BUDAPEST UNIVERSITY OF TECHNOLOGY AND ECONOMICS
Géza Pattantyús-Ábrahám Doctoral School of Mechanical Engineering Sciences

Training Plan

Valid from 1 September 2016


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I. THE ELEMENTS OF PhD EDUCATION

The PhD program is running according to individual curriculum. This curriculum is formulated in a negotiating process between the PhD student and the institutional roleplayers, the thesis supervisor, the department head, and the president of the partial program. This has to be approved by the Educational Committee of Doctoral Studies (DTB) and the Council of Doctoral School (DIT). The educational and research plans elaborated for each semester of the studies makes an integral part of the Work Plan.

The most significant part of the individual research work done in the advertised topic of the Doctoral School makes the core part of the program. Each PhD student has one and only one supervisor at a time who is fully responsible for directing the studies, the research and the degree preparation of the PhD candidate working on the designated topic. It is possible, however, to approve dual supervision in studies based on international cooperation, alternatively, in interdisciplinary topics accepted by the DIT, and with advertised topic description with the preliminary approval of the University Habilitation Committee and Doctoral Council (EHBDT).

In other cases (e.g. external topic supervision contracted with the Doctoral School) the DIT would nominate an internal supervisor to follow and assist with the professional progress of the candidate on behalf of the university.

During doctoral training at the Faculty of Mechanical Engineering the students concerned can mainly choose from among the course offer of the Faculty. The pool of the course offers can be widened with that of other faculties, occasionally of different universities of technical science after the preliminary approval of the vice-dean in charge of scientific affairs.

Directional education makes part of the training and and is mandatory to take. In the frames of it lecturing abilities and skills as long as communication skills get developed under the guidance of a designated teacher. The subject, and credits associated with the course concerned, is identified by the head of the supervisor’s department in accordance with the supervisor; the accomplishment is acknowledged by the department head following the recommendation of the designated teacher.

In the doctoral training 240 credits have to be obtained as follows.

a.) 30-50 credits – acquiring mandatory studies,

b.) 190-210 credits – scientific research work or creative artistic activity, directed educational activity.

According to the curriculum of the Faculty of Mechanical Engineering PhD credits are shared as follows.

- 30 credits: acquisition of study materials
- 140 credits: scientific activities
- max. 46 credits: publications
- max. 30 credits: lecturing, assisting the teaching process
The principles of a PhD student's curriculum are as follows.

a) Requirements of taking courses are concentrated in the first passage of the training program, thus, providing the possibility of the most possible time to do research work from the 3rd year of studies.

b) Subjects with global exam requirements are two-semester long. From among these will be identified those two the candidate has to sit a complex exam for at the end of the 4th semester.

c) On condition that the candidate has not accomplished them yet, any of the offered compulsory elective may be chosen in the 2nd and 3rd semesters.

d) The requirements of Individual research are quite decent in the 1st and 2nd semesters, however, research on literature and its evaluation is mandatory, while the rest two semesters, 3rd, 4th are already research-focussed.

e) The aim of Teaching activity is to acquire, with the assistance of a well-experienced lecturer, the methods of how to develop teaching materials, to convey knowledge orally, to get to know up-to-date teaching techniques, and to prepare measurement practice. Only character building activities directly associated with teaching belong to this passage. The evaluation of the accomplishment, after consulting with colleagues working together with the PhD candidate, is made by the department head concerned.
f) According to the curriculum of the training and to the Code of Studies and Examinations of BME (TVSZ):

- earning min. 20 credits per semester is mandatory,
- earning max. 45 credits per semester cannot be exceeded,
- research credits cannot be summarized,
- credits to be earned in education cannot be substituted by research credits,
- by the end of the 2nd semester, according to the TVSZ, 50 credit points have to be accomplished,
- by the end of the 4th semester min. 120 credit points are to be earned,
- Publication I-II. subjects are to be accomplished by the end of the 4th semester.


