# Structural engineering MSc course descriptions (from September 2017)

**Advanced mathematics**
BMETE90MX33 3 hours / 3 credits
Heat equation on an interval. The wave equation on an interval. The wave equation on the line. Convolution Fourier transform. The fundamental subspaces of a matrix. Orthogonal projection to a subspace. Power method. Singular value decomposition. Pseudoinverse.
*Literature:*
Howard Anthon, Robert C. Busby (2003) Contemporary Linear Algebra, Wiley.
T.W. Körner (1988) Fourier Analysis, Cambridge.
T.W. Körner (1993) Excercises for Fourier Analysis, Cambridge.

**Physics laboratory**
BMETE11MX22 1 hour / 1 credit
Measurement of the eigenmodes of a vibrating string by an oscilloscope. Study of the excited vibration of a mass on a spring with the help of a computer controlled ultrasonic distance detector. Basic measurements in optics (lenses, prism, polarization, diffraction). Measurement of submicron expansions (thermal expansion, magnetostriction) by Michelson interferometer. Measurement of specific heat and the heat of fusion in a stainless steel vacuum flask. Study of a solar collector model system.

**Accounting, controlling, taxation**
BMEGT35M014 2 hours / 2 credits
and
**Corporate Finance**
BMEGT35M411 2 hours / 2 credits
The main issues of 'window dressing' and their interpretation through financial ratio analysis and interpretation. The cost volume profit analysis and its relationship with costing and pricing decision-making. The operational and capital budgetary process in an international context and its advisory role through the process of variance analysis. The best international accounting practice both at the functional, planning and strategic stages. The wider developmental strategic and ethical international issues concerned with managerial accounting.
*Literature:*
Power Point presentations of the sessions and handouts distributed in the classroom.
Williams, Haka, and Bettner (2007) Financial and Managerial Accounting: The Basis for Business Decisions (14th Edition). McGraw Hill.
Drury (2004): Management and Cost Accounting (6th Edition), Thomson Publishing

**Engineering ethics**
BMEGT41M004 2 hours / 2 credits
The purpose of this course is to help future engineers be prepared for confronting and resolving ethical issues that they might encounter during their professional careers. It gives an overview of the moral problems engineers face in their different social roles, and it provides conceptual tools and methods necessary for pursuing those issues. Topics include engineering professionalism; social roles of engineers; ethical theories; ethical decision making techniques; social impacts of engineering, professional organizations; code of ethics of engineering societies. Case studies are discussed in a practice oriented approach. The primary goal is to stimulate critical and responsible reflection on moral issues surrounding engineering practice.
*Literature:*
Fleddermann, C.B. 2007. *Engineering Ethics* (3rd ed.) Upper Saddle River, N.J.:Prentice Hall.
*Code of Ethics;* American Society of Civil Engineers, http://www.asce.org/Leadership-and-Management/Ethics/Code-of-Ethics/

**Decision supporting methods**
BMEEPEKMST4 2 hours / 2 credits
The aim of the course is to familiarize students with some practically used or usable mathematical models in the field of construction management, scheduling and tendering process. The course covers a wide variety of topics dealing with least cost scheduling problems, multi attribute decision models, learning curves. There are two computational modeling tasks as homework assignments. Final grades will be based on the two assigned tasks 15-15% and test 70%.
*Literature:*
Levente Mályusz: Decision Support Methods, www.ekt.bme.hu.
Ravindra K. Ahuja, Thomas L. Magnanti, James B. Orlin: Network Flows: Theory, Algorithms, and Applications, Prentice Hall 1993.
Miklós Hajdu: Network Scheduling Techniques for Construction Project Management, Kluwer 1997.

**Methods in engineering analysis**
BMEEOHSMK51 2 hours / 3 credits
The objective of the course is that the student shall understand and be aware of the principles and basis of methods of engineering analysis and assessments, statistics, probability theory, reliability analysis, numerical methods, risk analysis, optimization and digital sign processing. It also serves as the basis of the subsequent MSc subjects on modelling, design and programming.

