delivery for value capture, Shaun West**

- Customers
- Organizational structure and culture
- Knowledge and information
- Products and activities
- Competitors, suppliers and partners
- Economics and finance
- Society and the environment.

### Teaching and learning methods

- Lectures
- 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 to the final exam grade.

### Literature


- Annarelli, A., Battistella, C., & Nonino, F. (2019). *The Road to Servitization*. *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

### Certification requirements

Module uses certification requirements

### Certification requirements for final examinations (conditions for attestation)

All students must have successfully competed both the individual and group work.

Individual and group work will contribute to the final exam grade.

### Basic principle for exams

**As a rule, all the standard final exams for modules and also all resit exams are to be in written form**

### Standard final exam for a module and written resit exam

**Kind of exam**

written

**Duration of exam**

120 minutes

**Permissible aids**

*Aids permitted as specified below:*

**Permissible electronic aids**

Open book exam

Calculator

Class notes

Dictionary

**Other permissible aids**

No other aids permitted

### Special case: Resit exam as oral exam

**Kind of exam**

oral

**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

MASTER OF SCIENCE
IN ENGINEERING

**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**

2021-2022

**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 defined below for each location/each time the module is held.
- Documentation is available in the languages defined below. Where documents are in several languages, the percentage distribution is shown (100% = all the documentation).
- The examination is available 100% in the languages shown for each location/each time it is held.

| | Berne | 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

**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 acquired competencies

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.

### Contents of module with emphasis on teaching content

- 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

### Certification requirements

Module does not use certification requirements

### Basic principle for exams

**As a rule, all the standard final exams for modules and also all resit exams are to be in written form**

### Standard final exam for a module and written resit exam

#### Kind of exam

written

#### 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.

**Special case: Resit exam as oral exam**

**Kind of exam**

oral

**Duration of exam**

30 minutes

**Permissible aids**

No aids permitted

MASTER OF SCIENCE
IN ENGINEERING

**Description du module, disponible en: EN, FR**

# *Signal Processing and Transmission*

## Informations générales

**Nombre de crédits ECTS**

3

**Code du module**

TSM_SignProc

**Valable pour l'année académique**

2021-2022

**Dernière modification**

2021-02-10

**Coordinateur/coordinatrice du module**

Heinz Mathis (OST, heinz.mathis@ost.ch)

**Explication des définitions de langue par lieu :**

- Les cours se dérouleront dans la langue définie ci-dessous par lieu/exécution.
- Les documents sont disponibles dans les langues définies ci-dessous. Pour le multilinguisme, voir la répartition en pourcentage (100% = documents complets)
- L'examen est disponible à 100% dans chaque langue sélectionnée pour chaque lieu/exécution.

| | Berne | 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

**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

### Conditions d'admission

Le module n'utilise pas de conditions d'admission.

### Principe pour les examens

**En règle générale, tous les examens de fin de module réguliers et les examens de rattrapage sont organisés sous la forme écrite**

### Examen de fin de module régulier et examen écrit de répétition

#### Type de l'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.

**Cas spécial: examen de répétition oral**

**Type de l'examen**

oral

**Durée de l'examen**

30 minutes

**Aides autorisées**

Sans aides

MASTER OF SCIENCE
IN ENGINEERING

**Module Description, available in: EN**

# *Smart Sensing*

## General Information

**Number of ECTS Credits**

3

**Module code**

TSM_SmartSens

**Valid for academic year**

2021-2022

**Last modification**

2020-12-14

**Coordinator of the module**

Joseph Moerschell (HES-SO, joseph.moerschell@hevs.ch)

**Explanations regarding the language definitions for each location:**

- Instruction is given in the language defined below for each location/each time the module is held.
- Documentation is available in the languages defined below. Where documents are in several languages, the percentage distribution is shown (100% = all the documentation).
- The examination is available 100% in the languages shown for each location/each time it is held.

| | Berne | Lausanne | | | Lugano | Zurich | | |
|---|---|---|---|---|---|---|---|---|
| **Instruction** | | **X** E 100% | | | | | | |
| **Documentation** | | **X** E 100% | | | | | | |
| **Examination** | | **X** E 100% | | | | | | |

**Module Category**

TSM Technical scientific module

**Lessons**

2 lecture periods and 1 tutorial period per week

## Entry level competences

**Prerequisites, previous knowledge**

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.

## Brief course description of module objectives and content

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.

## Aims, content, methods

### Learning objectives and acquired competencies

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

### Contents of module with emphasis on teaching content

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,…
- Micropower generation (1/14)
- Sensors fusion and networks (2/14)

### Teaching and learning methods

This course involves theoretical presentations and practical exercises

### Literature

Lecture slides, references to internet resources and books (e.g. Smart Sensor Systems: Emerging Technologies and Applications Wiley Gerard Meijer, Michiel Pertijs, Kofi Makinwa)

## Assessment

### Certification requirements

Module does not use certification requirements

### Basic principle for exams

**As a rule, all the standard final exams for modules and also all resit exams are to be in written form**

### Standard final exam for a module and written resit exam

**Kind of exam**

written

**Duration of exam**

120 minutes

**Permissible aids**

*Aids permitted as specified below:*

**Permissible electronic aids**

Calculator. No computer, neither smartphone nor smartwatch, no social network.

**Other permissible aids**

Open books.

