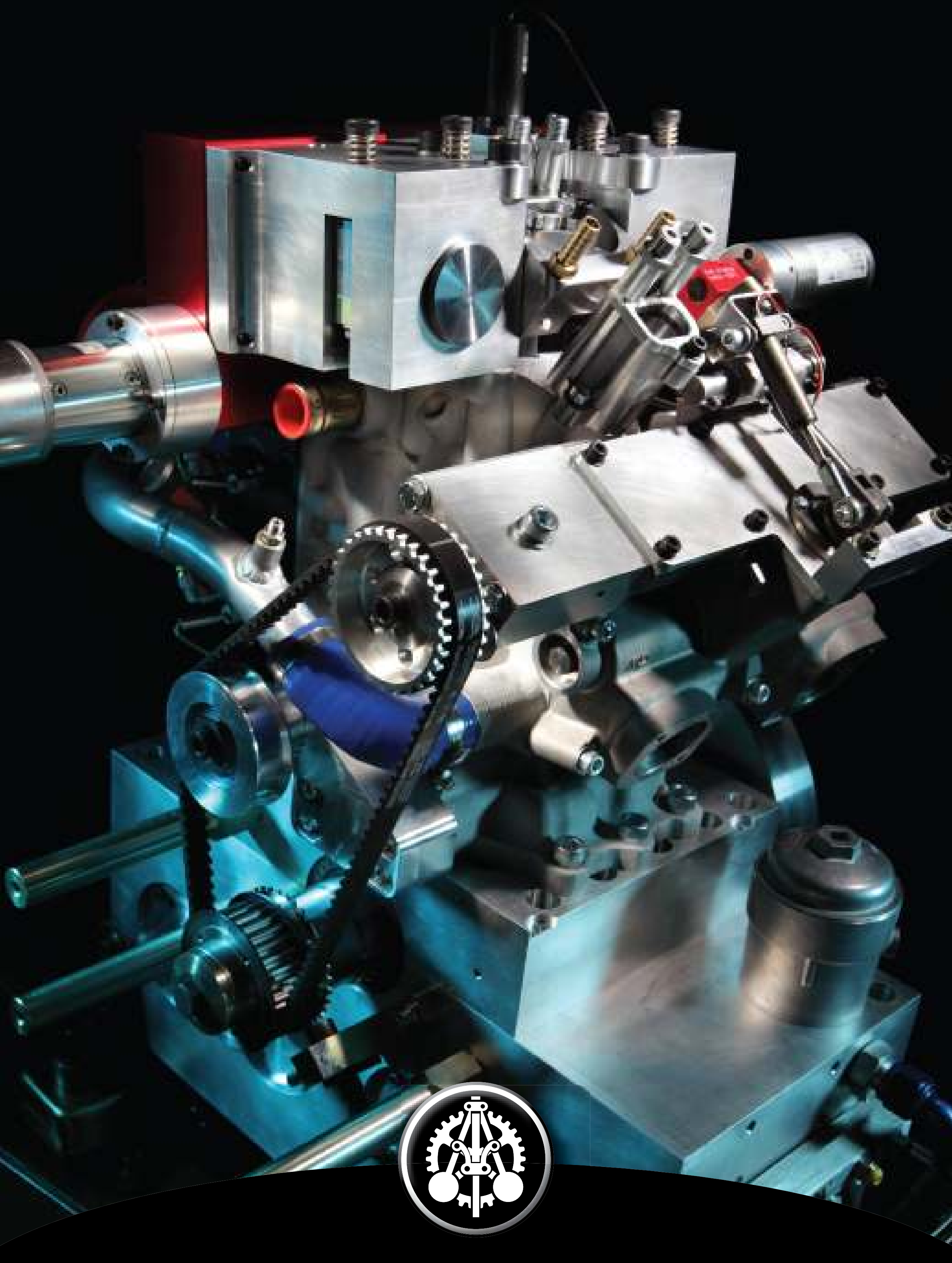

Faculty of Mechanical Engineering

Introduction

The Mechanical Engineering Program at the Budapest University of Technology and Economics began in 1863, and the Faculty of Mechanical Engineering was established soon afterward, beginning official operations in the 1871/72 academic year. The Faculty is justly proud of its continuous, progressive and more than 140-year history and now offers undergraduate and graduate programs in both Hungarian and English.

The Faculty of Mechanical Engineering offers a seven-semester undergraduate BSc degree program in English. Two specializations, 1) Engineering Design and Technology, and 2) Process Engineering give the students alternatives from the 5th semester. A two-year graduate program in English - Mechanical Engineering Modeling - leading to an MSc degree started in February 2009, and students can start their study either in the fall or in the spring semester. Individual postgraduate academic and research programs, which are usually completed in three to four years, are available for those who already have an MSc degree and wish to pursue a PhD degree.

The undergraduate BSc program of the Faculty of Mechanical Engineering is designed to continue a tradition of excellence by:

- providing well-grounded and broad knowledge that graduates of this Faculty can apply immediately in their work and also use as the basis for further studies; and
- graduating competent engineers who are not only masters of their profession, but also possess an ethical philosophy of engineering based on accuracy, punctuality and reliability as well as a respect for the human element.

The goals of our MSc and PhD programs are as follows:

- to train creative, inventive mechanical engineers who can apply the engineering skills and the knowledge they have gained from the natural sciences on a state-of-the-art level; and
- to foster the development of leaders in engineering research and development.

The courses in the Mechanical Engineering Modeling MSc-program deal with those time-dependent problems of mechanical engineering, which typically require the efficient modeling of tasks in order to access the continuously developing methods of computational engineering. As the joke says: ‘One designed by a civil engineer starts moving that is bad, one designed by a mechanical engineer does NOT move that is bad, too.’ Modern computational methods are very popular since they show their easy-to-use interface for engineers. This often causes misunderstanding and disappointment during the naive applications of engineering software. Computational methods are reliable if they are properly tested and the principles of their applied algorithms and procedures are understood. This is analogous to the modern cartoon industry: the 25 pictures of one second of a cartoon can be drawn by computers if the first and the last picture of that second are designed for them by the artist but the computers will totally fail if they have to draw the cartoon without any reference picture, or based on the first (or last) picture only.

The tasks of mechanical engineers that typically require the modeling of machines in motion and that of time-varying processes are based on solid and fluid mechanics, thermodynamics and electronics. Modeling means the understanding and active application of the related theories, which are supported by differential equations and numerical methods in mathematics. Modeling needs also experimental work during the research-development-innovation process, in case engineers do not have enough information about the motions and processes they want to capture by a model. Finally, modeling is also affected by the engineers knowledge in design, technology, and informatics, since the model should not be so complex that the available software is unable to solve them within reasonable time and for reasonable cost.

The above principles affected the formation of this master course. After the brief summary of the required fundamental courses (mathematics, mechanics, thermodynamics, electronics, control and informatics), the students have to choose a major and a minor specialization from the following list of modules:

1. Solid Mechanics 2. Fluid Mechanics 3. Thermal Engineering 4. Design and Technology

The possible combinations provide flexibility among more research-oriented knowledge (combinations of the first 3 modules), and the development-oriented one (major from modules 1-3 and module 4 as minor or vice versa).

This course is running in English only. It is based on the foundations provided by the long-standing positive traditions of some former successful courses of the Faculty of Mechanical Engineering at BME.

This course is also compatible to many master courses in mechanical engineering in the European Union (see, for example, U Bristol, U Bath, ENS Cachan, TU Karlsruhe, U Hannover, TU Munich).

Our Faculty offers its engineering education excellence rooted in, and being fully aware of its unique position of training decision makers, and technological leaders of tomorrow. Our aim in the course of the training is to qualify our graduates to perform as competent problem solvers, good communicators, excellent team workers, successful project leaders, and - above all - ethical participants of the world around them – both locally and globally.