g) The credit points of publication activities by no means can be separated, and can only be acknowledged if the following criteria are met.
- Publication I earns credit for the candidate only if they either have produced a professional article or a conference article in English by the end of the 3rd semester.
- Publication II earns credit for the candidate only if they have met the timely publication requirements by the end of the 2nd year, when complex assessment is scheduled, necessary to start the degree seeking process; namely they have already written 2 already published or accepted articles for publication, written in English.
- Publication III earns credit for the candidate only if the publication requirements necessary to start the degree seeking process are at least met, and the candidate has accomplished the publication level required.
- Publication IV earns credit for the candidate when his totally earned credit number reaches up to 34, and has already met the minimum requirements of degree seeking.

h) The accomplishment of Individual research and Publication I-IV is certified by the supervisor of the project. When there is external supervision there, a written assessment from the supervisor serves as basis to the internal supervisor to accept and certify the accomplishment.

i) Absolutorium certifying the successful accomplishment of the PhD training can be issued when Publication III has been completed and the totally collected number of credits reach at least 240.
III. REPORTS AND WORK PLANS

Reports

The interim reporting of PhD students goes according to local routine. The supervisor presents information on it in due course. There is also a mandatory oral report on research at the end of the 4th semester, in the frames of the complex exam. This particular exam has to be taken in front of a committee open to the public. The committee has at least 3 members; and min. one-third of them can not be legally employed by the institution running the doctoral school. The presidency of the committee can only be committed either to a full professor, a Professor Emeritus or a researcher/lecturer with the doctor of the Hungarian Academy of Sciences title. Each member of the committee holds a scientific degree. The supervisor of the examining students, by no means, can be the member of the committee.

The complex exam has two major parts: in one the theoretical preparedness (theory part) is being measured, while in the other the examinee gives and account on their scientific/artistic advancement (dissertation part).

In the theoretical part of the complex exam the examinee takes exam at least in two subjects/categories; the list of these can be found in the educational plan of the doctoral school. The theoretical exam may also have a written portion. In the second part of the complex exam, in the form of a presentation the examinee gives an account on their acquired knowledge of relevant technical literature, research results. Further, the examinee is to present the research plan prepared for the second part of the doctoral studies, respectively, the detailed schedule of preparing the dissertation and the dissemination of results in publications. The supervisor should be given the opportunity to, preliminary in writing, or maximum at the exam, prepare an assessment on the examinee.

The examination committee evaluates the theoretical and the dissertation parts of the exam separately. Minutes are taken with written evaluation in about the complex exam. The very same day of the oral exam the result of the exam has to be announced. The complex exam can be qualified successful if the majority of the committee members judge both parts of the exam a success. Failure in theory can get an extra repeat exam in the very same exam period on the incomplete subject/s. If the dissertation part proves to be a failure, this cannot be repeated in the same exam period.

Written reports are to be prepared by semester on the accomplishment of subjects, the advancement of research work, likewise about the publication activities of the given time frames.

Those PhD students whose reports clearly reveal deficiency and default will be given a notice by DTB, and obligate to submit a more detailed report of 2 or 3 pages. In the report the following has to be recorded

- original goal and expectable new scientific results,
- scientific work done so far,
- the estimation whether, if at all and when, the original goal, including publication requirements can be reached by the candidate.

The report will be evaluated by the professionally competent member of the Doctoral Study Committee (DTB). Further, the Council of the Doctoral School (DIT), considering also the opinion of DTB, decide on possible modifying or rescheduling of the program.
Work Plans

According to the Academic Rules and Regulations of BME a Work Plan has to be elaborated by PhD students. However, in the cited document there is no set requirements as regards contents or formal elements. DIT finds it necessary to set the principles and requirements of Work Plans.

Tasks can be divided into 4 major parts (see chart above):

- education (and associated exams in items 1, 2 and 3),
- independent scientific research work (item 4),
- publicizing research results (item 5),
- teaching activities (item 6).

Two Work Plans are expected by the Dean’s Office from the PhD students.

- right after their having been accepted for a PhD program, at the beginning of their related doctoral activities, a full Work Plan for the full, 4-year duration of their studies has to be submitted,
- another semester Work Plan is also a must at the beginning of each semester started. (This also refers to students recently registered.)

The major aspects of preparing Reports and Measurements are as follows:

Work Plan for 4 years

Work Plan is to elaborate and schedule activities to be done during studies; also, to present aims and recommendations associated with the below described three elements.

a) Education plan.

