International Civil Engineering Study Program
Module Descriptions for Courses Offered in English

Mainz, 13.10.2022

Table of Contents

Building Construction, 6 ECTS

Content:

The lecture will cover the following topics:

- From design to model (actions, requirements, forces and loads, modelling of structures, effects).
- Plane structural systems (general, bar-shaped structural systems, area-shaped structural systems).
- Spatial structural systems (beam grids, space trusses, folded structures, single curved shells, rhombic lamella structures, double curved shells, bar truss shells, suspended roof structures, cable net trusses, membrane trusses, free form finding).
- Spatial bracing and stability (unstable systems, bracing elements, wall and skeletal structures, bracing of skeletal structures, bracing of wall structures)
- Safety concept in civil engineering (general, action and resistance, structure of the verification concept, verification of ultimate and serviceability limit states, design value of actions, simplified combination rule for building construction).
- Design actions on structures (components of Eurocode 1 [as of 2014-07], dead loads according to DIN EN 1991-1-1, live loads according to DIN EN 1991-1-1, snow loads according to DIN1991-1-3, wind loads according to DIN EN 1991-1-4).
- Fundamentals of technical representation (dimensional tolerances, module order, dimensional order, structural drawings, scale levels, drawing sizes, plan content and title block, line types and line thicknesses, views, sectional planes, dimensioning and labelling)
- Building materials (classification of building materials, material characteristics, masonry, concrete - reinforced concrete - prestressed concrete, binders, steel, wood and wood-based materials, glass, plastics).
- Fundamentals of building physics (heat and moisture protection, structural fire protection, sound insulation)
- Interaction between structure and ground (general information, foundations, excavations, foundation underpinning, dewatering, working spaces)
- Walls (masonry made of artificial stones, walls made of concrete and reinforced concrete, walls made of wood and wood materials, partition walls)
- Ceilings (Actions and requirements for ceiling structures, ceilings made of wood, plane solid ceilings, vaulted solid ceilings, suspended ceilings).
- Floors (floor constructions, intermediate and compensation layers, wear layers, installation systems in the floor level, floor coverings)
- Roofs (general, roof coverings, thermal insulation, pitched roofs, flat roofs)
- Stairs (General notes, regulations, stair inclinations, stair rules, load-bearing principles, stair constructions)

Aim of the module: Students comprehend load-bearing elements for building structures and are enabled to design buildings in both planar as well as.
Test performance: 80% Written Exam 120 min and 20% assignment
Requirements: Obligatory: none. Desirable: completed preliminary internship
Duration: 1 Semester
Offered Semester: 1

Physics, 4 ECTS

Content:

The following topics will be covered in the lecture:

Kinematics

- Coordinates and vectors
- Velocity and acceleration
- Superposition of motions
- Translational and rotational motion.

Dynamics

- Newton's laws
- Mechanical forces
- Equilibrium of forces and moments
- Stress and pressure
- Hooke's law and elastic oscillations
- Mechanical work, energy, and power
- Law of conservation of energy
- Momentum and conservation of momentum law
- Rotational motion, angular momentum, and conservation of angular momentum.

Physical material properties

- Density, bulk density, bulk density.
- Stress, pressure, shear stress
- Stress-strain diagram, Young's modulus
- Shear modulus G
- Transverse strain, Poisson's ratio
- Relationship between elastic constants.

Aim of the module:

The student can mathematically describe (proven by examination) natural processes and mechanical material properties on the basis of principles and laws of Newtonian mechanics. With the help of the imparted basics and methods of mechanics (see module content), the students can solve physical/construction physics problems.

Test performance: Written Exam 120 min.
Requirements: None
Duration: 1 Semester
Offered Semester: 1

Traffic Infrastructures, 4 ECTS

Content:

The following content will be communicated to the students:

Field of Road Design

- Planning principles and processes
- Network design
- Basics in driving dynamics
- Horizontal and vertical alignment, design of cross sections
- 3D alignment
- Interchange and intersection design

Field of Traffic Planning

- Planning methodology
- Traffic census, traffic count
- Traffic prognosis
- Principles of traffic flow
- Capacity and level of service of roads
- Design according to the German HBS

Aim of the module:

- Students will hold basic knowledge about planning processes and road design. They will be able to design highways and motorways in horizontal, vertical and 3D alignment as well as cross sections in detail and to perform the related calculations (axis and gradients). They should be able to design interchanges and intersections.