Departments:

Department of Materials Science and Engineering
Department of Fluid Mechanics
Department of Energy Engineering
Department of Building Service Engineering and Process Engineering
Department of Machine and Industrial Product Design
Department of Manufacturing Science and Engineering
Department of Hydrodynamics Systems
Department of Mechatronics, Optics and Mechanical Engineering Informatics
Department of Applied Mechanics
Department of Polymer Engineering

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H-1111 Budapest

Dean: Prof. Dr. Tibor Czigány
Vice-Dean (scientific and international affairs):
Dr. Ádám Kovács
Course Director:
Mr. Axel Groniewsky, BSc Course Director

Curriculum of MSc Subjects
Mechanical Engineering Modelling

Subject		lect / sem / lab / cr / p/e/s							
		Beginning: spring				Beginning: fall			
Name	Code	1 Spring	2 Fall	3 Spring	4 Fall	1 Fall	2 Spring	3 Fall	4 Spring
Basic Subjects									
Differential Equations and Numerical Methods	BMETE90MX46	4/2/0/8/e					4/2/0/8/e		
Laser Physics	BMETE12MX00		3/1/0/4/e			3/1/0/4/e			
Analytical Mechanics	BMEGEMMMW01	3/0/0/4/e					3/0/0/4/e		
Advanced Fluid Mechanics	BMEGEÁTMW01	3/0/0/4/e					3/0/0/4/e		
Advanced Thermodynamics	BMEGEENMWAT	2/1/0/4/e					2/1/0/4/e		
Electronics	BMEVIAUM001		2/0/1/4/e			2/0/1/4/e			
Advanced Control and Informatics	BMEGEMIMW01		2/1/0/4/e			2/1/0/4/e			
Special Compulsory Subjects									
Machine Design and Production Technology	BMEGEGEMW01		2/1/0/4/e			2/1/0/4/e			
Major Compulsory Subject I			3/0/1/5/p			3/0/1/5/p			
Major Compulsory Subject II		2/1/0/5/p					2/1/0/5/p		
Teamwork project			0/0/3/3/p			0/0/3/3/p			
Final Project A				0/13/0/15/p				0/13/15/p	
Special Subjects									
Major Elective Subject I				1/0/2/3/e					1/0/2/3/e
Major Elective Subject II					1/0/1/3/e			1/0/1/3/e	
Major Elective Subject III					1/1/0/3/p			1/1/0/3/p	
Minor Compulsory Subject I		3/0/1/5/p					3/0/1/5/p		
Minor Compulsory Subject II			2/1/0/5/p			2/1/0/5/p			
Minor Elective Subject I				1/0/1/3/e					1/0/1/3/e
Minor Elective Subject II				2/0/0/3/p					2/0/0/3/p
Final Project B					0/13/0/15/p				0/13/0/15/p
Subjects in Economics									
Management	BMEGT20MW02				3/0/0/5/p			3/0/0/5/p	
Marketing	BMEGT20MW01			3/0/0/5/p					3/0/0/5/p
Elective Subjects									
Further Elective Subject					1/0/1/3/p			1/0/1/3/p	
Further Elective Subject				1/1/0/3/p					1/1/0/3/p
Criterion									
Industrial Practice	BMEGEMMMWSZ								
Total									
Total credit points		30	29	32	29	29	30	29	32
Total contact hours		17/4/1/22	14/4/5/23	8/14/3/25	6/14/2/22	14/4/5/23	17/4/1/22	6/14/2/22	8/14/3/25
Number of Exams		4	4	2	1	4	4	1	2

Modules available in the Mechanical Engineering Modelling MSc program

Two specialization modules (major and minor) need to be picked from the five which are available in the BME Mechanical Engineering Modelling MSc program. Though there are four modules available, it is not guaranteed that all of them will be started every year. It is not possible to start a module with less than 6 applicants. Therefore, it is important that all students decide which modules they would like to study at the beginning of the program. Therefore, the students decide which modules will be started. Those students who choose modules which end up not having enough applicants can choose to either change over to a different module which is being started, or to wait until the desired module is started in a future semester. The students should make a decision about the major module before the application. However, the major and minor modules can be reversed before the students choose the major/final project topics. The module in which the students perform the major and final projects becomes the “major” one, the other remains the “minor” one.

Curriculum of MSc Subjects
Mechanical Engineering Modelling - Fluid Mechanics Module

Subject		lect / sem / lab / cr / p/e/s							
		Beginning: spring				Beginning: fall			
Name	**Code**	**1 Spring**	**2 Fall**	**3 Spring**	**4 Fall**	**1 Fall**	**2 Spring**	**3 Fall**	**4 Spring**
Basic Subjects									
Advanced Fluid Mechanics	BMEGEÁTMW01	3/0/0/4/e					3/0/0/4/e		
Special subjects / Major or Minor Compulsory Subjects									
Computational Fluid Dynamics	BMEGEÁTMW02		2/2/0/5/p			2/2/0/5/p			
Flow Measurements	BMEGEÁTMW03	2/1/1/5/p					2/1/1/5/p		
Teamwork Project	BMEGEÁTMWTP		0/0/3/3/p			0/0/3/3/p			
Final Project A	BMEGEÁTMWDA			0/13/0/15/p				0/13/0/15/p	
Special subjects / Major or Minor Elective Subjects									
Large-Eddy Simulation in Mechanical Engineering	BMEGEÁTMW05			2/0/0/3/ p					2/0/0/3/p
Open Source Computational Fluid Dynamics	BMEGEÁTMW11			1/1/0/3/p					1/1/0/3/p
Multiphase and Reactive Flow Modelling	BMEGEÁTMW17			1/1/0/3/p					1/1/0/3/p
Unsteady Flows in Pipe Networks	BMEGEVGMW02			2/0/0/3/p					2/0/0/3/p
Building Aerodynamics	BMEGEÁTMW08				2/0/1/3/p			2/0/1/3/p	
Aerodynamics and its Application for Vehicles	BMEGEÁTMW09				2/0/0/3/p			2/0/0/3/p	
Advanced Technical Acoustics and Measurement Techniques	BMEGEÁTMW10				2/0/0/3/p			2/0/0/3/p	
Hemodynamics	BMEGEVGMW06				2/0/0/3/p			2/0/0/3/p	
Flow Stability	BMEGEVGMW07				2/0/0/3/p			2/0/0/3/p	
Theoretical Acoustics	BMEGEVGMW08				2/0/0/3/p			2/0/0/3/p	
Final project B	BMEGEÁTMWDB				0/13/0/15/p				0/13/0/15/p

List of abbreviations appearing in the curriculum:

lect – lecture; sem - seminar (classroom practice); lab - laboratory practice; cr – credits; p/e/s - practical mark/exam/signature

Curriculum of MSc Subjects
Mechanical Engineering Modelling - Solid Mechanics Module

Subject		lect / sem / lab / cr / p/e/s							
		Beginning: spring				Beginning: fall			
Name	Code	1 Spring	2 Fall	3 Spring	4 Fall	1 Fall	2 Spring	3 Fall	4 Spring
Basic Subjects									
Analytical Mechanics	BMEGEMMMW01	3/0/0/4/e					3/0/0/4/e		
Special subjects / Major or Minor Compulsory Subjects									
Finite Element Analysis	BMEGEMMMW02	2/0/2/5/p					2/0/2/5/p		
Continuum Mechanics	BMEGEMMMW03		2/1/0/5/p			2/1/0/5/p			
Teamwork Project	BMEGEMMMWPA		0/0/3/3/p			0/0/3/3/p			
Final Project A	BMEGEMMMWDA			0/13/0/15/p				0/13/0/15/p	
Special subjects / Major or Minor Elective Subjects									
Elasticity and Plasticity	BMEGEMMMW05			1/1/0/3/p					1/1/0/3/p
Nonlinear Vibrations	BMEGEMMMW06			1/1/0/3/e					1/1/0/3/e
Coupled Problems in Mechanics	BMEGEMMMW07			1/0/1/3/p					1/0/1/3/p
Mechanisms	BMEGEMMMW08				1/1/0/3/p			1/1/0/3/p	
Beam Structures	BMEGEMMMW09				1/1/0/3/e			1/1/0/3/e	
Experimental Methods in Solid Mechanics	BMEGEMMMW10				1/0/1/3/p			1/0/1/3/p	
Final project B	BMEGEMMMWDB				0/13/0/15/p				0/13/0/15/p

List of abbreviations appearing in the curriculum:

lect – lecture; sem - seminar (classroom practice); lab - laboratory practice; cr – credits; p/e/s - practical mark/exam/signature

Curriculum of MSc Subjects
Mechanical Engineering Modelling - Thermal Engineering Module

Subject		lect / sem / lab / cr / p/e/s							
		Beginning: spring				Beginning: fall			
Name	Code	1 Spring	2 Fall	3 Spring	4 Fall	1 Fall	2 Spring	3 Fall	4 Spring
Basic Subjects									
Advanced Thermodynamics	BMEGEENMWAT	2/1/0/4/e					2/1/0/4/e		
Special subjects / Major or Minor Compulsory Subjects									
Combustion Technology	BMEGEENMWCT		2/1/1/5/p			2/1/1/5/p			
Energy Conversion Units and their Equipment	BMEGEENMWEP	2/1/0/5/p					2/1/0/5/p		
Teamwork Project	BMEGEENMWPR		0/0/3/3/p			0/0/3/3/p			
Final Project A	BMEGEENMWDA			0/13/0/15/p				0/13/0/15/p	
Special subjects / Major or Minor Elective Subjects									
Measurements in Thermal Engineering	BMEGEENMWM2			1/0/3/4/p					1/0/3/4/p
Simulation of Energy Engineering Systems	BMEGEENMWSE			1/0/2/3/p					1/0/2/3/p
Thermal Physics	BMEGEENMWTP			2/0/1/3/p					2/0/1/3/p
Thermo-Mechanics	BMEGEMMMWTM				2/0/1/3/p			2/0/1/3/p	
Steam and Gas Turbines	BMEGEENMWTU				2/1/0/3/p			2/1/0/3/p	
Final project B	BMEGEENMWDB				0/13/0/15/p				0/13/0/15/p