The Academic Rules and Regulations should provide a solid basis for the Education Plan, with special regards on the appropriate share of basic, comprehensive exam and elective courses. The opinion of the supervisor, as a default, has to be clarified when working on this document.

b) Scientific activities.

Beside providing an overall description of the research plan, in this document it has to be made clear what pace will be followed in elaborating the chosen research topic, and also, the expectable scientific results should be identified.

c) Teaching activities.

This is important to know that the educational activities of a candidate, by no means, can only be calculated by the number of the independently given lectures, but also the preperatory hours spent on the subject matter, further, consultation, preparation, and cooperation associated with other classes of the department concerned.
The following chart is meant to be an aid to elaborate the presentation of scientific activities.

<table>
<thead>
<tr>
<th>Semester</th>
<th>Topic</th>
<th>Aim</th>
<th>Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Research on literature (technical books, periodicals, internet, etc.). Researching on existing methods, processes and results.</td>
<td>Getting acquainted with local and international research results. Establishing contact with experts of the filed concerned.</td>
<td>Collection of articles and resources. Contact list and correspondence, personal meetings.</td>
</tr>
<tr>
<td>4.</td>
<td>Participation in the practical realization of the new process.</td>
<td>Examination applying the new process.</td>
<td>Distributing the achieved partial results in scientific forums.</td>
</tr>
<tr>
<td>5.</td>
<td>Elaborating modelling programs. Analyzing connections mathematically and statistically.</td>
<td>Evaluating and setting out the results of the analysis.</td>
<td></td>
</tr>
<tr>
<td>6.</td>
<td>Simulation analysis of model behaviour.</td>
<td>Determining the optimal model to apply.</td>
<td>Summarizing the achieved results in an English publication.</td>
</tr>
<tr>
<td>7.</td>
<td>Measurements, simulations.</td>
<td>Elaborating and evaluating the simulation results of the experiments carried out.</td>
<td>Article in an international periodical with WoS. Participating in a scientific conference.</td>
</tr>
</tbody>
</table>
Mid-Term Report

The ease the administrative obligations:

a) On condition that the educational and elective tasks detailed in the Work Plan for 4 years, referring to this fact is satisfactory. Publication activities though are much accentuated that have to be detailed by authors’s names, location of issuance, number of volume, page numbers, etc.

b) As regards research work, more detailed report on the previous semester has to be prepared, since the original Work Plan for the 4 years focussed exclusively on planned activities and not on their results.

Once the scheduled educational and elective tasks of the previous semester work plan have been accomplished, pointing these out would suffice the requirement.

Semester Work Plan

a) As regards the semester work plan to be submitted for the following academic period, if there is no modification of these compared to the overall Work Plan for 4 years, only this fact has to be laid down.

b) It is mandatory though to submit a detailed work plan for research activities. When these goals have been met, it is simpler to prepare also a report concerning the following semester.

The Report and the Work Plan have to be submitted electronically and in one printed copy. The latter document has to be signed by the student, the supervisor, the Department Head, and the President of the Sub-Program.

Tasks associated with the aforementioned have to be set int he Work Plans together with plans for obtaining missing or inadequate language proficiency. Forms of Work Plans can be downloaded from the home page of the Doctoral School.
IV. ADMINISTRATION TASKS OF TEACHERS AND STUDENTS

Teachers

During the PhD-training – not taking into account the administration and summary work of Dean’s Office – the cooperation of three persons is needed for a successful end of the studies.

These persons are the following:
- Supervisor,
- Head of Department,
- Subprogram Chairman.

Their tasks are as follows:

Subprogram Chairman

a) He/she participates in the admission exam of the corresponding subprogram.
b) He/she assigns and undersigns the 4 year and Semester Work Plans.
c) He/she checks the performance of the PhD-student upon the Reports.