**Special case: Resit exam as oral exam**

**Kind of exam**

oral

**Duration of exam**

30 minutes

**Permissible aids**

No aids permitted

**Module Description, available in: EN**

# *Smart systems for building*

## General Information

**Number of ECTS Credits**

3

**Module code**

TSM_SmartSys

**Valid for academic year**

2021-2022

**Last modification**

2021-01-04

**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 defined below for each location/each time the module is held.
- Documentation is available in the languages defined below. Where documents are in several languages, the percentage distribution is shown (100% = all the documentation).
- The examination is available 100% in the languages shown for each location/each time it is held.

| | Berne | Lausanne | | | Lugano | Zurich | | |
|---|---|---|---|---|---|---|---|---|
| **Instruction** | | | | | | **X** E 100% | | |
| **Documentation** | | | | | | **X** E 100% | | |
| **Examination** | | | | | | **X** E 100% | | |

**Module Category**

TSM Technical scientific module

**Lessons**

2 lecture periods and 1 tutorial period per week

## Entry level competences

**Prerequisites, previous knowledge**

Basic knowledge about building technology

## Brief course description of module objectives and content

In this module, students shall become acquainted with smart systems that are already or soon to be found in buildings. Those include Building Automation and Control Systems (BACS), Smart Home, IoT-solutions, Energy Management Systems and building security. The students will get to know the purpose, functionality and applications of these systems. In addition, they will perform hands-on experiments with some of them. Also, necessary fundamentals will be addressed including system components, communication technologies and protocols.

## Aims, content, methods

### Learning objectives and acquired competencies

- Become acquainted with smart systems for buildings. Notably Building Automation and Control Systems (BACS), Smart Home, IoT-solutions, Energy Management Systems (EMS) and building security
- Understand the purpose, functionality and applications of these systems
- Acquire the necessary fundamentals. I.e. system components, communication systems and protocols

**Acquired competencies**. The students shall be able to:

- Select and understand smart systems for buildings
- Devise smart systems for a given building

### Contents of module with emphasis on teaching content

1. **Introduction**: History of (smart) buildings, definition and structure of a smart building system, applications overview
2. **Fundamentals**. System components, communication technologies (wired and wireless), protocols
3. **Applications**. Building Automation and Control Systems, Smart Home, Internet of Things, Energy Management Systems, building security
4.

### Teaching and learning methods

- 3 lecture periods per week, with blended exercise sessions and hands-on experiments (case study)
- Teaching: Frontal teaching and storytelling. Discussion of practical examples. Guided learning using lecture notes and textbooks
- Exercises: Solving practical problems under the guidance of the tutors (*coaching*)

### Literature

-

## Assessment

### Certification requirements

Module does not use certification requirements

### Basic principle for exams

**As a rule, all the standard final exams for modules and also all resit exams are to be in written form**

### Standard final exam for a module and written resit exam

**Kind of exam**

written

**Duration of exam**

120 minutes

**Permissible aids**

*Aids permitted as specified below:*

**Permissible electronic aids**

**Other permissible aids**

### Special case: Resit exam as oral exam

**Kind of exam**

oral

**Duration of exam**

30 minutes

**Permissible aids**

*Aids permitted as specified below:*

**Permissible electronic aids**

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**Other permissible aids**

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**Module Description, available in: EN, FR**

# *Software Engineering and Architectures*

## General Information

**Number of ECTS Credits**

3

**Module code**

TSM_SoftwEng

**Valid for academic year**

2021-2022

**Last modification**

2019-11-24

**Coordinator of the module**

Martin Kropp (FHNW, martin.kropp@fhnw.ch)

**Explanations regarding the language definitions for each location:**

- Instruction is given in the language defined below for each location/each time the module is held.
- Documentation is available in the languages defined below. Where documents are in several languages, the percentage distribution is shown (100% = all the documentation).
- The examination is available 100% in the languages shown for each location/each time it is held.

| | Berne | 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

**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
- Basic knowledge of Scrum

## 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 acquired competencies

- 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

### Contents of module with emphasis on teaching content

**Modern Software Engineering**

- Agile Development
  - value creation and innovation
  - risk and complexity in software development
  - agile competence pyramid
- Principles and Practices
  - effective communication among stakeholders
  - project retrospectives, feedback techniques
  - ongoing requirements, solicitation and management
- Modern Software Engineering Methodologies
  - benefits/difficulties and comparison of different approaches (i.e. plan-driven, hybrid and agile)
  - implications for project management
  - incremental planning
- Research in Agile Development

**Software Architectures**

- Role of software architecture and software architects
  - reference models, reference architectures
  - architectural structures and views
  - software architecture documentation
- Advanced design concepts
  - the SOLID principles
  - Attribute Driven Design
  - design by contract
- Architectural patterns
  - for distributed architectures
  - architecture patterns vs design patterns
  - pattern styles
- Selection, creation, and evaluation of software architectures
  - quality attributes
  - architecture analysis methods
- Research in Software Architecture

**Software Evolution**

- 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

### 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

### Certification requirements

Module uses certification requirements

### Certification requirements for final examinations (conditions for attestation)

Assignments are completed in time and passed. Assignments can be oral presentations and written.

### Basic principle for exams

**As a rule, all the standard final exams for modules and also all resit exams are to be in written form**

### Standard final exam for a module and written resit exam

**Kind of exam**

written

**Duration of exam**

120 minutes

**Permissible aids**

*Aids permitted as specified below:*

**Permissible electronic aids**

No electronic aids permitted

**Other permissible aids**

Any paper documentation

### Special case: Resit exam as oral exam

**Kind of exam**

oral

**Duration of exam**

30 minutes

**Permissible aids**

No aids permitted

**Description du module, disponible en: EN, FR**

# Génie logiciel: méthodes de développement et architecture

## Informations générales

**Nombre de crédits ECTS**

3

**Code du module**

TSM_SoftwEng

**Valable pour l'année académique**

2021-2022

**Dernière modification**

2019-11-24

**Coordinateur/coordinatrice du module**

Martin Kropp (FHNW, martin.kropp@fhnw.ch)