- Students will be able to analyze traffic planning tasks and to develop traffic concepts. They are furthermore able to prepare and to perform each step to fulfill the necessary verifications in the dimensioning process for road traffic infrastructures

Test performance: Final exam
Requirements: None
Duration: 1 Semester
Offered Semester: 2

Building Physics, 5 ECTS

Content:

The lecture will cover the following topics:

Sound insulation

- Fundamentals of sound insulation
- Vibrations, sound waves, acoustical quantities
- Calculation of sound levels
- Basics of indoor acoustics, Sabine's formula
- Structural sound insulation
- Airborne sound insulation and impact sound insulation
- Acoustical properties of building components
- Sound propagation outdoors, point and line sound sources
- Eigenfrequencies of plates, Coincidence effect
- Double shell resonance and double shell sound protection

Thermal insulation

- Basics of thermal insulation
- Heat transfer
- Thermal insulation of individual components
- Use of solar energy
- Energy saving regulations, Annual energy demand
- Evaluation of thermal insulation measures

Humidity protection

- Fundamentals of moisture protection
- Gas laws, behavior of ideal gases and of vapors
- Condensation on surfaces
- Indoor humidity balance
- Water vapor diffusion
- Condensation inside the building component
- Glaser diagram

Aim of the module:

The students are able to solve problems in building physics (proven by examination) with the help of standardized calculation methods. In particular, they are able to determine and evaluate the sound, thermal and moisture properties of a building component and the entire building structure.

Test performance: Written Exam 120 min.
Requirements: None
Duration: 1 Semester
Offered Semester: 2

Solid Construction 1, 5 ECTS

Content:

During the lectures, the following topics are presented:

- Fundamentals of the composite material reinforced concrete.
- Design principles with the inclusion of durability.
- Design methods for verifying the structural safety of reinforced concrete components (bending design, shear force design)
- System assumption and internal force determination for design in reinforced concrete structures
- Reinforcement design
- Drawing representation of reinforced concrete structures

Aim of the module:

After participation in the module courses:

- The students will know the specific properties of the composite material reinforced concrete and the applications derived from them.
- The students will know the basic design procedures for the verifications of load-bearing capacity, serviceability, and durability and can apply them to practical examples.
- Students will be able to detail reinforced concrete components constructively.

Test performance: Written Exam 120 min.
Requirements: Obligatory: participation in Technical Mechanics 1 and 2. Desirable: passed PL in Technical Mechanics 1 and 2
Duration: 1 Semester
Offered Semester: 3

Construction Process Engineering 5 ECTS

Content:

The following topics will be covered in the lecture:

Basic elements of construction
- Labor – Services and costs
- Equipment - types, costs, and services, list of construction equipment
- Materials - types and costs
- Planning using Building Information Modeling - BIM

Concrete and reinforced concrete construction methods, e.g.
- Formwork and scaffolding
- Reinforcement work
- Formwork pressure calculation

Steel construction methods
- Assembly technologies
- Joining technologies

Earthworks methods, e.g.
- Hydraulic excavator and excavator truck operation.
- Soil compaction and soil improvement
- Road construction

Methods of excavation support and special civil engineering, e.g.
- Equipment
- Anchorages
- Injections

Lifting technology methods, e.g.
- Compression or traction hoists
- Tower cranes
- Mobile cranes
- Slinging equipment

Methods of demolition
- Equipment and tools

The overall structure of the construction site
- Site infrastructure and site logistics
- Planning and allocation of site equipment elements

Comparison of costing methods
- Determination of the most economical construction method

Basic principles of costing and pricing

- Economic and temporal classification of cost determination (=calculation)
- Division costing
- Calculation via the bid amount

Aim of the module:

Students are able to (proven by exam)

- Know the essential site equipment elements, basic calculation procedures for determining equipment performance and equipment costs, typical construction and civil engineering process techniques, and be familiar with basic construction estimating. Independently develop and conduct a presentation on the subject area.