Head of Department

a) He/she organizes the announcement of PhD-topics for the next 4 year period and submits the corresponding documentation to the Dean’s Office until deadline.
b) He/she organizes (committee, place) the admission exams of the applicants candidating to his/her Department and participates on it.
c) He/she send the examination report to the Dean’s Office.
d) He/she assigns and undersigns the 4 year and Semester Workplans.
e) He/she checks the performance of the PhD-student upon the Reports.
f) He/she provides the infrastructure for the research work given in the Work Plan.
g) He/she organizes and checks the teaching activity of the PhD-student(s).

Supervisor

He/she is responsible from the beginning for the activities, especially for the research activity of the PhD-student. It means the following:

a) He/she prepares the documentation of the announcement of the research topic.
b) Prior of the admission exam he/she provides consultation for the candidate(s).
c) He/she participates in the admission exam of his/her candidate(s).
d) He/she helps to compile the 4-year and Semester Work Plan and confirms them by his/her signature.
e) He/she directs and checks the studies, as well as teaching and research activities of the PhD-student.
f) In Mid-term Reports he/she evaluates the performance of the PhD-student.

PhD-students

a) A the beginning of the training he/she makes a rough 4-year Work Plan, and in all semesters a detailed Semester Work Plan, taking into account the consideration of the supervisor.
b) Making of Mid-Term Reports in each semester – Global Exam at the end of the 4th semester.
c) On the request of the DTB he/she makes an extra detailed written report about the activities as written in
Chapter III.

d) In case of change of subject he/she admits the corresponding request supported by the Supervisor and the Head of Department in printed form to the Dean’s Office.

e) In case of change of topic or/and supervisor he/she admits the corresponding request supported by the Supervisor and the Head of Department addressed to the Dean in printed form to the Dean’s Office. Prior the decision the Dean consults with the DIT.

f) All other changes, e.g. passive semester, research journey abroad, etc. can be allowed before the beginning of the semester by the Dean. Missing of request or such a change without permission can imply the withdrawal of the scholarship.

g) Student documents (requests, work plans, reports, etc.) should be submitted both in electronic and in printed form.
V. SUBJECTS

One semester (elective) subjects

ACOUSTICS
AIR-CONDITIONING
AIR-CONDITIONING SYSTEMS
APPLIED ARTIFICIAL INTELLIGENCE
APPLIED LASER TECHNOLOGY
ARTIFICIAL INTELLIGENCE IN MANUFACTURING
BIOMATERIALS
CERAMICS AND COMPOSITES
COLORIMETRY
COMPUTATIONAL FLUID DYNAMICS
CONTROL AND SUPERVISING OF MANUFACTURING SYSTEMS
COOLING MACHINES AND HEAT PUMPS
DEFORMATION AND FRACTURE OF METALLIC MATERIALS
DESIGN OF METAL-CUTTING MACHINE TOOLS AND MACHINE SYSTEMS
DESIGN OF POLYMER PRODUCTS
DRIVE TECHNOLOGY
DYNAMICS AND SIMULATION OF MULTIBODY SYSTEMS
ELECTRICAL- AND MAGNETIC MATERIALS
ELECTRON MICROSCOPY
ELEMENTS OF PRECISION INSTRUMENTS
ENGINEERING DESIGN
ENGINEERING DIAGNOSTICS
ENVIRONMENTAL TECHNOLOGY
FLUID MACHINERY AND HYDRODYNAMIC SYSTEMS
FLUID MECHANICS
FLUID MECHANICS MEASUREMENTS
FLUIDIZED BED CONVERSION
GAS AND STEAM TURBINES
GAS DYNAMICS
GREEN TECHNOLOGIES
HEAT TREATMENT
HEATING
INTERNAL COMBUSTION ENGINES
INDUSTRIAL AIR TECHNOLOGY
LARGE EDDY SIMULATION
MATERIALS AND PROCESS TECHNOLOGY
MATERIALS SCIENCE
MATERIALS TESTING
MECHANICS OF COMPOSITES
MECHATRONICS
METROLOGY (GTT)
METROLOGY (MOGI)
MODELLING OF FOOD INDUSTRIAL PROCESSES
NANOCOMPOSITES
NEURAL NETWORKS AND THEIR APPLICATIONS
NONEQUILIBRIUM THERMOMECHANICS OF SOLID CONTINUA
NONSMOOTH DYNAMICAL SYSTEMS
OPTICAL INSTRUMENTS AND MEASURING TECHNOLOGY
OPTICS
PLASTIC DEFORMATION
POLYMER COMPOSITES
POLYMER PROCESSING TECHNOLOGIES
POLYMER STRUCTURES
POST-PROCESSING OF FLOW FIELDS
PROCESS SIMULATION
PROCESS SUPERVISION AND DIAGNOSTICS
PRODUCT DEVELOPMENT
RESEARCH METHODOLOGY
SENSORS AND ACTUATORS
STRUCTURAL MATERIALS
THEORY OF MACHINING
THERMODYNAMIC WORKING FLUIDS
TRIBOLOGY
TURBULENCE AND ITS MODELLING
WELDING
Subjects of the Complex Exam