**Numerical methods**
BMEEOFTMK51 3 hours / 4 credits
The aim of this course is that students learn and apply skill level at solving engineering problems numerically on computers, as well as to introduce the basics of Building information Modelling (BIM). At the beginning of the semester BIM systems and their application opportunities are introduced, later the principles of the most relevant numerical techniques including their advantages, disadvantages and applicability are presented during laboratory practices. Students may learn and apply mathematical procedures suitable for solving and visualizing technical problems on computer practices. A further purpose of this course is to prepare the students for later independent research.

**Geodynamics**
BMEEOGMMS51 2 hours / 3 credits
The subject focuses on the understanding of dynamic effects that are transferred from the geological environment to the engineering structures. The students are getting familiar with geophysics, rock stress and its interpretation and graphic representation, local and world-scale (Word Stress Map). The deformations caused by seismic waves in igneous, metamorphic and sedimentary rocks also form part of the subject, as well as deformations caused by historic earthquakes. A main topic is the understanding of the Earth's structural geology and seismicity with special emphasis on the Carpathian basin. The lectures will help in learning the detection methods of seismic waves and acquire the information content of the seismograms. By completing the course the students will able to determine the parameters that are necessary for appropriate seismic design. Engineering seismological approach will help the students to place the structures in the geological environment allowing the minimal risk and reducing the cost by proper seismic design.

**FEM for civil engineers**
BMEEOTMMS51 4 hours / 5 credits
The goal of the subject is to present the theoretical bases of the finite element method and its practical application to typical structural engineering problems. The classic approach to the finite element method will be followed in presenting the basic idea of the method, the element types, the applied interpolation functions, the various matrices and the basic steps of their construction, the resulting system of equation and the solution techniques of it. All these will be demonstrated and practiced

through examples, showing how the various structure types (trusses, beams, frames, plates, shells, 3D solids) can be analysed. An introduction to nonlinearities from various sources will be given, with special focus on the effect and handling of geometric nonlinearity. Beside the static problems, the application of the finite element method to some heat transfer problems of the structural engineering practice will also be discussed.

**Soil-structure interaction**
BMEEOGMMS52 4 hours / 5 credits
The scope of the subject is to teach the students the fundamentals of geotechnics required for structural design, such as familiarity with and use of EC7. These include geotechnical categorization; types and contents of geotechnical documentations; geotechnical and structural design of piles for different loading types, design of soil-supported ground slabs along with the determination of the values of subgrade reaction modulus; design of pile-supported ground slabs and "rigid inclusion" slabs; structural design of excavation support structures, determination of soil reaction moduli along with their effect on deformations and internal forces; design of ground anchors; geotechnical questions of bridge abutments; and the basics of soil dynamics and geotechnical earthquake engineering.

**Structures I.**
BMEEOHSMS51 4 hours / 5 credits
The objective of the subject is the modelling of beams, membrans, plates and the simplest circular shell structures. The most important analytical solutions, the basics and assumptions of numerical solutions are introduced. It's presented that the different structural considerations can be implemented in the design codes and regulations. The fundamental membrane solutions, shear lag effect, effective width, shear deformation, second-order effects and large deformations, anisotropy and the vibration of floors are also analysed. The main focus of the subject is the analysis of plates and slabs.

**Numerical modeling project**
BMEEOTMMS5P 2 hours / 5 credits
The goal of the subject is that the students solve a civil engineering problem the complexity of which is in accordance with the level of the MSc course and with the credit and time-frame of the subject. The problem should be solved by high level application of some analytical or numerical method (e.g., finite element method). The problem is solved by the individual work of the student, helped by a tutor.