List of abbreviations appearing in the curriculum:

lect – lecture; sem - seminar (classroom practice); lab - laboratory practice; cr – credits; p/e/s - practical mark/exam/signature

e - exam, p - practical mark, ge - global exam

Curriculum of MSc Subjects
Mechanical Engineering Modelling - Design and Technology Module

Subject		lect / sem / lab / cr / p/e/s							
		Beginning: spring				Beginning: fall			
Name	Code	1 Spring	2 Fall	3 Spring	4 Fall	1 Fall	2 Spring	3 Fall	4 Spring
Special subjects / Major or Minor Compulsory Subjects									
Machine Design and Production Technology	BMEGEGEMW01		2/1/0/4/e			2/1/0/4/e			
Product Modelling	BMEGEGEMW02		2/0/1/5/p			2/0/1/5/p			
Advanced Manufacturing	BMEGEGTMW01	1/0/3/5/p					1/0/3/5/p		
Teamwork Project	BMEGEGEMWP1		0/0/3/3/p			0/0/3/3/p			
Final Project A	BMEGEGEMWDA			0/13/0/15/p				0/13/0/15/p	
Special subjects / Major or Minor Elective Subjects									
CAD Technology	BMEGEGEMW04			1/0/2/4/e					1/0/2/4/e
Materials Science	BMEGEMTMW01			2/0/0/3/e					2/0/0/3/e
Structural Analysis	BMEGEGEMW05			1/0/2/4/p					1/0/2/4/p
Process Planning	BMEGEGTMW02				1/1/0/3/p			1/1/0/3/p	
NC Machine Tools	BMEGEGTMW03				1/1/0/3/p			1/1/0/3/p	
Fatigue and Fracture	BMEGEMTMW02				2/0/0/3/e			2/0/0/3/e	
Final project B	BMEGEGEMWDB				0/13/0/15/p				0/13/0/15/p

List of abbreviations appearing in the curriculum:

lect – lecture; sem - seminar (classroom practice); lab - laboratory practice; cr – credits; p/e/s - practical mark/exam/signature

Subjects of the final exam

The subjects for the final exam need to be chosen from the major module subjects (totaling 16 cr):
- Major Compulsory Subject I, 5 cr
- Major Compulsory Subject II, 5 cr
- Major Elective Subject, 3 cr
- Major Elective Subject, 3 cr

Description of MSc Subjects

Basic Subjects

Mathematics Mi - Differential Equations and Numerical Methods

BMETE90MX46

Dr. Péter Moson, Dr. György Paál

First order ordinary differential equations, difference between linear and nonlinear equations. Elementary methods of solution (undetermined coefficients, variation of parameters, etc.) The existence and uniqueness theorem. Modelling with first order equations. First order difference equations. Introduction into numerical methods: explicit, implicit schemes, stability problems, multi-step methods. Second order linear ordinary differential equations, homogeneous and nonhomogeneous equations. Series solutions of second order equations, ordinary points, regular singular points, Bessel equations. Systems of first order ordinary differential equations. Classification of equilibrium points; Introduction into Lyapunov stability; almost linear systems. 2-dimensional autonomous systems. Linearization. Phase space analysis near equilibrium points (linearization, Poincaré theory), periodic orbits. Classification of abstract vector spaces, inner product spaces, generalized Fourier series. Orthogonal function systems, trigonometric Fourier series, Gibbs phenomenon. Sturm-Liouville problems, vibrating string, heat transfer problem in Cartesian and in cylindrical coordinates, Bessel functions, vibrating drumhead.

Laser Physics

BMETE12MX00

Dr. Emőke Lőrincz

Theory of laser oscillation, characteristics of laser light, laser applications. Interaction of photons with atoms, linebroadening mechanisms, coherent amplification, optical resonator, conditions of continous wave and transient laser oscillation. Properties of laser beams: monochromacity, coherence, directionality, brightness. Laser types: solid-state, semiconductor, gas, fluid (dye) and miscellaneous. Laser applications: industrial, medical, communication, measurement technique.

Analytical Mechanics

BMEGEMMMW01

Dr. Gábor Stépán

Review of Dynamics, Strength of Materials and Vibrations. D'Alambert's Priciple. Dynamic effects in Strength of Materials. Maximum equivalent stress calculation in structures of large acceleration (ventilator and turbine blades, engine parts). Natural frequencies and vibration modes of multi DoF systems. Rayleigh's ratio, Stodola iteration and Dunckerley's formula. Calculation of natural frequencies in beam structures by means of analytical estimation and finite element code. Natural frequencies and vibration modes of continuum beams (bending, longitudinal). Vibrations of strings. Calculation of natural frequencies in beam structures subjected to bending vibrations by solving partial differential equations. Bending vibrations of rotating shafts. Variation of natural frequencies due to gyroscopic effects. Campbell diagrams.

Advanced Fluid Mechanics

BMEGEÁTMW01

Dr. Gergely Kristóf

Overview of the fundaments of fluid mechanics. Vorticity transport equation. Potential flows, solution methods based on analytical solutions. Percolation, Darcy flow. Wells. Boundary layers. Similarity solutions for laminar and turbulent boundary layers. Transition. Turbulent boundary layers. BL control. Overview of computational fluid dynamics (CFD). Turbulence models. Fundaments of gas dynamics. Wave phenomena. Isentropic flow. Normal shock waves. Oblique shock waves, wave reflection. Prandtl-Meyer expansion. Supersonic jets. Atmospheric flows. Aerosols. Aeroacoustics. Pipe networks. Case studies.

Advanced Thermodynamics

BMEGEENMWAT

Dr. Balázs Czél

General model structure of thermodynamics. Equation of state (gases, liquids and solids). Laws of thermodynamics. System of body and environment, heat, work, reservoirs, extended systems. Irreversible processes, availability, exergy analysis, entropy generation minimization. Multi component phase equilibrium. Reaction equilibrium. Basics of non equilibrium thermodynamics. Second law. Linear laws. Onsager reciprocity. Local equilibrium. Heat conduction, diffusion, cross effects. Rheology. Poynting-Thomson body.

Electronics

BMEVIAUM001

Dr. Balázs Rakos

Electronic components: Diode, Zener diode, Transistors (bipolar and field effect transistors), Common-emmiter characteristics.

Discrete circuits: Emitter-follower circuit, Amplification, Impedance matching, Series connection of amplifier stages, Feedback.

Integrated circuits: Operational amplifier, Mathematical operations, Wave shape generation, Function generation, Filters, Power supply.

Advanced Control and Informatics

BMEGEMIMW01

Dr. Péter Korondi, professor

Short overview of the classical design methods of PID controllers. Sensors and actuators of an internet based motion control system. Implementation of discrete time PID controller for an internet based motion control system. Linear Time Invariant systems. Controllability and Observability. Canonical forms, the Kalman decomposition, realization theory, minimal realizations. Sate feedback control: pole placement, Linear Quadratic Regulator (LQR), Linear Quadratic Gaussian (LQG) control designs. Discrete Time Systems. Robust Control, H infinity control, Sliding Mode Control, Implementation of sliding control desing for an internet based motion control system.

Machine Design and Production Technology

BMEGEGEMW01

Dr. Gábor Körtélyesi
(Special Compulsory Subject)
The goal of the course is to give a theoretical overview on the fields of machine design and production technology, according to the detailed topics below. Some elements of the methodology are covered on the seminars throughout a semester project.
Machine design: Design principles and methods. Requirements. Modern design techniques. Structural behavior and modeling. Design of frame structures. Polymer and composite components. Load transfer between engineering components. Structural optimization (object function, design variables, constrains, shape and size optimization).
Production: Machine-tools and equipment, devices and fixtures, kinematics, machining principles, production procedures and processes, production volume, batches and series. Manufacturability and tooling criteria, preliminary conditions and production analysis, methods of sequencing operations, production planning and scheduling. Production management (TQC and JIT), automated production; cellular manufacturing, machining centres and robots. Product data and technical document management (PDM, TDM), engineering changes and production workflow management (CE, ECM).