Test performance: Written exam 90 min. (80%) and independent presentation (20%).
Requirements: Obligatory: None. Desirable: Passed modules Mathematics 1 and Mathematics 2
Duration: 1 Semester
Offered Semester: 3

Urban Planning, 5 ECTS

Content:

During the lecture the following topics are presented:

Field of Urban Planning

- Layout of urban traffic infrastructures.
- Basics of geometric road design
- Design of roads, junctions and connections in urban context
- Design of public squares considering different functions
- Specific surface structures and materials
- Integration of sustainable traffic modes

Field of Road Pavements

- Principles of pavement structures
- Road materials and layers
- German quality assurance concept
- Design of road pavements according to the German RStO
- Pavement monitoring concepts

Field of Railroad Systems

- Development, legal bases, organization of railroads.
- Railway crossings (road/rail).
- Fundamentals of the wheel/rail system
- Rails and track loading
- Superstructure design and maintenance
- Track curves, alignment, and switches
- Cross-section design
- Earthworks and engineering structures for railroads

Other at a glance (power supply, signals, control and safety technology, vehicle dynamics, railroad operation, station facilities)

Aim of the module:

Students are able to (proven by exam):

Field of Urban Planning

- Students are able to develop design and layout concepts for urban traffic infrastructures (road space, balance of functions and connection of traffic modes).

Field of Road Pavements

- Students are able to design pavement structures and to choose suitable material for each layer. They are furthermore able to develop pavement monitoring concepts and to calculate a pavement maintenance program.

Field of Railroad Systems

- Students should have basic knowledge of the system components of railroads and their functions. In particular, they should be familiar with the structural features of the rail body and the track and be able to assess track designs and constructions in terms of their functional efficiency and serviceability.

Test performance: Written Exam 120 min.
Requirements: None
Duration: 1 Semester
Offered Semester: 3

International Project Management, 5 ECTS

Content:

The following content will be communicated to the students:

- Fundamentals of Project management
  - Project management standards and methods
  - Project organization: structures, processes
- Project Organization
  - Goals and structuring
  - Structural and process organization
  - Information, communication, documentation
  - Management systems and tools Time planning
- Project planning
- Cost Management
  - Cost determination
  - Cost controlling
  - Cash flow planning
- Schedule Management
  - Schedules and their hierarchies
  - Forms of presentation
  - Creation of schedules
  - Deadline controlling
- Project Control & Audit
  - Contract relationships and types of contracts
  - Project execution forms
  - Construction contracts
- New tools and methods
  - Lean Construction Management
  - Building Information Modeling

Aim of the module:

- Students will understand and analyze project management techniques as well as broader management issues.
- Assess the contractual, economic and social impacts of International Projects during their life cycle.
- Students will comprehend the different stages of a project (project initiation, planning, and execution) in the context of International civil and construction engineering.

Test performance: Final exam
Requirements: None
Duration: 1 Semester
Offered Semester: 4

Steel Construction, 5 ECTS

Content:
During the course, the following content will be taught:

- Steel construction in history
- Material properties of steel: material constants, fabrication and constitutive law
- Elastic and plastic material behavior
- Basics of the second order theory and the theory of stability of elastic and rigid beams for different support conditions
- Basics of the torsional buckling of beams
- Code calculation of beams by using first and second order theory beyond the ultimate and serviceability limit states
- Basics auf bolts and weldings
- Capacity of flexible bolted and welded connections
- Construction concepts of steelwork connections
- Steel construction bracings and its structural design

Aim of the module:

- The students have the ability to develop, evaluate, select and calculate regular steel structures. As a result, they can use the Eurocode methods and have the required background and knowledge base in steel construction. Furthermore, they can identify and justify the advantages and disadvantages of different design solutions.