**Structural dynamics**
BMEEOTMMN-1 3 hours / 4 credits
The purpose of the course is that students become familiar with the dynamic tasks occurring in the structural engineering practice, and the mechanical-mathematical background of their solution methods. There will be emphasized: the differential equations used to describe the continuum of mechanical vibration and their analytical and numerical solution methods, free vibration of multiple degrees of freedom systems and its approximate solutions, computation methods of mass and stiffness matrix of the (finite element method) discretized structures, taking into account the damping, dynamic issues supporting effect of the soil, the mechanical background of earthquake analysis of structures and the efect of wind.

**Nonlinear mechanics**
BEMEOTMMN-2 3 hours / 4 credits
The subject is the continuation of the Strength of Materials subjects taught in the Civil Engineering BSc programme on the expansion and the generalization of its linear models. Its two main goals are:
A./ the students will become acquainted with the approaches of nonlinear mechanics, its variables used in theoretical and numerical modeling, and the principal equations required for the formulation of nonlinear mechanical problems. The application of various nonlinear strain and stress tensors is analysed, furthermore the origination of the equations in the form of a general boundary and/or initial value problem or as a variational problem formthe most important types of engineering structures. B./

The second important goal is to get to know the theoretical background required for the - primarly finite element -analysis of nonlinear problems, with an emphasis on the tehoretical and practical differences between the linear and nonlinear analysis.

**Plasticity**

BMEEOTMMN61 2 hours / 3 credits

The purpose of the subject is, that the students acquire the basic concepts and methods of plasticity. In the frame of this they will get to know the material models, yield and hardening conditions of plasticity. The torsion problem of prismatic bars, and planar problems of solids will be learnt through examples and applications. There will be an emphasis given to the plastic load bearing capacity of elasto-plastic frame structure, and their limit states.

**Nonlinear FEM**

BMEEOTMMN62 2 hours / 3 credits

The main goal in this subject is, that the students get to know the solution with the finite element method (FEM) of the nonlinear mechanical problems typical in engineering practice, alongside with the mathematical background of the solutions. The specialities of one- and multidimensional problems will be discussed. There will be interpreted the nonlinear behaviour of the most important stuctures (beams, frames, plates, shells) from the practical use, with a focus on the important questions about the effect of large displacements and plastic deformations. Beyond the general nonlinearity the students will learn the special techniques (finite strip method, finite volume method, boundary element method, meshfree
methods, smooth and finite particle methods, etc.). As an organic part of the course, students will analyse case studies solved by computer simulation, in order to deeper understand the modeling techniques of various nonlinearities and connect theory and practice.

**Analysis of rods and frames**

BMEEOTMMN63 2 hours / 3 credits

The goal of the subject is to get students to know the modeling possibilities of rod structures appearing in the structural engineering practice, the theoretical background of the models. Based on the linear mechanical model of the generalized beam element students will be acquainted with the calculation of the stiffness matrix and load vector of frame structures and their generalizations e.g. trusses, grids, and infilled frames. Higher-order analysis of kinematically indeterminate structures with high importance in engineering practice will be learnt.

**Discrete element method**

BMEEOTMMN64 2 hours / 3 credits

The goal of the subject is to get students to know the basics of the concept and methodology of the discrete element methods (DEM) occurring in the structural engineering practice, and allow an insight to the operation of a discrete element software. Students will learn the most important variations DEM, th applied equations of motion, their numeric solution methods with the limits of applicability, advantages and disadvantages. Students will analyse the model of a simple engineering problem.

**Applied fracture mechanics**

BMEEOHSMT61 3 hours / 4 credits

The objective of the subject is the presentation of the basic theories and methods of fracture mechanics, and their application in the field of civil engineering. The basic definitions of fracture mechanics and their mathematical representation, and the basic calculation methods are also introduced. The design methods in Eurocode based on fracture mechanics are presented.

**Prestressing technologies**
BMEEOHSMT62 2 hours / 3 credits
The objective of the subject is the presentation of the prestressed structures and its design procedures. The main types of prestressed structures, applied materials and prestressing technologies are introduced. The effect of prestressing for the design procedures is discussed. Special prestressed structural systems and prestressing technologies for bridges are also presented. The Eurocode based design procedures and their practical application are showed.