**Explication des définitions de langue par lieu :**

- Les cours se dérouleront dans la langue définie ci-dessous par lieu/exécution.
- Les documents sont disponibles dans les langues définies ci-dessous. Pour le multilinguisme, voir la répartition en pourcentage (100% = documents complets)
- L'examen est disponible à 100% dans chaque langue sélectionnée pour chaque lieu/exécution.

| | Berne | 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

**Leçons**

2 leçons et 1 leçon de pratique par semaine

## Compétences préalables

**Connaissances préalables, compétences initiales**

- Conception et programmation orientées selon l'objet dans plus d'un langage de programmation
- Unified Modeling (UML)
- Design Patterns: Elements of Reusable Object-Oriented Software (Gamma, Helm, Johnson, Vlissides; ISBN 0-201-63361-2)
- Notions de gestion des versions et des configurations
- Notions de tests unitaires (par exemple junit ou nunit)
- Connaissance de base de Scrum

## Brève description du contenu et des objectifs

Le module fournit une étude approfondie des sujets sélectionnés dans le domaine du génie logiciel. Ces sujets sont issus des domaines suivants: méthodes de spécification, méthodes de développement agiles, architecture logicielle, évolution du logiciel.

## Objectifs, contenus, méthodes

### Objectifs d'apprentissage, compétences à acquérir

- L'étudiant comprend et peut expliquer les avantages d'une méthodologie de développement itérative et incrémentale.
- En fonction des caractéristiques d'un projet donné, l'étudiant est en mesure de sélectionner, d'adapter et d'appliquer la méthodologie de développement appropriée.
- L'étudiant connaît des principes de conception et d'architecture avancés et peut les utiliser pour diriger la phase de conception d'un système.
- L'étudiant est conscient qu'un logiciel est un système complexe en évolution constante.
- L'étudiant sait comment améliorer, étendre et intégrer des logiciels existants, tout en maintenant leur qualité.

### Contenu des modules avec pondération du contenu des cours

**Génie Logiciel**

- Principes et valeurs des méthodes de développement agiles
  - Création de valeur
  - Gestion du risque
  - Culture d'équipe
  - Relations clients
- Bonnes pratiques et techniques de gestion
  - Gestion de la communication entre parties prenantes
  - Revues de projets
  - Assurance qualité
  - Gestion des changements
  - Planification itérative et incrémentale
- Méthodologies de développement modernes
  - Vue d'ensemble et comparaison de différentes approches
  - Unified Process (UP), eXtreme Programming (XP), Scrum
  - Implications sur la gestion de projet

**Architecture logicielle**

- Le role de l'architecture est des architectes logiciels
  - notion d'architecture
  - modèles de référence, architectures de référence
  - structures et vues architecturales
  - architecture et documentation
  - les roles de l'architecte logiciel
- Principes de conception avancés
  - interface-oriented design
  - couplage et cohésion
  - gestion des dépendances
  - les principes SOLID
  - conception par contrat
- Modèles de conception et d'architecture
  - styles d'architectures
  - modèles pour architectures distribuées
- Sélection, création et évaluation d'architectures logicielles
  - qualités systémiques
  - méthodes d'analyse

**Evolution du logiciel**

- Principes d'évolution
  - Développement, maintenance, évolution
  - "Software aging"
  - Compréhension du code
- Analyse et qualité du logiciel
  - métriques
  - techniques d'analyse et de visualisation
  - contrôle de qualité continu
- Evolution de code hérité
  - Re-Technologies: Reverse Engineering, Re-Engineering, Re-Factoring
  - Re-engineering orienté objet
  - Travailler efficacement avec du code hérité
  - Tester des systèmes hérités

### Méthodes d'enseignement et d'apprentissage

travail personnel, lectures et exercices

### Bibliographie


1. Mary & Tom Poppendiek: Lean Software Development
   Kent Beck: eXtreme Programming Explained 2nd Ed.
2. Ken Schwaber et al, Agile Software Development with Scrum, Prentice Hall, 2002
3. Alistair Cockburn: Agile Software Development
4. Robert C. Martin: Agile Software Development
5. Tom Mens: Software Evolution
6. Doug Schmidt et.al.: Pattern-oriented Software Architecture, Vol. 2
   Frank Buschmann et al: Pattern-oriented Software Architecture, Vol. 4
7. Len Bass, Paul Clements, Rick Kazman: Software Architecture in Practice 2nd Ed.
8. Gernot Starke: Effektive Software Architekturen 2. Auflage
9. Lehmann "Laws of Software Evolution Revisited"
10. Martin Fowler et al, Refactoring
    Joshua Kerievsky, Refactoring to Patterns
11. Michael Feathers, Working Effectively with Legacy Code
12. Andreas Zeller: Why Programs Fail ISBN 1558608664


## Evaluation

### Conditions d'admission

Le module utilise les conditions d'admission

### Conditions d'admission à l'examen de fin de module (exigences du certificat)

Les devoirs ont été réalisés dans les délais et jugés satisfaisants. Les devoirs peuvent être évalués sous forme orale et/ou écrite.