Test performance: Final exam
Requirements: None
Duration: 1 Semester
Offered Semester: 4

Sustainable Built Environment, 6 ECTS

Content:

The module will cover the following subjects:

- Sustainability concept
- Systems-oriented thinking
- Carbon footprints, energy and water considerations
- Technology in building with sustainable materials (bamboo, clay, and wood)
- How to research material beyond approval limits
- How to work transdisciplinary in another language

Aim of the module:

After completing the module, students will be able to:

- understand the importance of sustainability for the environment
- identify the potential for sustainable construction operations in civil engineering
- assess the carbon footprint of buildings and infrastructure
- assess sustainable materials based on their mechanical properties
- offer design and construction solutions to achieve the sustainable development goals
- work within an international team for a joint project

Test performance: A group project study and presentation
Requirements: None
Duration: 1 Semester
Offered Semester: 4

Solid Construction 2, 5 ECTS

Content:

The following topics will be covered in the lecture:

- Supplementary verifications in the ultimate limit state of reinforced concrete components.
- Optimization of reinforcement: tension and shear force cover line.
- Design of components subjected to compressive loads
- Design of foundation components
- Serviceability limit state design: deflection limit, crack width design
- Complex verifications for resource conservation
- Drawing representation of reinforced concrete structures

Aim of the module:

After participation in the module courses, students will be able to:

- Carry out the design and construction of reinforced concrete components using practical examples (e.g., uniaxially tensioned slabs, beams, columns, and foundation components).
- Apply the serviceability checks (e.g., deflection limitation and crack width limitation).
- Apply the design procedures and extended verifications for resource optimization in a meaningful way.

Test performance: Written Exam 120 min.
Requirements: Obligatory: participation in Technical Mechanics 1 and 2. Desirable: passed PL in Technical Mechanics 1 and 2, Solid Construction 1
Duration: 1 Semester
Offered Semester: 4

Facility Management, 5 ECTS

Content:
The following content will be communicated to the students:

- Applied Facilities Management Introduction
- Building Services Space and Weight
- Cooling, Heating, and Ventilation Loads
- Building Services Design (Elec & Water)
- Operational plans
- Maintenance planning
- Repair Planning
- Work control strategies
- Occupant support and customer service
- Regulatory environment
- Indoor environmental health
- Energy management
- Trends in sustainable ('green') building design, operation, and maintenance.

Aim of the module:

Students will be cognizant of the planning process involved in facility management; they will be able to develop an Operation Plan including cost, schedule, and resources.

Test performance: Final exam and project
Requirements: None
Duration: 1 Semester

Introduction of Hydrology, 6 ECTS

Content:

The following subjects will be covered during the lectures:

- Introduction and scope of Hydrology
- Hydrologic cycle
- Hydrological data sources, measurements, and monitoring approaches
- Surface water hydrology; runoff and catchment, hydrographs, hydrographs routing, and reservoir panning
- Groundwater hydrology; groundwater, wells, and aquifers

Aim of the module:

After completing the module, students will be able to:

- Understand the importance of engineering hydrology
- Be familiar with the different phases of the earth's water and associated processes
- Understand the concepts of surface and groundwater hydrology
- Use topographical maps to perform fundamental hydrological analysis
- Use and analyze the hydrological data for the real-world engineering problems

Test performance: Written Exam 120 min.
Requirements: None
Duration: 1 Semester
Offered Semester: 5

Construction Engineering, 6 ECTS

Content:

During the lectures, the following topics are presented:

- Fundamentals of the composite material reinforced concrete.
- Design principles with the inclusion of durability.
- Design methods for verifying the structural safety of reinforced concrete components (bending design, shear force design)
- System assumption and internal force determination for design in reinforced concrete structures
- Reinforcement design
- Drawing representation of reinforced concrete structures

Aim of the module:

After participation in the module courses:

- The students will know the specific properties of the composite material reinforced concrete and the applications derived from them.
- The students will know the basic design procedures for the verifications of load-bearing capacity, serviceability, and durability and can apply them to practical examples.
- Students will be able to detail reinforced concrete components constructively.