**Structures project**
BMEEOHSMS5P 2 hours / 5 credits
The objective of the course is that the student shall solve a structure-specific problem, by which his/her problem solving skills are improved, gains the skill of literature review, aims the comprehensive thinking. Aim is that the student becomes able to efficiently solve problems arising during design or research tasks. The subject of the study can be any structure-related problem discussed and agreed with the supervisor; not exclusively: modelling, analysis and/or design of part of or whole structural system, experimental analysis; research, research and development or expert design task; based on individual problem statement or joining to ongoing research program.

**Seismic design**
BMEEOHSMT-3 3 hours / 4 credits
The objective of the course is that the student shall understand the description and characterization of seismic effects and consequences, shall be aware of the basic principles of vibration analysis, behaviour, analysis and design of single and multi degree of freedom elastic or elasto-plastic structural systems, simplified modelling techniques of structures, principles of design regulations and codes, behaviour and design methods of quasi-elastic and dissipative structures.

**Stability of structures**
BMEEOHSMT-2 3 hours / 4 credits
The objective of the subject is the presentation of the most important problems in the stability analysis and stability design of steel structures. The student will learn the terminology of theory of engineering stability and theory of torsion of thin-walled members, as well as their practical importance and applicability. The most relevant modes of instabilities of engineering steel structures will be presented (flexural buckling, flexural-torsional buckling, lateral-torsional buckling, plate buckling). To each instability mode the student will learn the background and mathematical bases, as well as the Eurocode design procedures and their practical applications.

**Strenthening of structures**
BMEEOHSMT63 2 hours / 3 credits
The objective of the subject is the presentation of the diagnostic of existing structures with different materials and structural systems, the possible causes of structural damages, methods of reinforcement and the most common building materials. According to this, the tools and steps of the diagnostic of existing structures, the verification of the structure's load bearing capacity, the basic principles of qualification, the required content of expertise, the methods of reconstruction and reinforcement, the most common ways of structural damages (direct and indirect) and the different structural systems of existing residential buildings are presented during the semester. Case studies are also introduced.

**Structures II.**
BMEEOHSMC-1 3 hours / 4 credits
The objective of the subject is the presentation of the hazards, structural reliability and their role in structural design. The behaviour of complex structures, curved steel and concrete shells, 3D truss structures and their design are introduced. The most important analytical solutions and the basics and assumptions of numerical solutions are presented. Additionally, the design methods of cable and membrane structures are concluded in the subject.

**Geotechnical and engineering geological project**
BMEEOGMMS53 2 hours / 5 credits
The goal of the subject,that the students are getting familiar with the geotechnical and engineering geological design process. The students get to know through a project work the geotechnical, engineering geological data collection, modelling, design and calculation tasks. Furthermore, they get familiar with practical application of analytical and numerical design methods.

**Engineering geology MSc.**
BMEEOGMMG-1 3 hours / 4 credits
The goal of the subject, that the studnets get familiar with the physical properties of the main type of rocks. It is introducing to the students the most common types of landslide problems, their solutions, the risk analysis in the field of engineering geology, the importance of the in-situ stresses in the rock mechanical design. The students get to know the theoretical background of the rock mass classification systems, the relations between the different rock mass classification systems. They learn to use these systems for rock engineering design in normal and weak rock masses. With the completion of the subject they learn to use the introduced design methods and monitoring through examples.