Subjects of the Fluid Mechanics module

Special Subjects / Major or Minor Compulsory Subjects

Computational Fluid Dynamics

BMEGEÁTMW02

Dr. Gergely Kristóf
Main objective of the subject is providing sufficient theoretical background and practical knowledge for professional CFD engineers. Detailed thematic description of the subject: Numerical approximations of derivatives and integrals. Discretisation of divergence, gradient and Laplace operator by means of finite volume method. Numerical modelling of incompressible flows, resolution of pressure-velocity coupling in terms of psi-omega method and pressure correction method. Characteristics of turbulence and turbulence modelling. Application of finite volume discretisation method in a one-dimensional case. Stability of the central differencing scheme, upwinding, and numerical diffusion. Solution of algebraic systems which are obtained by the discretisation of the governing equations of fluid flows. Iterative methods, multigrid methods. Compressible flow modelling. Method of characteristics, application of finite volume method. Introduction to multiphase flow modelling. Application of User Defined Functions (UDFs) in ANYSYS-Fluent simulation system. Seminars in CFD Laboratory: Generation of block-structured meshes with ICEM CFD software. Individual assignment. Convergence checking, mesh independency checking, comparison of results of various models with measured data. Handing in the report of the individual assignment. Group assignment (in groups of 3 students). Convergence checking, mesh independency checking, comparison of results of various models with measured data. Tutorial examples in multiphase flow modelling. Handing in the report of group assignment. UDF examples. Presentation of the results of group assignments.

Flow Measurements

BMEGEÁTMW03

Dr. János Vad
Main objective of the subject is getting acquainted with the measurement principles, application areas, advantages and limitations of various flow measuring techniques applied in industrial practice as well as in research & development related laboratory activities. Detailed thematic description of the subject: Practical / industrial aspects of flow measurements. Measurement of temporal mean pressures: static, total, dynamic. Probes and methods. Manometers. Pressure-based measurement of velocity magnitude and direction. Anemometers, thermal probes. Measurement of unsteady pressures. Temperature measurements. Hot wire anemometry. Laser optical flow diagnostics: Laser Doppler Anemometry (LDA), Phase Doppler Anemometry (PDA), Particle Image Velocimetry (PIV). Flow visualization. Flow rate measurements with use of contraction elements and deduced from velocity data. Comparison. Flowmeters: ultrasonic, MHD, capacitive cross-correlation technique, Coriolis, vortex, rotameter, turbine, volumetric. Industrial case studies. Collaboration of measurement technique and computational simulation. Laboratory exercise.

Teamwork Project

BMEGEÁTMWTP

Dr. Viktor Szente

Experimental and/or numerical (CFD) teamwork project proposals will be announced by the supervisors on the registration week or before for group of 2-3 students. The Teamwork Project proposals are defined as being complex problems for the 1st or 2nd semester, and also can be continued partly by a single student in course of the Final Project A or B (BMEGEÁTMWDA or BMEGEÁTMWDB) in the 3rd and 4th semester, hence resulting in a fully complex MSc Thesis of the student at the end of the curriculum. A so-called Evaluation Team (ET) is formed in that the group's supervisor + two advisors are participating, being the members of ET.

Final Project A

BMEGEÁTMWDA

Dr. György Paál

The aim of the course is to develop and enhance the capability for complex problem solving of the students under advisory management of the so-called Evaluation Team. The student's supervisor and two advisors form the Evaluation Team (ET). Detailed thematic description of the subject: various experimental and/or numerical (CFD) project proposals are announced by the supervisors well before the registration week. The project proposals are defined as being complex problems both for the 3rd and further on the 4th semester, since they are to be continued in course of the Final Project B (BMEGEÁTMWDB) in the 4th semester. The findings of the complex, two-semester long project will be summarised in the final Master (MSc) Thesis.

In course of the Final Project A and further on the Final Project B the student will work on one selected challenging problem of fluid mechanics.

1st ET meeting on the 4th week: 1st project presentation by the student

2nd ET meeting on the 8th week: 2nd project presentation by the student

3rd ET meeting on the 14th week: 3rd project presentation by the student

On the 15th week: submission of the major Project Report in printed and electronic format.

Evaluation Team members assess the students work, presentations & report.

Note, that for students taking the major in Fluid Mechanics of Mechanical Engineering Modelling MSc various Final Project A proposals are announced also by the Dept. Hydrodynamic Systems (under their own subject code BMEGEVGMWDA).

Special Subjects / Major or Minor Elective Subjects

Large-Eddy Simulation In Mechanical Engineering

BMEGEÁTMW05

Dr. Gergely Kristóf

The main objective of the subject is to get familiar with the concept of Large-Eddy Simulation and its widely used techniques. A secondary objective is to gain knowledge about post-processing techniques specially suited for instantaneous and steady 3D flow data. Applications from turbulent heat transfer and noise production will be shown.

Detailed thematic description of the subject: Motivations why to use Large-Eddy Simulation (LES). Filtering of the incompressible Navier-Stokes equations, basic filter properties. Numerical requirements of the simulation. Subgrid scale modelling approaches. Interacting error dynamics. Practical aspect of the simulation (domain time and mesh requirements). Special LES boundary conditions: inlet turbulence generation. Hybrid and zonal LES/RANS approaches. Postprocessing of LES results: flow topology description, vortex detection methods. Case studies: internal cooling channel, flow around an airfoil, near field of a jet.

Open Source Computational Fluid Dynamics

BMEGEÁTMW11

Dr. Gergely Kristóf

Introduction to OpenFOAM including Linux basis, and other required software such as gnuplot and paraview. Installation of OpenFOAM on several Linux distributions and virtual linux systems (Ubuntu, Opensuse, Fedora) from packages and on other systems from source. Solution of simple 2D fluid dynamics problems using OpenFOAM (driven cavity flow, 2D boundary layer, Poiseuille flow) including the comparison with theoretical results. Detailed introduction to OpenFOAM software components including meshing tools, solvers and post-processing tools. Single phase stationary and transient flows, turbulence, compressible flows. Introduction to models, boundary conditions and solvers required for the simulation of these problems. Examples on these problems. Multiphase and reactive flows, including the introduction to models, boundary conditions and solvers required for the simulation of these problems. Examples on these problems. Extension of OpenFOAM capabilities by program code development in C++. Compiling code components, the implementation of boundary conditions, applications and models. Personalized projects using OpenFOAM. Further open source CFD tools (Code Saturn, Palabos).

Multiphase And Reactive Flow Modelling

BMEGEÁTMW17

Dr. Jenő Miklós Suda

Physical phenomena, major concepts, definitions and modelling strategies. Mass transport in multi-component systems: diffusion and chemical reactions. Modelling chemical reactions: flames, combustion models, atmospheric reactions. Fluid dynamical and thermal phenomena in two-phase pipe flows: flow regimes in vertical, horizontal and inclined pipes. Advanced multi-phase flow instrumentation. Transport through deforming fluid interfaces: jump conditions at discontinuities. Single-fluid and interpenetrating media modelling approaches. Obtaining practical transport equations for multiphase pipe flows by cross sectional integration and cross sectional averaging. Closure relations. Mixture and multi-fluid models. Using experimental correlations. Relevant dimensionless numbers. Gravity and capillary waves. Dispersed particle transport. Sedimentation and fall-out, particle agglomeration and break-up. Bubble growth and collapse. Phase change and heat transfer in single-component systems: boiling, cavitation, condensation. Related heat transport problems and industrial applications. Computational Multi-Fluid Mechanics (CMFD): general methods and limitations, usage of general purpose computational fluid dynamics codes, design of specialized target software. Numerical modelling free surfaces and fluid-fluid interfaces. Review of applications in power generation, hydrocarbon and chemical industry.

Unsteady Flows In Pipe Networks

BMEGEVGMW02

Dr. Csaba Hős

Overview of the program, introduction. Overview of applied numerical methods (Newton-Raphson, Runge-Kutta). 1D instationary flow of quasy-constant density fluid, MOC. Method of characteristics (realisation). Dynamics of air wessel. Dynamical model of pumps. Water hammer, transient pipe network simulation, homework. Open channel flow, basic equations. Lax-Wendroff scheme. Application of MOC for open channel flow. Gasdynamics. 1D transient gas.