ACOUSTICS
BUILDING SERVICE SYSTEMS
COMBUSTION TECHNOLOGY
COMFORT THEORY
ENERGY MANAGEMENT
ENGINEERING DESIGN
ENGINEERING DIAGNOSTICS
ENVIRONMENTAL TECHNOLOGY
FLUID MACHINERY AND HYDRODYNAMIC SYSTEMS
FLUID MECHANICS
HEAT ENGINES
HEAT TREATMENT
MANUFACTURING ACCESSORY DEVICES
MANUFACTURING PROCESS PLANNING
MANUFACTURING SYSTEMS
MATERIALS AND PROCESS TECHNOLOGY
MATERIALS SCIENCE
MATERIALS TESTING
MECHANICS
MECHATRONICS
METROLOGY (MOGI)
NUMERICAL METHODS\(^1\)
OPTICS
PLASTIC DEFORMATION
POLYMER COMPOSITES
POLYMER PROCESSING TECHNOLOGIES
POLYMER STRUCTURES
PROCESS EQUIPMENT DESIGN
PROCESS INSTRUMENTATION AND CONTROL
PROCESSES AND EQUIPMENT
PRODUCT DEVELOPMENT
PRODUCTION SYSTEMS
ROBOTICS
STRUCTURAL MATERIALS
THERMAL POWER PLANTS
THERMODYNAMICS / HEAT TRANSFER
TRANSPORT PHENOMENA
VENTILATION SYSTEMS
WELDING

\(^1\)Numerical Methods in Machine Design + Numerical Methods in Mechanics
ANNO\textit{T}ATIONS

RESEARCH METHODOLOGY \hspace{1cm} BMEGEMIDKMD \hspace{1cm} 3 kp
Responsible: Dr. Kiss, Rita
Lecturers: Dr. Kiss, Rita; Dr. Ábrahám, György; Dr. Ronkay, Ferenc


Department of Materials Science and Technology

MATERIALS SCIENCE I. (PhD Final exam) \hspace{1cm} BMEGEMT9001 \hspace{1cm} 3 cp
MATERIALS SCIENCE II. (PhD Final exam) \hspace{1cm} BMEGEMT0001 \hspace{1cm} 3 cp
MATERIALS SCIENCE \hspace{1cm} BMEGEMT8001 \hspace{1cm} 3 cp
Lecturers: Dr. Artinger, István; Dr. Dévényi, László; Dr. Szabó, Péter János


MATERIALS AND PROCESS TECHNOLOGY I. (PhD Final) \hspace{1cm} BMEGEMT9002 \hspace{1cm} 3 cp
MATERIALS AND PROCESS TECHNOLOGY II. (PhD Final) \hspace{1cm} BMEGEMT0002 \hspace{1cm} 3 cp
MATERIALS AND PROCESS TECHNOLOGY \hspace{1cm} BMEGEMT8002 \hspace{1cm} 3 cp
Lecturers: Dr. Artinger, István; Dr. Krállics, György; Dr. Bobor, Kristóf

Chip-free technologies for making the preforms. System of the main technological processes (metal forming, welding, casting and powder metallurgy) as the function of the dimensional accuracy, the deformability of the material, and the material and energy consumption and the number of produced pieces. Change of the geometry and material properties in the various components by different mechanical, thermal, electrical and magnetic fields. The technological procedures of surface property modification. The main aspects of the process design. Application of computer aided systems for the design of technological processes.

