Module Description, available in: EN

Lifecycle Management of Infrastructures

General Information

Number of ECTS Credits

3

Module code

FTP_Life

Valid for academic year

2026-27

Last modification

2025-10-07

Coordinator of the module

Thomas Herrmann (ZHAW, hemm@zhaw.ch)

Explanations regarding the language definitions for each location:

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

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

Module Category

FTP Fundamental theoretical principles

Profile Recommendations

This module is recommended for the following profiles:

	Zurich
Profile	BE, CE

Lessons

2 lecture periods and 1 tutorial period per week

Entry level competences

Prerequisites, previous knowledge

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

MS Excel (implementation of formulae, graphs)

Brief course description of module objectives and content

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

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

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

Aims, content, methods

Learning objectives and competencies to be acquired

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

Module content with weighting of different components

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

Teaching and learning methods

Lecture: Introduction in the relevant concepts with examples

Exercises: applications and use cases

Literature

Supplementary publications. No book that we follow

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

Assessment

Additional performance assessment during the semester

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

Basic principle for exams

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

Standard final exam for a module and written resit exam

Kind of exam

Written exam

Duration of exam

120 minutes

Permissible aids

Aids permitted as specified below:

Permissible electronic aids

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

Other permissible aids

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

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

Special case: Resit exam as oral exam

Kind of exam

Oral exam

Duration of exam

30 minutes

Permissible aids

Aids permitted as specified below:

Permissible electronic aids

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

Other permissible aids

No other aids permitted