Building Aerodynamics

BMEGEÁTMW08

Dr. Jenő Miklós Suda

Basics of meteorology: characteristics of atmospheric boundary layer and its modelling. Arising of wind forces, bluff-body aerodynamics: boundary layer separation, characteristics of separated flows, vortices, their effects on the flow description of complex 3-dimensional flow fields. Wind comfort, dispersion of pollutants in urban environment / Numerical simulation of dispersion of pollutants in urban environment by using MISKAM code. Numerical simulation of dispersion of pollutants in urban environment using the MISKAM code. Usage of wind tunnels in determination of wind loading. Flow visualization around buildings in wind tunnel. Static wind load on buildings and structures, prediction of static wind load by using EUROCODE and ASCE standards. Fundamentals and philosophy. Wind and structure interaction, aero-elasticity. Aerodynamics of bridges, prediction of dynamic wind load on buildings, structures by using EUROCODE, basics of numerical simulation using solid-fluid interaction. Design of cooling towers. Design and wind load of water spheres. Wind load on telecommunication masts - aerodynamic and related design issues, developments. Aerodynamics of membrane structures. CFD and wind tunnel case studies (large buildings, stadium roofs).

Aerodynamics and its Application for Vehicles

BMEGEÁTMW09

Dr. Jenő Miklós Suda

Introduction, bluff body aerodynamics. Characteristics of atmospheric boundary layer. Basics of car design (in co-operation with MOME: Moholy-Nagy University of Arts and Design Budapest). Aerodynamics of automobiles. Aerodynamics of buses and trucks. Aerodynamics of racing cars. Wind tunnels and their use for vehicle aerodynamics. Definition of projects, forming groups of students. Measurement of car models evaluation of car bodies from aerodynamic and design point of view (in co-operation with MOME: Moholy-Nagy University of Arts and Design Budapest).

Individual project: passenger car modelling. 2-4 students form one group. Every group will receive two modelling wood of 3 various given dimensions. With the help of plasticine, a passenger car of M 1:20 scale can be created. The relative position of the pieces of woods can be freely chosen, as far as the model resembles a car. The ground clearance (underbody gap) is 11mm, the distance of the axes is 140mm. The diameter of the wheels is 30mm, their width is 8mm. Wheels can be formed of the plasticine provided. In the larger piece of wood – under the passenger compartment – four boreholes are created, in order to attach the model to the aerodynamic force measuring mechanism. The maximum length of the model is 250mm, its minimum height is 60mm, and its width is between 82 and 90mm. The perpendicular cross section of the model has to be determined (together with the wheels), in order to determine drag and lift coefficients. There is a possibility to place attachments on the car model, like spoilers, ski boxes, etc. Besides the force measurement, there will be a possibility for flow visualization around the car, during which the location and size of the separation bubbles, the size of the dead water region behind the car, effect of spoilers and other attachments, and soiling of the rear face of the car can be observed. The measurements groups have to prepare a project presentation on the last class. The groups have to send their presentation by e-mail 2 working days before the presentation at the latest.

Advanced Technical Acoustics and Measurement Techniques

BMEGEÁTMW10

Dr. János Vad

3D homogeneous wave equation and the general solution. The 3D solution of the wave equation in bounded space, room modes. The sound propagation in tubes, the sudden cross-sectional area change and tube termination. The simple expansion chamber silencer, and the sound propagation in horns. Sound propagation in duct and higher order modes. The ray theory, sound propagation in non-homogeneous media. Spherical waves, and the point monopole, dipole and quadrupole sound sources, model laws. The flow generated sound, Lighthill's acoustic analogy and the inhomogeneous wave equation. The attenuation of sound waves. Acoustic measurements, microphones, analysers, calibrators. Anechoic and reverberating chambers. Basic acoustic measurement problems. The sound intensity measurement, the microphone array.

Hemodynamics

BMEGEVGMW06

Dr. György Paál

Introduction to physiology. Circulation system, arterial and venous system. Blood flow measurement methods, invasive techniques. Non-invasive blood flow measurements, Transmission properties of cuff-systems, estimation of eigenfrequency. Introduction to the method of characteristics (MOC). MOC and Solution for rapid change, Alievi (Joukowsky)-wave. MOC and study of the transmission properties of invasive blood pressure measurement technique (arterial catheter). Models and methods for the description of blood flow in blood vessels, material properties, Streeter-Wiley Model 1 and Model 2. Characteristic physiological quantities and their influence in hemodynamics. Flow in aneurysms.

Flow Stability

BMEGEVGMW07

Dr. György Paál

Mechanisms of instability, basic concepts of stability theory, Kelvin-Helmholz instability. Basics of linear stability for continuous and discrete systems with examples; stability of discretization techniques (explicit and implicit Euler technique, Runge-Kutta schemes) and linear stability analysis of surge in turbomachines. The Hopf bifurcation theorem with application to turbomachinery. Galerkin projection and its applications. Lorenz equations, derivation (Rayleigh-Bénard convection), linear and nonlinear stability, interpretation of the bifurcation diagram. Loss of stability of parallel inviscid and viscous flows. Instability of shear layers, jets, boundary layers. Compound matrix method.

Theoretical Acoustics

BMEGEVGMW08

Dr. György Paál

Wave equation. Lighthill's theory, monopole, dipole, quadrupole sound sources. Green's functions on the example of the vibrating string. Free space Green's functions. Modification of Green's functions in the vicinity of solid bodies. Vortex sound equation.

Final Project B

BMEGEÁTMWDB

Dr. György Paál

The aim of the course is to develop and enhance the capability for complex problem solving of the students under advisory management of their project supervisor and two advisors. Each student's project is guided by the project supervisor and depending on the problem -if applicable- by two advisors. They form the so-called Evaluation Team (ET). ET meetings are organized 3 times per semester.

Detailed thematic description of the subject: Several experimental and/or numerical (CFD) final project proposals will be announced by the project leaders well before the registration week. The final project proposals are defined as being complex problems of mainly fluid mechanics, usually they must be the continuation of the major projects' proposals. The students will work on complex problems proposed in the 3rd semester in course of the Final Project A (BMEGEÁTMWDA). The Final Projects A and B together serves as a two-semester project that results in the Master (MSc) Thesis of the student. In course of the Final Project B one single student will work on the selected challenging problem of fluid mechanics.

1st ET meeting: on the 4th week: 1st project presentation by the student

2nd ET meeting: on the 8th week: 2nd project presentation by the student

3rd ET meeting: on the 14th week: 3rd final project presentation by the student

On the 15th week: submission of the final Project Report (ie. the Master Thesis) in printed and electronic format. Evaluation team members assess the students work, presentations & report.

Note, that for students taking the Final Project A that was announced by the Dept. Hydrodynamic Systems (under subject code BMEGEVGMWDA) must continue their project in course of the Final Project B announced also by the Dept. Hydrodynamic Systems (under code BMEGEVGMWDB).

Subjects of the Solid Mechanics module

Special Subjects / Major or Minor Compulsory Subjects

Finite Element Analysis

BMEGEMMMW02

Dr. András Szekrényes

The basic equations of linear elasticity, Green-Lagrange strain tensor. Stability of linear elastic systems, the Euler method. FE formulation of stability problems, geometric stiffness matrix. Buckling, lateral buckling and lateral-torsional buckling of slender beams with symmetric cross section. Torsion of straight prismatic beams. Second order dynamics, vibration of beams with initial load. Dynamic stability analysis including flutter and divergence. Elastic structures subjected to conservative and nonconservative loads. Beck's column, stability diagrams and phase plane portraits. FE solution of nonlinear dynamic problems. Direct time integration schemes, central difference method, Newmark's method, numerical examples. Modeling of parametrically excited linear elastic systems, harmonic balance method. Solution for system of Mathieu-Hill DE equations, application of infinite matrices and finite determinants. Elastic column subjected to periodic compressive force, stability diagrams, calculation of the displacement response. Simulations and animations of parametrically unstable systems. Classification and FE solution of nonlinear static structural problems, classical and modified Newton-Raphson methods. Tangent stiffness matrix and iteration schemes. The principle of virtual work. Degenerate beam element with von Kármán type nonlinearity. Nonlinear TRUSS structures. Nonlinear vibration of elastic structures, solution by direct iteration technique. Chaotic motion of elastic structures. Nonlinear bending of elastic beams including large displacements and large strains. Modeling examples in ANSYS including elasticity, plasticity, static and dynamic elastic stability, nonlinear structural static/dynamic and thermomechanical problems.