MATERIALS TESTING I. (PhD Final exam) \hspace{1cm} BMEGEMT9101 \hspace{1cm} 3 cp
Lecturers: Dr. Czoboly, Ernő; Dr. Krállics, György; Dr. Orbulov, Imre Norbert

Basic testing methods and quantities. The effect of the static and the dynamic loading, and the effect of the state factors. Characterization of ductile and brittle state of the materials. Description of the conditions of forming ductile or brittle state. Basic principles and testing methods of fracture mechanics. Linear elastic and

**MATERIALS TESTING II. (PhD Final exam)**

BMEGEMT0101 3 cp

Lecturers: Dr. István Mészáros; Dr. János Ginsztler

The place and role of nondestructive material testing in the production and in quality assurance systems. Classification of NDT/NDE methods. Traditional NDT investigation techniques: visual testing, liquid penetrate testing, ultrasonic testing, radiographic testing, magnetic testing, eddy current testing. Novel NDT methods: special electromagnetic methods, special eddy current methods (remote field, low frequency techniques). Acoustic emission testing. The reliability of NDT testing, statistical analysis. Optical and electron microscopic microstructural investigations and their application possibilities. Automatization of NDT testing.

**MATERIALS TESTING**

BMEGEMT8101 3 cp

Lecturers: Dr. Ernő Czoboly; Dr. Mészáros, Norbert; Dr. Krállics, György

One semester summary of Materials Testing I-II.

**BIOMATERIALS**

BMEGEMT8674 3 cp

Lecturers: Dr. Mészáros, István; Dr. Bagi, István

The subject focused on the special materials (metals, alloys, and ceramics) used in biomedical applications. Summarizes the requirements and discusses the structure, technology and important properties of biomedical materials. The most important chapters are the followings: Summary of the physical, biological background of life functions. The special materials used in medical instruments and devices. The deterioration processes and expected lifetime of the materials implanted into the living body.

**WELDING I. (PhD Final exam)**

BMEGEMT9102 3 cp

**WELDING II. (PhD Final exam)**

BMEGEMT0102 3 cp

**WELDING**

BMEGEMT8102 3 cp

Lecturers: Dr. Dobránszky, János; Dr. Májlinter, Kornél

Welding Technology.

Role of welding in the manufacturing process. Physical basics of welding, formation of the welded joint, effects of welding process on the properties. Fusion and pressure welding processes used in industry: process variables, principles, equipment, welding consumables and applications. Automatization of welding, fundamentals of robotics, computer aided welding technology design. Quality management. Technological tests. Role and significance of non-destructive evaluation in welding technology. Thermal cutting and thermal spraying methods.

Weldability.

Correlations of the welding technology, the engineering structures and materials to weld. Welding heat process. Metallurgical processes in the melt and at the surface of that. Physico-chemical effects influencing the chemical composition and mechanical properties of weld metal. Cold cracking, hot cracking, lamellar tearing, hydrogen embrittlement. Test methods for weldability. Weldability of carbon steels, high-alloyed steels, ferrous, aluminum, copper, nickel, titanium alloys, heat-resistant materials and polymers.

**HEAT TREATMENT I. (PhD Final exam)**

BMEGEMT9103 3 cp

**HEAT TREATMENT II. (PhD Final exam)**

BMEGEMT0103 3 cp

**HEAT TREATMENT (PhD)**

BMEGEMT8103 3 cp

**PLASTIC DEFORMATION I. (PhD Final exam)** BMEGEMT9104 3 cp
**PLASTIC DEFORMATION II. (PhD Final exam)** BMEGEMT0104 3 cp
**PLASTIC DEFORMATION (PhD)** BMEGEMT8104 3 cp

Lecturers: Dr. Kráľics, György; Dr. Bobor, Kristóf

**Theory of metal forming**

**Metal forming and forging processes**

**CERAMICS AND COMPOSITES** BMEGEMT8665 3 cp
Lecturer: Dr. Orbulov, Imre Norbert

The subject deals with the production, properties and application possibilities of industrial ceramics and metal matrix composites. The subject discusses the advantages and disadvantages of the different production methods and routes. Besides this the subject analysis the relationships between the micro- and macrostructure of the materials and the achievable mechanical properties. The subject also deals with the special design and measure techniques of the composites’ mechanical properties.