### Principe pour les examens

**En règle générale, tous les examens de fin de module réguliers et les examens de rattrapage sont organisés sous la forme écrite**

### Examen de fin de module régulier et examen écrit de répétition

**Type de l'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**

Documentation papier

### Cas spécial: examen de répétition oral

**Type de l'examen**

oral

**Durée de l'examen**

30 minutes

**Aides autorisées**

Sans aides

MASTER OF SCIENCE
IN ENGINEERING

**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**

2021-2022

**Last modification**

2020-12-24

**Coordinator of the module**

Guido Schuster (OST, guido.schuster@ost.ch)

**Explanations regarding the language definitions for each location:**

- Instruction is given in the language defined below for each location/each time the module is held.
- Documentation is available in the languages defined below. Where documents are in several languages, the percentage distribution is shown (100% = all the documentation).
- The examination is available 100% in the languages shown for each location/each time it is held.

| | Berne | Lausanne | | | Lugano | Zurich | | |
|---|---|---|---|---|---|---|---|---|
| **Instruction** | | | | | | **X** E 100% | | |
| **Documentation** | | | | | | **X** E 100% | | |
| **Examination** | | | | | | **X** E 100% | | |

**Module Category**

TSM Technical scientific module

**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 acquired competencies

- 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

### Contents of module with emphasis on teaching content

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

### Certification requirements

Module does not use certification requirements

### Basic principle for exams

**As a rule, all the standard final exams for modules and also all resit exams are to be in written form**

### Standard final exam for a module and written resit exam

#### Kind of exam

written

#### Duration of exam

120 minutes

**Permissible aids**

*Aids permitted as specified below:*

**Permissible electronic aids**

No aids permitted

**Other permissible aids**

Open book

**Special case: Resit exam as oral exam**

**Kind of exam**

oral

**Duration of exam**

30 minutes

**Permissible aids**

No aids permitted

MASTER OF SCIENCE
IN ENGINEERING

**Module Description, available in: EN**

# *Structural Vibrations*

## General Information

**Number of ECTS Credits**

3

**Module code**

TSM_StrVibr

**Valid for academic year**

2021-2022

**Last modification**

2021-01-12

**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 defined below for each location/each time the module is held.
- Documentation is available in the languages defined below. Where documents are in several languages, the percentage distribution is shown (100% = all the documentation).
- The examination is available 100% in the languages shown for each location/each time it is held.

| | Berne | Lausanne | | | Lugano | Zurich | | |
|---|---|---|---|---|---|---|---|---|
| **Instruction** | | | | | **X** E 100% | | | |
| **Documentation** | | | | | **X** E 100% | | | |
| **Examination** | | | | | **X** E 100% | | | |

**Module Category**

TSM Technical scientific module

**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 a mechanical systems (mass, springs, dampers, natural frequencies,…)
- System Dynamic Analysis: stability and control
- Fourier transform and frequency domain
- Entry-level experience with MATLAB/Simulink and NASTRAN NX

## Brief course description of module objectives and content

Passive vibration control: dynamic isolation, impact alleviation and Tuned Mass Dampers. Dynamic response of elastomeric materials. Numerical modelling of damping in Finite Element packages. Techniques for experimental testing.  Vibrations issues in high-performance machine tools.

## Aims, content, methods

### Learning objectives and acquired competencies

- Consolidate theoretical knowledge on structural vibrations
- Passive solutions for vibration alleviation: dynamic isolation, Impact alleviation, Tuned Mass Dampers
- Numerical modeling by lumped masses and Finite Elements (structural damping)
- Experimental Modal Analysis

### Contents of module with emphasis on teaching content

- Brief theoretical review
- Energy dissipation: viscous and hysteretic damping. Elastomeric material: information available on commercial catalogues and corresponding numerical models
- 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. Dynamic response of a flexible structure interacting with a position-controlled loop. Mention of the interaction with the cutting process: forced response and stability. Damping modelling in machine structure and guideways

### Teaching and learning methods

Frontal theoretical lessons with interaction. Self-developed numerical analysis in MATLAB/Simulink and Siemens Nastran NX.

Group projects under extensive teacher support, possibly with test bench design.

### Literature

Lecture slides and lecture notes.

## Assessment

### Certification requirements

Module uses certification requirements

### Certification requirements for final examinations (conditions for attestation)

The group exercise reports, the group project and the final exam contribute with the same weight to the final mark. Each of those scores alone must be sufficient.

### Basic principle for exams

**As a rule, all the standard final exams for modules and also all resit exams are to be in written form**

### Standard final exam for a module and written resit exam

#### Kind of exam

written

#### Duration of exam

120 minutes

#### Permissible aids

*Aids permitted as specified below:*

#### Permissible electronic aids

calculator

#### Other permissible aids

No other aids permitted

**Special case: Resit exam as oral exam**

**Kind of exam**

oral

**Duration of exam**

30 minutes

**Permissible aids**

No aids permitted

MSE MASTER OF SCIENCE IN ENGINEERING

**Modulbeschreibung, verfügbar in: DE**

# Baudynamik und Erdbebeningenieurwesen

## Allgemeine Angaben

**Anzahl ECTS-Credits**

3

**Modulkürzel**

TSM_StrucEng

**Gültig für akademisches Jahr**

2021-2022

**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 unten definierten Sprache je Standort/Durchführung statt.
- Die Unterlagen sind in den unten definierten Sprachen verfügbar. Bei Mehrsprachigkeit, siehe prozentuale Verteilung (100% = komplette Unterlagen)
- Die Prüfung ist in jeder je Standort/Durchführung angekreuzten Sprache zu 100% verfügbar.

| | Berne | Lausanne | | | Lugano | Zurich | | |
|---|---|---|---|---|---|---|---|---|
| **Unterricht** | | | | | | | **X** D 100% | |
| **Dokumentation** | | | | | | | **X** D 90% | **X** E 10% |
| **Prüfung** | | | | | | | **X** D 100% | |

**Modulkategorie**

TSM Technisch-wissenschaftliche Vertiefung

**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, 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

Die Grundlagen 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 das selbständige Lösen von Übungsaufgaben zum Themenbereich vertieft. Diese werden im Unterricht anschliessend besprochen.