Continuum Mechanics

BMEGEMMMW03

Dr. Attila Kossa

Historical overview. Mathematical background (Cartesian tensors, properties and representations, invariants, tensor fields, derivatives of tensors, integral theorems). Kinematics. Bodies and configurations. Lagrangian and Eulerian description of a continuum. Deformation gradient. Deformation of arc, surface and volume elements. Deformation and strain tensors. Polar decomposition: stretch and rotation tensors. Displacement, infinitesimal strain and rotation. Material time derivative. Rates of deformation: stretching and spin tensors. Conservation of mass, continuity equation. Concept of force. Cauchy's theorem on the existence of stress. First and second Piola-Kirchhoff stress tensors. Linear momentum principle. Equation of motion. Angular momentum principle. Balance of energy: concepts on stress power, rate of work, internal energy. First and second law of thermodynamics. Clausius-Duhem inequality. Dissipation function. Constitutive theory. Principles of determinism and local action. Material frame indifference and objectivity. Constitutive equations of elasticity, viscoelasticity, plasticity and fluid mechanics.

Teamwork Project

BMEGEMMMWPA

Dr. Attila Kossa
Solution of complex problems by forming group of students including the following topics: cutting processes, vibration measurements, robot control, stability theory.

Final Project A

BMEGEMMMWDA

Dr. András Szekrényes
The Final Project A subject is dedicated to the preparation of the first half of the MSc thesis. Each student must choose a proposal and a supervisor or supervisors. The proposals are available at the websites of the department or they can be requested from the professors in the course of a personal communication. The aim of the subject is to develop and enhance the problem solving capability of the students under advisory management of their supervisor. The requirement is a practical mark at the end of the semester, which is determined entirely by the supervisor.

Special Subjects / Major or Minor Elective Subjects

Elasticity And Plasticity

BMEGEMMMW05

Dr. Attila Kossa
Introduction to the constitutive modelling in solid mechanics. Classification of the constitutive theories. Gradient, divergence and curl in cylindrical coordinate system. Small strain theory. Compatibility of strain. Governing equations of linear elasticity. Hooke's law. Plane stress and plane strain problems. Airy stress function. Torsion of prismatic bar. Analytical stress solution of rotating disc and of thick-walled tube with internal pressure. One-dimensional plasticity. Uniaxial extension and compression problems with hardening. Elastic-plastic deformation of thick-walled tube with internal pressure. Haigh-Westergaard stress space. Formulation of the yield criteria. Linear isotropic and kinematic hardening. Nonlinear hardenings. Formulation of the constitutive equation in 3D elastoplasticity. Radial return method.

Nonlinear Vibrations

BMEGEMMMW06

Dr. Gábor Stépán, professor
Nonlinearities in mechanical systems: springs, dampers, inertia. Phase plane analysis of 1 degree-of-freedom systems. Saddles, nodes and spirals, stable and unstable equilibria. Vibrations of conservative nonlinear systems. Catastrophe theory: typical bifurcations of equilibria. Construction of trajectories and their analysis in case of inverted pendulum supported by spring, pitchfork bifurcation. The dynamic effects of nonlinear damping. Forced vibration and resonances in systems of nonlinear springs. Analytical and numerical calculation of resonance curves in case of hardening and softening characteristics. Self-excited vibrations. Liénard and Bendixson criteria for limit cycles. Hopf bifurcation theory. Stick-slip oscillations, estimation of stable and unstable periodic motions.

Coupled Problems in Mechanics

BMEGEMMMW07

Dr. Ádám Kovács
Coupled field problems. Diffusion equations. Coupled piezo-thermo-mechanical equations. Steady-state thermal analysis. Thermo-mechanical analysis. Micro-electromechanical systems. Beam and plate type microstructures. Sensors and actuators. Piezoelectric-thermo-mechanical analysis of an actuator. Electro-mechanical analysis of a capactive pressure sensor. Fluid-structure interaction. Fluid-structure coupled acoustic analysis. Contact problems. Contact simulation of two microcantilevers. Shape memory alloys, smart structures.

MECHANISMS

BMEGEMMMW08

Dr. Ambrus Zelei, research associate
Overview of structural elements and kinematic fundamentals. Basics of synthesis of planar mechanisms. Fourbar mechanisms. Coupler curves. Single and double dwell mechanisms. Velocity and acceleration analysis. Apparent velocity, Aronhold-Kennedy theorem, coordinate partitioning method, and the method of appended driving constraints. Spatial representation of position and orientation. Parameterization of rotations, Euler angles, Tait-Briant angles, Roll-Pitch-Yaw angles, Axis-angle representation, Exponential mapping, Euler parameters. Joint- and operational space. Forward kinematics. The Denavit-Hartenberg convention. Equation of motion of robots, Euler-Lagrange method, Recursive Newton-Euler approach. The concept of natural coordinates. Dynamic equation of motion in terms of non-minimum set of generalized coordinates. Constrained systems. Service robot-, and haptic application examples. Impulsive dynamic analysis. Numerical simulation.

Beam Structures

BMEGEMMMW09

Dr. András Szekrényes
General theory of free torsion of prismatic bars. Saint-Venant warping function, the circulation theorem of shear stresses. Warping of thin-walled sections, the sector area function, definition of shear center. Transformation of the sector area function. Examples for open and closed sections. Constrained torsion of thin-walled open sections, bimoment, torsional warping constant, warping statical moment. Governing differential equation and boundary conditions under constrained torsion, examples: U-section and I-section beams. Demonstration of the importance of shear center through real models. Shearing of thin-walled section beams. Shear-warp function, shear center. Engineering solutions for open and closed sections, modified statical moments. Nonlinear bending theory of slender beams by E.P. Popov. Nonlinear DE of flexure. Solution by elliptic integrals of the first and second kind. Solution of classical beam problems including large deformations. FE formulation of Timoshenko beams. Isoparametric Timoshenko beam element, shear locking, interpolation with exact nodal solution, examples. The basic theory of sandwich beams with thin and thick facesheets. Definition of anti-plane core materials, application examples.

Experimental Methods in Solid Mechanics

BMEGEMMMW10

Dr. András Szekrényes

Strain measurement methods, theory and practice, strain gauges. Application to an aluminium block. Linear elastic fracture mechanics of composites, fracture model of Griffith, definition of critical energy release rate. Evaluation of fracture mechanical test results. Direct and indirect data reduction schemes. Standard and direct beam theories, J-integral, the virtual crack-closure technique, compliance calibration, area method. Classification of fracture tests, mode-I and mode-II configurations. Manufacturing of composite specimens. Force and displacement control in fracture mechanics. Necessary and sufficient conditions of stable crack propagation in brittle materials. Stability criterion in theory and practice. Demonstration examples for stable and unstable crack advance. Test methods for the mode-III interlaminar fracture, the modified split cantilver beam, edge-cracked torsion and 4-point plate bending specimens. Dynamic stability and vibration analysis of delaminated beams. Vibration testing using modal hammer and sweep excitation tests. Measurement of the frequency response function and mode shapes. Evaluation of vibration tests. Numerical simulation of parametric instability in delaminated beams by harmonic balance and finite element methods. Mode shape simulation and calculation of phase plane portraits. The mixed-mode bending problem. Mode partitioning in mixed-mode I/II tests by global and local methods using distributed dislocation theory. Application of improved beam theory schemes (Winkler, Timoshenko) to cracked beams. Fracture envelopes and fracture criteria of laminated materials.

Final Project B

BMEGEMMMWDB

Dr. András Szekrényes

The Final Project B subject is dedicated to prepare the second half of the MSc thesis. As the continuation of the Final Project Project A, the aim of the subject is to demonstrate the ability of the student to solve high level, practical engineering problems, based on acquired knowledge in the fields of mechanical engineering. In some special cases the students can choose a different topic than that of the Final Project A, however in this case the thesis should be prepared in the course of one semester. The projects have to be prepared by the students under the guidance of supervisors. The Final Projects include tasks in design, simulations, laboratory tests, manufacturing as well as controlling, interfacing and software tasks. The expected result is mostly a Final Report prepared according to written formal requirements. During the Final Exam, the results have to be explained in an oral presentation.

Subjects of the Thermal Engineering module

Special Subjects / Major or Minor Compulsory Subjects

Combustion Technology

BMEGEENMWCT

Dr. Ferenc Lezsovits

Course is started with introduction of fuel properties and fuel supply systems. It is followed by calculation of mass and energy balance of combustion, stoichiometry and CO_2 and pollutant emission, flue gas loss calculation, condensation of flue gas components. Heat transfer in combustion chamber has important role on energy balance and retention time formation. After that combustion process of different fuels, parameters of combustion will be presented as homogenous / heterogeneous reactions, flow type and concentration effects on chemical reactions. Nowadays application of catalysts in combustion process and flue gas cleaning has become important part of this technology. Anaerobe biogas generation, gas cleaning and features and gasification technology overview, features of generated gas, gas cleaning technologies, tar filtering and/or condensation, torrefaction and pirolysis will be discussed as well. Carbon capture and storage (CCS) technologies will be also presented. In the end comparison of different thermal conversion technologies (combustion, gasification, etc.) on mass and energy balance will be presented. Finally, solutions applied in firing technic will be demonstrated as firing system in general, control and regulation, firing system principals for liquid and gaseous fuels, andfor soild fuels, and waste material incineration.