**Environmental geology**
BMEEOGMMG-2 3 hours / 4 credits
The students are getting familiar with the pollution sources that endanger environment and understand the mitigation methods. The subject provides information on the transport mechanism of pollutants in subsurface area and the conditions that influence their dispersion. The studied topics include the legal regulation of environmental geological surveys and the geological constrains of environmental impact assessment of existing and planned engineering structures. By studying remediation techniques the course leads a better understanding of various methods of pollutant removal from the geological environment. Special focus area is mining related pollution and site remediation. Waste disposal and pollution control also form important parts of the course. The exercise classes help students to learn environmental geological practice that helps in the sustainable operation and design of engineering structures. The course provides perspectives in environmental pollution reduction and in cost effective mitigation of polluted sites.

**Geotechnical design**
BMEEOGMMG-3 3 hours / 4 credits
The goal of this course is to acquire knowledge of the basics of geotechnical design, geotechnical approaches according to Eurocode 7, requirements of the contents of infrastructural and structural plans, methodology of soil borings and complex laboratory tests, evaluation of in-situ tests results, design optimization of large-scale geotechnical projects, soil anchor and soil nail design, jet-grouting technology and its design, design and qualification of subgrades and subbases, design of monitoring systems and design based on observation.

**Earthworks of infrastructures**
BMEEOGMMG-4 3 hours / 4 credits
The aim of the course is that the students understand the geotechnical aspects of infrastructures' earthworks. In this course the student gets to know the effect of earthquakes on subsoil and earthworks (damages, stability calculation, liquefaction, case studies, failures), the concepts of embankment construction on soft soils (primary consolidation, secondary compression, wick drains, vibroflotation, dynamic compaction, dynamic replacement, staged construction), design, construction and control of soil and rock dams and flood protection dikes, and calculation of quick condition and sandpiping.

**Tunneling**
BMEEOGMMG61 2 hours / 3 credits
The goal of this course is to teach the most important segments of the tunnel design and the construction. The course is focus on the frequently used tunneling technics and calculation methods in both soil and

rock environment. During the semester the student calculates the most important stresses on the tunnel, using both numerical and analytical methods. The tunnel designs are shown in a detailed both the construction and operation system, as well.

**Hydrogeology**
BMEEOGMMG62 2 hours / 3 credits
The goal of the subject, that the students getting familiar with the geological, geophysical methods of water exploration, the stratigraphy of ground, karstic and fissure water, the origin and properties of ground water (temperature, chemical nature). The students acquire the methodology for recharge, water flow, infiltration calculations, furthermore the water level and discharge measurements, water tracing and modelling the water flow in karstic and jointed rock mass. They learn the properties, classification and usage of thermal water. The subject introduce to the students the regional water management, the hydrogeological effect of mining and civil engineering, protecting of water resources through case studies. They get information about the dewatering methods and learn the usage of hydrogeological models for civil engineering works.

**Numerical methods in geotechnics**
BMEEOGMMG63 2 hours / 3 credits
The aim of the course is that the students get to know the use of numerical methods that aid the geotechnical and engineering geological design. The students get familiar with the advantages and disadvantages of analytical methods and applications of finite element methods to geotechnical and engineering geological problems by using different commercially available software. The students get to know the special elements and material models that are typically used in case of FE modelling of geotechnical problems. The students get to know the most frequently used rock mechanical methods for modelling fractured rocks.

**Engineering geology of Hungary**
BMEEOGMMG64 2 hours / 3 credits
The goal of the subject, that the students getting familiar with the main geological regions of Hungary and gain the required regional and local geological knowledge for engineering design and operate of facilities. Furthermore it is also an important additional part of the course to present knowledge about the main geological structures of Hungary, the location of the most important soils and rocks, the surface-forming processes with anthropogenic effects, the most important relief forms caused by flowing water, wind. Introduces to the students the karstic landforms, and the surface forming effect of mining, road, railway and other civil engineering constructions. Furthermore the subject give comparison between the Hungarian and well-known international geological units and landforms.

**Diploma project**
BMEEODHM__ 20 credits
The objective of the Diploma project is that the student should prove the fulfilment of the general requirements of the master programme; the Diploma project enables the intense work supported by the supervisor. The thesis topic should be defined according to the training and outcome requirements.