Des Weiteren kommt eine speziell für die Themen entwickelte Lernsoftware (Freeware-NonLin) zum Einsatz, mit deren Hilfe die Studierenden die Systemantwort von einfachen Systemen bei verschiedenen dynamischen Einwirkungen berechnen und die Ergebnisse plausibilisieren können. Dieses ist auch zum Selbsstudium sehr gut geeignet.

### 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

### Zulassungsbedingungen

Modul verwendet keine Zulassungsbedingungen

### Grundsatz Prüfungen

**In der Regel werden alle regulären Modulabschlussprüfungen und Wiederholungsprüfungen in schriftlicher Form gehalten**

### Reguläre Modulschlussprüfung und schriftliche Wiederholungsprüfung

**Art der Prüfung**

schriftlich

**Prüfungsdauer**

120 Minuten

**Erlaubte Hilfsmittel**

*Erlaubt sind die aufgeführten Hilfsmittel:*

**Zulässige elektronische Hilfsmittel**

programmierbarer Taschenrechner

**Weitere erlaubte Hilfsmittel**

ausgeteilte Foliensätze

eigene 10-seitige Zusammenfassung (ohne Beispiele)

### Spezialfall: Wiederholungsprüfung als mündliches Examen

**Art der Prüfung**

mündlich

**Prüfungsdauer**

30 Minuten

**Erlaubte Hilfsmittel**

Ohne Hilfsmittel

**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**

2021-2022

**Letzte Änderung**

2020-12-31

**Modul-Koordinator/in**

Susanne Karn (OST, susanne.karn@ost.ch)

**Erläuterungen zu den Sprachdefinitionen je Standort:**

- Der Unterricht findet in der unten definierten Sprache je Standort/Durchführung statt.
- Die Unterlagen sind in den unten definierten Sprachen verfügbar. Bei Mehrsprachigkeit, siehe prozentuale Verteilung (100% = komplette Unterlagen)
- Die Prüfung ist in jeder je Standort/Durchführung angekreuzten Sprache zu 100% verfügbar.

| | Berne | Lausanne | | | Lugano | Zurich | | |
|---|---|---|---|---|---|---|---|---|
| **Unterricht** | | | | | | | **X** D 100% | |
| **Dokumentation** | | | | | | | **X** D 100% | |
| **Prüfung** | | | | | | | **X** D 100% | |

**Modulkategorie**

TSM Technisch-wissenschaftliche Vertiefung

**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 Planungsmethoden zur Arbeit in grösseren Räumen und mit unterschiedlichen Planungsmassstäben, wie sie beispielsweise in Agglomerationsräumen 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 Gestaltungskompetenzen in Planung, Konzeption und Projektierung vermittelt.
Das Modul behandelt mit Schwerpunkt in der Landschaftsarchitektur, speziell der Freiraum- und Landschaftsplanung insbesondere Ansätze zum ‚konzeptionellen Entwurf' und 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.
In den Übungen werden in der Tradition der Stegreife sogenannte „Instant-Entwürfe“ bearbeitet. Aufgabe in diesen Instant-Arbeiten ist es, sich der integralen Gestaltung der bebauten und nichtbebauten Umwelt auf innovative Art und Weise zu nähern. Dabei ist die Erfahrung wichtig, dass sowohl Formen und Strukturen im grossen Masstab, grössere Räume im kleinen Massstab, als auch Nutzungen, Prozesse und Aufgabenstellungen gestaltet werden können.
Die Übungen haben das Ziel, Ihre Entwurfskompetenz zu fördern sowie ein breites 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 und sich mit sicherer ‚entwerferischer Hand' den Fragestellungen zu nähern, als auch sich Planung und Entwurf als System zu erkennen und für deren Lösung adäquate Prozesse vorzuschlagen.

## Ziele, Inhalte, Methoden

### Lernziele, zu erwerbende Kompetenzen

Fachliche Ziele:

- Kenntnisse über aktuelle Theorien und Methoden in Planung und Entwurf sowie über deren Bedeutung in aktuellen Planungsaufgaben. Damit die Kompetenz, die Aufgabenstellungen mit den dafür geeigneten Methoden zu organisieren.
- Kenntnisse über die aktuelle Praxis sowie die Kompetenz, neue Aufgabenstellungen an Best-Practice zu messen und dementsprechend anspruchsvolle Prozesse in die Wege zu leiten.
- Verstärken der gestalterischen Kompetenz und diese wirksam in kleinmassstäbliche Entwurfsprozesse / Planung grösserer Räume einbringen.
- Kompetenz, sich in interdisziplinären Entwicklungsaufgaben kompetent einbringen zu können und mit anderen beteiligten Entwerfenden und Planungsspezialisten kommunizieren zu können.
- Innovativ selbstständig sowie auch team-orientiert anspruchsvolle Planungsaufgaben bearbeiten können

Methodische Ziele:

- Fähigkeit, unterschiedliche Anforderungen beteiligter Akteure zu systematisieren und in einem übergeordneten Gestaltungsprozess einzubinden und wirksam zu machen.
- Fähigkeit, in komplexen Gestaltungsprozessen, Aufgaben (oder Teilaufgaben) an spezialisierte Beteiligte zu delegieren.