Energy Conversion Units and their Equipment

BMEGEENMWEP

Dr. Ákos Bereczky

Basics. Cooling systems and main parameters. Absorption cooling systems and special cooling systems. Fuel cells. Combustion technology, parameters and emissions. Different hot water and steam generation systems. Different hot water and steam generation main parameters. Steam turbines, different steam turbine cycles. Steam turbines, different steam turbine constructions. Gas turbines, different gas turbine constructions and cycles. Main parameters and characteristic of internal combustion engines. Management of internal combustion engines. Gas engines. Cogeneration and tri-generation systems and parameters.

Teamwork Project

BMEGEENMWPR

Dr. Tamás Laza

The complex task covers a semester project in the diverse topics of energetics.

Final Project A

BMEGEENMWDA

Dr. Tamás Laza

In course of the Final Project A one student or group of 2 students will work on one selected challenging problem of mechanical engineering. Several experimental and/or numerical project proposals will be announced by the project leaders. The aim of the course is to develop and enhance the capability for complex problem solving of the students under advisory management of their project leader. At the end of each semester a written Project Report is to be submitted and the summary and findings of the investigations on the selected problem is to be presented as Project Presentation.

Special Subjects / Major or Minor Elective Subjects

Measurements In Thermal Engineering

BMEGEENMWM2

Dr. Ákos Bereczky
Measurement methods and techniques of thermal processes. System - model - measurement - evaluation. State of the art data acquisition methods, systems and signal transducers. Operational and service measurements, engine diagnostics, performance characteristic. Stability and vibrations tests. Evaluation methods in data processing. Questions of safety, availability and reliability. Application of LabView graphical programming environment.

Simulation of Energy Engineering Systems

BMEGEENMWSE

Dr. Pál Szentannai
Methods of determination the dynamic models. Type of equation groups. Linear – nonlinear, distributed – concentrated parameters. Application of Matlab/Simulink interactive programming language. Case studies: simple and complex energy conversion processes. Student projects: dynamic modelling and simulation experiment.

Thermal Physics

BMEGEENMWTP

Dr. Balázs Czél
Physical backgrounds, mechanism and models of heat conduction in solids; measurement of thermo-physical properties; steady state and transient methods; numerical modeling of 1D and 2D heat conduction problems, inverse heat conduction problem. Heat conduction review (heat diffusion equation, boundary conditions). What are thermophysical properties? Different heat conduction models. Finite difference and control volume method for the solution of heat conduction problems. Measurement of the thermal conductivity. Measurement of the thermal diffusivity. Measurement of the specific heat capacity; direct determination of the temperature dependency of the properties. Inverse heat conduction problems. 2D steady-state heat conduction with contact boundary condition. Transient heat conduction with different boundary conditions (modeling the laser flash method). Transient heat conduction with contact boundary condition. Transient heat conduction with temperature dependent thermophysical properties (modeling the BICOND method).

Thermo-Mechanics

BMEGEMMMWTM

Dr. Ádám Kovács
Temperature dependence of material properties. Governing equations of coupled thermal and mechanical fields. Thermal boundary conditions. Thermal stresses in beams, plane problems, plates, thick-walled tubes and rotating disks. Instationary heat conduction, transient thermal stresses. Numerical thermal stress analysis. Heat conductance and capacitance matrices. Computer simulation of thermal stresses.

Steam And Gas Turbines

BMEGEENMWTU

Dr. Krisztián Sztankó
Preliminary, property of Parsons and Laval steam turbines, property of modern steam turbines. Properties of impulse stage. Curtis stage, negative reaction number evoluation, sonic speed, velocity bended, efficiency curve, properties of reaction stage, long blade bended criteria, equistress design, determination of steam turbine's main geometry, wet steam turbines, calculate pressure variation with Stodola constans. Reheated condensation steam turbine. Design of Package gas turbine. Uncool gas turbine cycle calculation. Real gas turbine cycle and optimum parameters. Properties of single shaft and dual shaft gasturbine, wing shape theory and compressor stage.

Final Project B

BMEGEENMWDB

Dr. Tamás Laza
The aim of the subject of is to demonstrate the ability of the student to solve high level, practical engineering problems, based on acquired knowledge in the fields of mechanical engineering. The projects have to be prepared by the students under the guidance of supervisors. The Final Projects include tasks in design, simulations, laboratory tests, manufacturing as well as controlling, interfacing and software tasks. The expected result is mostly a Final Report prepared according to written formal requirements. During the Final Exam, the results have to be explained in an oral presentation.

Subjects of the Design and Technology Module

Special Subjects / Major or Minor Compulsory Subjects

Product Modelling

BMEGEGEMW02

Dr. Károly Váradi, professor
The process of product modeling. Traditional and concurrent design. Product lifecycle management. Integrated product development. Conceptual design. Geometric models. Assembly models. Presentation techniques. Simulation models (Finite element analysis. Kinematic simulation. Behavior simulation). Optimization (object function, shape and size optimization). Application models. Virtual prototyping. Rapid prototyping. Product costing models.

Advanced Manufacturing

BMEGEGTMW01

Dr. Márton Takács
Introduction to Advanced Manufacturing. Visiting the manufacturing laboratory of the Department. Conventional machining operations. Fundamentals of machining operations. Mechanics of metal cutting. Machinability. Chip control. Fundamentals of advanced manufacturing (non-conventional machining). Reverse engineering. Rapid Prototyping. Mold design and manufacturing. Production Planning - Material Requirements Planning. Production Planning - Advanced models and algorithms. Consultation on semester essay. Electro Discharge Machining EDM), processes and application. Micro EDM machining. Laser Beam Machining. Laser marking. Rapid Prototyping. NC tool path planning by CAM system. Hard Cutting. Gear production.

Teamwork Project

BMEGEGEMWP1

Dr. Tibor Szalay
The complex task covers a semester project in the diverse topics of manufacturing.

Final Project A

BMEGEGEMWDA

Dr. Tibor Szalay
In course of the Final Project A one student or group of 2 students will work on one selected challenging problem of mechanical engineering. Several experimental and/or numerical project proposals will be announced by the project leaders. The aim of the course is to develop and enhance the capability for complex problem solving of the students under advisory management of their project leader. At the end of each semester a written Project Report is to be submitted and the summary and findings of the investigations on the selected problem is to be presented as Project Presentation.

Special Subjects / Major or Minor Elective Subjects

CAD Technology

BMEGEGEMW04

Dr. Attila Piros
Lecture topics: Introduction, using of the intelliFiles. Theory of the TOP-DOWN design. Integrated CAD systems. Virtual product development. Parametric design. Design of the mechanisms. Topics of the labs: Introduction, overview on the 3D part modelling. TOP-DOWN design in static constructions. Overview on 3D assembly modelling. Design of the cast parts. 3D model based technical drafting. Integration of the imported 3D data. Modelling of the parts with similar geometry. Design of the moving parts' kinematic. Modelling of the complex kinematic. Creating of kinematic analyses. TOP-DOWN design in moving constructions. Tolerancing in the CAD systems.

Materials Science

BMEGEMTMW01

Dr. István Mészáros
Structure of crystalline solids. Imperfections in crystals. Mechanical properties of alloys. Dislocations and strengthening mechanisms. Deterioration mechanisms of engineering materials. Phase diagrams. Phase transformations. Material characterization. Non-destructive evaluation techniques. Electrical properties of metals, alloys and semicinductiors. Superconductivity. Magnetic properties. Soft and hard magnetic materials.

Structural Analysis

BMEGEGEMW05

Dr. Tibor Goda
Structural analysis and machine design. Fundamentals of FEM. Basic element types of professional FE systems. Preparing FE models (symmetry conditions, mesh structure, boundary conditions, loading models and material properties). Material and geometric nonlinearity. Time-dependent behaviour. Steady state and transient heat transfer. Integrated CAD-FEM systems. Structure optimization.