Test performance: Written Exam 120 min.
Requirements: Obligatory: participation in Technical Mechanics 1 and 2. Desirable: passed PL in Technical Mechanics 1 and 2
Duration: 1 Semester
Offered Semester: 5

Geotechnical Engineering, 6 ECTS

Content:

The following content is covered within this module:

- General overview of geotechnical engineering
- Index properties, classification, and phase relations of the soil mass
- Concept of total and effective stresses in soils
- Compaction of soils
- Permeability and seepage in soils
- Consolidation of soils
- Lateral earth pressure concepts
- Shear strength of soils
- Stability of slopes

Aim of the module:

The students will be able to

- Understand the essential characteristics and phase relationships of soil
- Differentiate and classify the various types of soils
- Calculate total, effective, and pore water pressures under different conditions of loading and underground water
- Understand the idea behind the compaction process and solve related problems
- Comprehend the water flow theory in soils and solve corresponding one- and two-dimensional seepage problems
- Calculate the consolidation settlement of soils
- Evaluate the shear strength properties of soils for drained and undrained cases
- Identify the laboratory experiments to investigate the strength properties of soils
- Calculate the active and passive lateral earth pressures
- Identify the different types of landslides and perform stability analysis

Test performance: Final exam and a project with a presentation
Requirements: None
Duration: 1 Semester
Offered Semester: 5

Geographical Information Systems, 6 ECTS

Content:

The following content is covered within this module:

- Definition and components of Geographical Information Systems (GIS)
- Applications of GIS in engineering
- Map projections and coordinate systems
- Global Positioning System (GPS)
- Data acquisition with unmanned air vehicles (UAVs)
- Geospatial data types and their basic properties
- Geospatial database systems
- Visualization of spatial data
- Spatial data query and analysis
- Geospatial data analysis
- Application of an open-source GIS software QGIS

Aim of the module:

The students will be able to

- Understand the basics of GIS and its components
- Comprehend the map generation processes, including projections and coordinate systems.
- Identify the use of GPS and UAVs in engineering implementations
- Create and update a geodatabase
- Perform queries in the geodatabase
- Perform geospatial analysis with the vector and raster data
- Produce GIS-based solutions to engineering problems requires geospatial analysis
- Use QGIS software

Test performance: Final exam, project, and computer exercises
Requirements: None
Duration: 1 Semester
Offered Semester: 5

Optimization in Civil Engineering, 6 ECTS

Content:

The following content is covered within this module:

- Introduction to the "optimization" concept in civil engineering and current applications in different sub-branches.
- Critical aspects of optimum design for engineering structures
- Size, shape, and topology optimizations
- Conventional and unconventional optimization methods
- Constrained and unconstrained optimizations
- Utilization of Excel solver and Python programming language in solving the optimization problems

Aim of the module:

The students will be able to

- Understand the optimization concept and its importance in civil engineering
- Learn different optimization algorithms and their implementations for engineering problems that have different characteristics
- Gain the ability to construct mathematical formulations and solution steps for the engineering optimization problems
- Acquire programming abilities in Python language and develop their own computer codes to solve optimization problems

Test performance: Final exam, assignments, and computer exercises
Requirements: Basic understanding of computer programming and familiarity with Microsoft Excel
Duration: 1 Semester
Offered Semester: 5

Study Skills, 5 ECTS

Content:

The following subjects will be covered during the lectures:

- Introduction of scientific work and research methodology
- Types of research methods
- Ethics and plagiarism concepts
- Literature survey
- Citation techniques and implementations
- Presentation of research findings
- Manuscript preparations

Aim of the module:

After completing the module, students will be able to

- Understand the basics of the scientific research
- Learn the steps of research paper preparation
- Compare and understand the different citation approaches
- Perform the literature survey using the various citation databases
- Analyze, evaluate and present their research findings

Test performance: A research report and presentation
Requirements: None
Duration: 1 Semester
Offered Semester: Every Semester