### Modulinhalt mit Gewichtung der Lehrinhalte

- Grundverständnis Landschaft, Einführung Theorien und Methoden, Planungsinstrumente (2 Wochen)
- Planungstheorien und -Methodik, Instrumente (3 Wochen)
- Entwurfstheorien im städtebaulichen und freiraumplanerischen Entwerfen (3 Wochen)
- komplexe Planungs- und Entwurfsmethoden, Multifunktionalität, konzeptioneller Entwurf (2 Wochen)
- interdisziplinäre Zusammenarbeit beim Planen und Entwerfen, Fallbeispiele / Werkstattberichte, Prozessgestaltung und Partizipation (4 Wochen)

### Lehr- und Lernmethoden

- Vorlesungen

- Textexegesen, Übungen, Stegreife
- Werkstattberichte

### Bibliografie


- 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 gestzalten - Entwurfsperspektiven zur Verbindung von Naturschutz und Freiraumnutzung., Birkhäuser Verlag, 2014

## Bewertung

### Zulassungsbedingungen

Modul verwendet Zulassungsbedingungen

### Zulassungsbedingungen für die Modulabschlussprüfung (Testatbedingungen)

Bearbeitung der Übungen (Einzel- und Teamarbeiten). Die Übungsresultate können bei fehlender Qualität vom Dozent / von der Dozentin abgelehnt werden und müssen gegebenenfalls für die Prüfungs-Zulassung nachbearbeitet werden. Eine individuelle Beurteilung von Teamresultaten bleibt vorbehalten.

### Grundsatz Prüfungen

**In der Regel werden alle regulären Modulabschlussprüfungen und Wiederholungsprüfungen in schriftlicher Form gehalten**

### Reguläre Modulschlussprüfung und schriftliche Wiederholungsprüfung

**Art der Prüfung**

schriftlich

**Prüfungsdauer**

120 Minuten

**Erlaubte Hilfsmittel**

*Erlaubt sind die aufgeführten Hilfsmittel:*

**Zulässige elektronische Hilfsmittel**

Keine elektronischen Hilfsmittel zulässig

**Weitere erlaubte Hilfsmittel**

Summary Umfang 2 A4 Seiten (einseitig beschrieben)

### Spezialfall: Wiederholungsprüfung als mündliches Examen

**Art der Prüfung**

mündlich

**Prüfungsdauer**

30 Minuten

**Erlaubte Hilfsmittel**

*Erlaubt sind die aufgeführten Hilfsmittel:*

**Zulässige elektronische Hilfsmittel**

Keine elektronischen Hilfsmittel zulässig

**Andere zulässige Hilfsmittel**

Summary Umfang 2 A4 Seiten (einseitig 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**

2021-2022

**Last modification**

2019-10-11

**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 defined below for each location/each time the module is held.
- Documentation is available in the languages defined below. Where documents are in several languages, the percentage distribution is shown (100% = all the documentation).
- The examination is available 100% in the languages shown for each location/each time it is held.

| | Berne | Lausanne | | | Lugano | Zurich | | |
|---|---|---|---|---|---|---|---|---|
| **Instruction** | | | | | | **X** E 100% | | |
| **Documentation** | | | | | | **X** E 100% | | |
| **Examination** | | | | | | **X** E 100% | | |

**Module Category**

TSM Technical scientific module

**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 acquired competencies

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

### Contents of module with emphasis on teaching content

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 (~4 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 (~4 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
- 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

- Materials Science of Thin Films, 2nd edition, Milton Ohring, Academic Press
- Introduction to Optics, Frank Pedrotti, Pearson
- Optical Thin Films and Coatings, Editors: Angela Piegari, François Flory, Elsevier

## Assessment

### Certification requirements

Module does not use certification requirements

### Basic principle for exams

**As a rule, all the standard final exams for modules and also all resit exams are to be in written form**

### Standard final exam for a module and written resit exam

Kind of exam

written

**Duration of exam**

120 minutes

**Permissible aids**

*Aids permitted as specified below:*

**Permissible electronic aids**

Calculator

**Other permissible aids**

Personal formulary: 4 A4 pages

**Special case: Resit exam as oral exam**

**Kind of exam**

oral

**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**

2021-2022

**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 defined below for each location/each time the module is held.
- Documentation is available in the languages defined below. Where documents are in several languages, the percentage distribution is shown (100% = all the documentation).
- The examination is available 100% in the languages shown for each location/each time it is held.

| | Berne | Lausanne | | | Lugano | Zurich | | |
|---|---|---|---|---|---|---|---|---|
| **Instruction** | | | | | | **X** E 100% | | |
| **Documentation** | | | | | | **X** E 100% | | |
| **Examination** | | | | | | **X** E 100% | | |

**Module Category**

TSM Technical scientific module

**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 acquired competencies

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.

### Contents of module with emphasis on teaching content

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

### Certification requirements

Module does not use certification requirements

### Basic principle for exams

**As a rule, all the standard final exams for modules and also all resit exams are to be in written form**

### Standard final exam for a module and written resit exam

**Kind of exam**

written

**Duration of exam**

120 minutes

**Permissible aids**

*Aids permitted as specified below:*

**Permissible electronic aids**

pocket calculator

**Other permissible aids**

All documents

### Special case: Resit exam as oral exam

**Kind of exam**

oral

**Duration of exam**

30 minutes

**Permissible aids**

No aids permitted

**Modulbeschreibung, verfügbar in: DE**

# *Siedlung und Verkehr*

## Allgemeine Angaben

**Anzahl ECTS-Credits**

3

**Modulkürzel**

TSM_Urban

**Gültig für akademisches Jahr**

2021-2022

**Letzte Änderung**

2018-11-06

**Modul-Koordinator/in**

Carsten Hagedorn (OST, carsten.hagedorn@ost.ch )

**Erläuterungen zu den Sprachdefinitionen je Standort:**

- Der Unterricht findet in der unten definierten Sprache je Standort/Durchführung statt.
- Die Unterlagen sind in den unten definierten Sprachen verfügbar. Bei Mehrsprachigkeit, siehe prozentuale Verteilung (100% = komplette Unterlagen)
- Die Prüfung ist in jeder je Standort/Durchführung angekreuzten Sprache zu 100% verfügbar.

| | Berne | Lausanne | | | Lugano | Zurich | | |
|---|---|---|---|---|---|---|---|---|
| **Unterricht** | | | | | | | **X** D 100% | |
| **Dokumentation** | | | | | | | **X** D 100% | |
| **Prüfung** | | | | | | | **X** D 100% | |

**Modulkategorie**

TSM Technisch-wissenschaftliche Vertiefung

**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, Betriebswirtschaft

## Kurzbeschreibung der Inhalte und Ziele

Das Modul behandelt die Zusammenhänge von Siedlungsentwicklung und Mobilität auf den verschiedenen Planungsebenen. Zielsetzungen und Umsetzungsmöglichkeiten einer nachhaltigen Mobilität sind dabei zentrale Themen. Die Möglichkeiten und Effekte eines nachhaltig wirksamen Mobilitätsmanagements werden anhand von Beispielen thematisiert.