Process Planning

BMEGEGTMW02

Dr. Gyula Mátyási
Introduction; demands and requirements of absolving mark in the subject; principles, concepts, terms, definitions concerning on manufacturing process planning and manufacturing processes, equipment, tooling and experience; The stages and steps of manufacturing process planning; deterministic and heuristic methods, issue of Type and Group Technology, methods of prevention and elimination; Production analysis; general sequencing problems; determination of all sequence variations; methods of matrix reduction and vector variants; abstract methods for process plans and production workflows; Scheduling; Process chains and diagrams; shop-floor programming and scheduling (GANTT diagrams), Network plans, leak control (Process graphs and trees), process chain representations, diagrams (Workflow techniques). Assembly (objects); definitions of assembly; units and items, object oriented assembly tree and documents Assembly and manufacturing (processes); assembly procedures, operations, methods and organisation structures; process oriented assembly tree and documents. Quality control (object and process oriented view of quality assurance); probability functions and distributions, dimensional chains and analysis; assembling methods and assurance; economic view of manufacturing; Quality assurance; Production strategies (TQC, JIT); statistical process control (SPC); measure and charts of process capability; charts attributes.

Nc Machine Tools

BMEGEGTMW03

Dr. István Németh
The lectures include the following topics: Fundamentals of the kinematics of machine tools and the NC technology. Classification of metal-cutting machine tools. Selection criteria of machine tools. Structural building blocks: friction, rolling and hydrostatic guideways; ball screws; linear motors; rack and pinion mechanisms; hydrostatic screws; indexing and NC rotary tables; rotary actuators: gears, warm wheel, torque motor. Spindles: belt drive, gear drive, direct drive, integrated spindle; rolling, hydrostatic, aerostatic bearings; tool holders and tool clamping; lathe and milling spindles. Lathes and turning centres. Milling machines and machining centres. Automatic tool and worcriece changing peripheries. Multi-functional machine tools. Parallel kinematics machine tools. The seminars support the design assignment and help the student in selecting the motion unit components (i.e. ball screw, rolling guideway, servo motor) and designing the main structural element i.e. frames, moving slides, tool changers) of machine tools.

Fatigue And Fracture

BMEGEMTMW02

Dr. Imre Norbert Orbulov
Cyclic loading. High cycle fatigue. S-N curve. Fatigue limit. Low cycle fatigue. Manson-Coffin relation. Neuber theory. Linear elastic fracture mechanics. Energy concept. Stress field near the crack tip. Stress intensity factor. Fracture toughness. Fracture mechanical design. Non linear fracture mechanics. Crack opening displacement. J-integral. Stable crack growth. Testing techniques. Design philosophy in nonlinear fracture mechanics. Environment assested cracking. Case studies.

Final Project B

BMEGEGEMWDB

Dr. Tibor Szalay

The aim of the subject of is to demonstrate the ability of the student to solve high level, practical engineering problems, based on acquired knowledge in the fields of mechanical engineering. The projects have to be prepared by the students under the guidance of supervisors. The Final Projects include tasks in design, simulations, laboratory tests, manufacturing as well as controlling, interfacing and software tasks. The expected result is mostly a Final Report prepared according to written formal requirements. During the Final Exam, the results have to be explained in an oral presentation.

Subjects In Economics

Management

BMEGT20MW02

Dr. Irén Gyökér

The objectives of the course are that the students know the duties of management and the attributes of the manager job with the current formed perception in different ages. Over the set targets the students will understand the characteristic of human behaviour, the behaviour of managers and their employee, the team properties in the labour-environment and the corporations how develop their functional rules. The applicable (for previous) management methods and their expected effects on the members of corporation and their capacities are presented in the course of the discussed themes.

Marketing

BMEGT20MW01

Dr. Zsuzsanna Szalkai

Marketing in the 21st century. Strategic marketing planning. The modern marketing information system. Consumer markets and buyer behavior. Business markets and business buyer behavior. Competitive strategies. Market segmentation, targeting, and positioning. Product strategy and new-product development. Managing services. Designing pricing strategies. Marketing channels. Integrated marketing communication.

Further Elective Subject

Biologically Inspired Systems

BMEGEMIMGBI

Dr. Péter Korondi, professor

The design of engineering structures increasingly involves mimicking and improvement of natural, living structures to perfection. In addition to a more accurate understanding and systematization of living systems, it is increasingly important that both engineering students and engineers get acquainted with this topic. The basic goal of the course is the analysis of different biological systems and of the engineering structures mimicking them throughengineering and systems theory considerations. Specific solutions of biological systems for different materials, structures, sensor systems, motion and control can be properly applied.

Criterion

Industrial Practice

BMEGEMMMWSZ

Dr. András Szekrényes

One of the requirements to obtain the MSc diploma is to carry out the internship in a company that performs some activities in the field of mechanical engineering. The industrial practice fulfilled in the BSc level is accepted automatically if the student accomplished the internship through the organization of the Department of Applied Mechanics. If the accomplishment took place through the organization of another department, then a certification needs to be provided to the department's responsible (Dr. András Szekrényes). If the student does not possess a valid industrial practice, then it has to be accomplished in the course of the MSc qualification. The required duration of the industrial practice is 4 weeks. It is possible to request the organization of the industrial practice from the department's responsible. To obtain the signature in Neptun it is required to apply the Industrial practice subject before the acqusition of the MSc diploma.

2019/2020 ACADEMIC CALENDAR

Fall Semester: All accepted Preparatory Beginners

Preparatory Classes (Math, Physics) **for Placement Test**	**21 – 23 August**
Placement Tests: Math (26.08.), Physics (27.08.) and English Language (28.08.)	**26 – 28 August**
Placement Test Results Posted Outside Student's Office	**30 Aug at 12 am**
Presentation of Schedules for Freshmen in Bldg. R 1. Student's Office	30 Aug at 12 am -1 pm
Registration in Students' Office, Bldg. R 1. **(after payment of tuition fees)**	**26 Aug – 6 Sept 2019**
Appointments for Obligatory Medical Check-up (Necessary for Health Insurance).	2 Sept – 6 Sept 2019
Orientation Program Newly enrolled regular and Exchange Students	2 – 6 September
First day of classes	**9 Sept at 8:15 am (Monday)**
Opening ceremony	**19 Sept (Thursday)**
Last Day of Classes	**13 Dec (Friday)**
Examinations in fall semester of 2018/2019	2 Jan 2020 - 29 Jan 2020
Work days (instead of 24 and 27 Dec.)	7, 14 Dec 2019 (Saturdays)
Winter Holidays	**24 Dec 2019 - 1 Jan 2020**

Fall Semester: BSc/MSc Students

Registration in Student's Office	**26 Aug – 6 Sept 2019**
First Day of Classes	9 Sept 2019 (Monday)
Last Day of Classes	13 Dec 2019 (Friday)
Delayed submission	14 Dec 2019 – 20 Dec 2019
Winter Holidays for All Students	**24 Dec 2019 – 1 Jan 2020**
Examination Period (Check with your Faculty!)	**2 Jan 2020 – 29 Jan 2020**
Work days (instead of 24 and 27 Dec.)	7, 14 Dec 2019 (Saturdays)
Last Day of Final Exams	**29 Jan 2020**

Spring Semester: All Students

Orientation Program Newly enrolled regular and Exchange Students	**30 Jan - 1 Feb 2020**
Registration in Students' Office, Bldg. R 1.	5 Feb – 7 Feb 2020
First Day of Classes	**10 Feb 2020 (Monday)**
Last Day of Classes	**22 May 2020 (Friday)**
Delayed submission	25 May – 29 May 2020
Examination Period (Check with your Faculty!)	**2 June – 29 June 2020**
Last Day of Final Exams	**3 July 2020**

Days off for All Students

Sports day	12 Sept 2019 (Thursday)	Free day	27 Dec. 2019 (Friday)
National Day 1956	23 Oct 2019 (Wednesday)	Good Friday	10 April 2020 (Friday)
All Saints' Day	1 Nov 2019 (Friday)	Easter Monday	13 April 2020 (Monday)
Students' Scientific Conference	12 Nov 2019 (Tuesday)	Spring Holiday	14 – 17 April 2020
Open day	29 Nov 2019 (Friday)	Labour Day	1 May 2020 (Friday)
Free day	24 Dec. 2019 (Tuesday)	Whit Monday	1 June 2020 (Monday)


Szabadság Bridge
DANUBE
City Center
Budapest
Petőfi Bridge
Infopark
Lágymányosi Bridge
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Administration Block A
Fluid Mechanics Building Ae
Chemistry Building Ch
Mechanical Engineering Building D
Building Construction Laboratory El
Physics Building F
Production Engineering Building G
Informatics Buildings I, Q
Vehicle Engineering Building J
Central Building K
Central Library Kö
Hydraulic Machinery Laboratory L
Mechanics Building Mm/Mg
Mechanical Technology Building Mt
Classrooms R, T, H, E
Electrical Engineering
and Informatics
Buildings St, V1, V2
Nuclear Training Reactor TR
Office of
International Education,
Central Academic Office: R