## Ziele, Inhalte, Methoden

### Lernziele, 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

Grundlagen
- Aktueller Wissens- und Forschungsstand
- Zusammenhänge zwischen Raumentwicklung und Mobilität
- Einflussfaktoren der Mobilität
- Mobilitätsverhalten und Verkehrsmittelwahl
- Nachhaltige Mobilität und Raumentwicklung

Siedlungsentwicklung
- Historische und aktuelle Raumtheorien
- Modelle und Konzepte im Fokus von Zentralität, Urbanität und Identität
- Zukunftsfähige Siedlungsstrukturen
- Raum- und Bautypologien in Theorie und Praxis
- Planerische Grundlagen zum nachhaltigen Umgang mit Dichte, Mischung und Nutzflächenbedarf
- Stadtverkehrskonzepte
- Parkraumkonzepte und Parkraummanagement

Standortplanung und Standortentwicklung
- Standortevaluation und Standortbewertung
- Verkehrserzeugung von Nutzungstypen
- Beurteilung der Verkehrsauswirkungen
- Bewertung der Umweltverträglichkeit
- Verkehrserschliessung
- Konzepte für verkehrsintensive Nutzungen

Mobilitätsmanagement
- Bausteine nachhaltiger Mobilität
- Mobilitätsdienstleistungen und -angebote
- Kommunale, standortbezogene und betriebliche Mobilitätskonzepte
- Massnahmenpakete für den Freizeit- und Einkaufsverkehr
- Wirkungen und Effekte von Massnahmen

Verkehrsplanung
- Ebenen und Instrumente der Verkehrsplanung
- Stadt und Verkehr, Stadtverkehrskonzepte
- Parkraumkonzepte und Parkraummanagement
- Rad- und Fussverkehrsplanung
- Transportwesen, Güterverkehr
- Verkehrsmodelle

### 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

**Zulassungsbedingungen**

Modul verwendet keine Zulassungsbedingungen

**Grundsatz Prüfungen**

**In der Regel werden alle regulären Modulabschlussprüfungen und Wiederholungsprüfungen in schriftlicher Form gehalten**

**Reguläre Modulschlussprüfung und schriftliche Wiederholungsprüfung**

**Art der Prüfung**

schriftlich

**Prüfungsdauer**

120 Minuten

**Erlaubte Hilfsmittel**

Ohne Hilfsmittel

**Spezialfall: Wiederholungsprüfung als mündliches Examen**

**Art der Prüfung**

mündlich

**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**

2021-2022

**Last modification**

2021-03-03

**Coordinator of the module**

Hans-Peter Hutter (ZHAW, hans-peter.hutter@zhaw.ch)

**Explanations regarding the language definitions for each location:**

- Instruction is given in the language defined below for each location/each time the module is held.
- Documentation is available in the languages defined below. Where documents are in several languages, the percentage distribution is shown (100% = all the documentation).
- The examination is available 100% in the languages shown for each location/each time it is held.

| | Berne | Lausanne | | | Lugano | Zurich | | |
|---|---|---|---|---|---|---|---|---|
| **Instruction** | | | | | | **X** E 100% | | |
| **Documentation** | | | | | | **X** E 100% | | |
| **Examination** | | | | | | **X** E 100% | | |

**Module Category**

TSM Technical scientific module

**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 and frameworks
  corresponding to chapters 1-5, 7-8, 11 from Markus Dahm, "Grundlagen der Mensch-Computer-Interaktion", Pearson Studium, ISBN 3-8273-7175-9, 2006

## 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 and handwriting recognition as well as several additional sensors. This has fostered innovative ways of user interaction with the information available on these devices that were only 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 completely into a virtual world in order to efficiently interact with the vast amount of available information. In these scenarios, haptic interaction plays a major role.
This module gives a solid introduction into 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 the development of these advanced user interfaces and immersive systems will be given through hands-on exercises and a lab visit.

## Aims, content, methods

### Learning objectives and acquired competencies

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

### Contents of module with emphasis on teaching content

- 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 (50%)
  - Fundamentals of recognition-based UIs (Hidden-Markov Models, Deep Neural Networks)
  - Conversational User Interfaces
  - Gesture Recognition, Handwriting Recognition
  - Multimodal Interfaces, Brain Computer Interface
- Immersive Systems (35%)
  - 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)
  - Introduction to 3D computer graphics (rendering pipeline, photo-realistic and non-photo-realistic rendering, ray-tracing, particle systems, volume rendering)
  - Computer Haptics (human haptic perception, computer haptic interfaces, haptic rendering and applications)

### Teaching and learning methods

- Ex cathedra
- Self study of literature / publications
- Practical exercises

### Literature

## Assessment

### Certification requirements

Module uses certification requirements

### Certification requirements for final examinations (conditions for attestation)

Attendance at practical exercises. Labs will be graded. The lab grades will account for about 20% of the module grade.

**Basic principle for exams**

**As a rule, all the standard final exams for modules and also all resit exams are to be in written form**

**Standard final exam for a module and written resit exam**

**Kind of exam**

written

**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

**Special case: Resit exam as oral exam**

**Kind of exam**

oral

**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**

2021-2022

**Last modification**

2018-11-07

**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 defined below for each location/each time the module is held.
- Documentation is available in the languages defined below. Where documents are in several languages, the percentage distribution is shown (100% = all the documentation).
- The examination is available 100% in the languages shown for each location/each time it is held.

| | Berne | Lausanne | | | Lugano | Zurich | | |
|---|---|---|---|---|---|---|---|---|
| **Instruction** | | | | | | **X** E 100% | | |
| **Documentation** | | | | | | **X** E 100% | | |
| **Examination** | | | | | | **X** E 100% | | |

**Module Category**

TSM Technical scientific module

**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 acquired competencies

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

### Contents of module with emphasis on teaching content

- Introduction: (1/3)
    - 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)
    - 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)
    - 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

### Certification requirements

Module does not use certification requirements

### Basic principle for exams

**As a rule, all the standard final exams for modules and also all resit exams are to be in written form**

### Standard final exam for a module and written resit exam

**Kind of exam**

written

**Duration of exam**

120 minutes

**Permissible aids**

No aids permitted

**Special case: Resit exam as oral exam**

**Kind of exam**

oral

**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**

2021-2022

**Last modification**

2021-02-12

**Coordinator of the module**

Luciano Saperi (ZHAW, sarp@zhaw.ch)

**Explanations regarding the language definitions for each location:**

- Instruction is given in the language defined below for each location/each time the module is held.
- Documentation is available in the languages defined below. Where documents are in several languages, the percentage distribution is shown (100% = all the documentation).
- The examination is available 100% in the languages shown for each location/each time it is held.

| | Berne | Lausanne | | | Lugano | Zurich | | |
|---|---|---|---|---|---|---|---|---|
| **Instruction** | | | | | | **X** E 100% | | |
| **Documentation** | | | | | | **X** E 100% | | |
| **Examination** | | | | | | **X** E 100% | | |

**Module Category**

TSM Technical scientific module

**Lessons**

2 lecture periods and 1 tutorial period per week

## Entry level competences

**Prerequisites, previous knowledge**

The students are expected to have knowledge on the basic modulation schemes including amplitude, frequency and phase.

They must also have studied the fundamentals of coding techniques. Other required competences that may be acquired through personal work are statistics, probabilities, wave theory, Fourier analysis and the OSI reference model.

## Brief course description of module objectives and content

The module starts with the basics of the Physical and Data Link layers of advanced wireless systems.

Then the students will be exposed to the definition or functioning 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 learnt material to compare the existing standards for a given problem in the context of the merits and limitations of each technology.

## Aims, content, methods

### Learning objectives and acquired competencies

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
- · find specific information in the standardisation documents

select the most suitable wireless technology for a practical problem.

### Contents of module with emphasis on teaching content

Common Fundamentals (25%)

Applications, requirements, market and frequency spectrum issues in wireless communications. Wireless receivers and transmitters. Digital modulation and coding. Radio propagation.

Standards(75%)

Introduction to a selection of the most important standards at the time of the course (the actual technologies taught may differ somewhat fom this list) :

- · GPS
- · RFID
- · WLAN / Bluetooth
- · GSM / UMTS / LTE
- · DAB / DVB

etc.

### Teaching and learning methods

- · Lectures
- · Work through exercises or perform simulations under supervision
- · Self-study:
- completion of exercises
- research using the standards documents, online and library resources

analysis of case studies

### Literature

- · Ke-Lin Du, M.N.S. Swamy, „Wireless Communication Systems“, Cambridge, 2010
- · M. Sauter, „From GSM to LTE“, Wiley, 2011
- · Mobile & Wireless Networks and Services, Jean-Frédéric Wagen
- · Digital Communications, J. Proakis, M. Salehi, McGraw-Hill Press
- · Introduction to Communication Systems, F. G. Stremmler, Addison-Wesley
- · Information Transmission, Modulation and Noise, M. Schwarz, McGraw-Hill
- · Principles of Mobile Communication, G. Stuber, Kluwer Academic Publishers
- · Introduction to Space-Time Wireless Communications, A. Paulraj, N. Nabar, D. Gore, Cambridge Press
- · Mobilfunksysteme, C. Lüders, Vogel Verlag
- · Grundkurs Mobile Kommunikationssysteme, M. Sauter, Wieweg Verlag
- · Digitale Signalverarbeitung, D. von Grünigen, Fachbuchverlag Leipzig
- · Standards, e.g. 3GPP, IEEE 802.x, ETS 300 401, ISO-IEC_CD 18000-6C, ISO/IEC FDIS 15693-x: 2000(E),
- · Klaus Finkenzeller, RFID-Handbuch, 3. Auflage, Hanser.
- · WCDMA Requirements and Practical Design, (ed.) R. Tanner, J. Woodard, Wiley
- · J. Schiller, Mobilkommunikation, Addison-Wesley.
- · Digitale Fernsehtechnik in Theorie und Praxis; W. Fischer, 2006 Springer
- · Digital Television; W. Fischer, 2007 Springer
- · Digital Video Broadcasting; U. Reimers, 2005 Springer

Telemetrie mit GSM/SMS und GPS Einführung, J-M Zogg, Franzis Verlag

## Assessment

### Certification requirements

Module does not use certification requirements

### Basic principle for exams

**As a rule, all the standard final exams for modules and also all resit exams are to be in written form**

### Standard final exam for a module and written resit exam

**Kind of exam**

written

**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.

### Special case: Resit exam as oral exam

**Kind of exam**

oral

**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

## Inhaltsverzeichnis