**ENGINEERING DIAGNOSTICS I. (PhD Final exam)** BMEGEMT9106 3 cp


Deformation mechanisms of metallic materials. The characteristic instability points of the different deformation mechanisms and their calculations. Crack initialisation mechanisms, phenomenological criteria. The descriptions of crack propagation, fracture mechanics parameters, their measurements and applications for design purposes. Fatigue and its connection to fracture mechanics. The effect of temperature on the afore-mentioned processes.

The subject summarizes the most important electrical conductive and magnetic materials used in mechanical engineering and in industrial applications. Conduction and polarization processes, properties, requirements. Bulk and thin film conductive materials, their properties, technological aspects. Superconductivity, and superconductive materials. Semi-conductive materials, devices and technologies. Magnetic properties. Ferro and ferromagnetic materials, magnetic thin films. Types of soft- and hardmagnetic materials and their technologies.


Department of Fluid Mechanics

**ACOUSTICS I. (PhD, PhD Final exam)**  
**BMEGEÁT4A13**  
3 cp  
**Responsible:** Dr. Kristóf, Gergely  
**Lecturer:** Dr. Koscsó, Gábor

The subject of acoustics, the concept of sound and two-fold nature of sound. Homogeneous wave equation, the general solution and solution in bounded space, organ pipe and room natural frequencies. Spherical waves, acoustic resonators, the Helmholtz-resonator and applications. Sound propagation in ducts, higher order modes, cross section step and termination in tubes. Simple expansion chamber, sound propagation in tubes of varying cross section. Ray acoustics. Energetic relations of acoustic waves, sound pressure, intensity and power. Point monopole, dipole and quadrupole sound sources, the acoustic source model law. Flow generated noise, Lighthill’s acoustic analogy, inhomogeneous acoustic wave equation. The attenuation of sound.

**ACOUSTICS II. (PhD Final exam)**  
**BMEGEÁT4A24**  
3 cp  
**Responsible:** Dr. Kristóf, Gergely  
**Lecturer:** Dr. Horváth, Csaba


**POST-PROCESSING OF FLOW FIELDS**  
**BMEGEÁT4A35**  
3 cp  
**Responsible:** Dr. Kristóf, Gergely  
**Lecturer:** Dr. Lohász, Márton Máté


**FLUID MECHANICS I. (PhD, PhD Final exam)**  
**BMEGEÁT4A08**  
3 cp  
**Responsible and lecturer:** Dr. Vad, János

The subject provides an overview on fundamentals of Fluid Mechanics (continuity, equations of motion with practical applications, laminar and turbulent flows, similarity theory, hydraulics, fundamentals of gas dynamics). It gives an in-depth insight into the descriptive equations of Fluid Mechanics, from various perspectives of physics and mathematics, including the aspects of transport theory and numerical modelling. It gives an overview on turbulence modelling, and on the possibilities of numerical computations on
turbulent flows, taking the application example (among others) of characteristics of atmospheric flows. The subject provides details on some selected chapters of Fluid Mechanics (free jets and their applications; vortex laws and their applications; flows past bluff bodies). Finally, it gives a short summary on some advanced Fluid Mechanics measurement techniques, including the aspects of computer-controlled data acquisition and processing. The subject is supplemented by a more detailed discussion on the specific chapters related to the individual research projects of the PhD students involved.

**FLUID MECHANICS II. (PhD Final exam)**

Responsible and lecturer: Dr. Kristóf, Gergely


**FLUID MECHANICS MEASUREMENTS**

Responsible: Dr. Vad, János
Lecturers: Dr. Balczó, Márton; Dr. Suda, Jenő Miklós; Dr. Parti, Mihály, Dr. Vad, János


**GAS DYNAMICS**

Responsible and lecturer: Dr. Kristóf, Gergely


**INDUSTRIAL AIR TECHNOLOGY**

Responsible and lecturer: Dr. Vad, János


**ENVIRONMENTAL TECHNOLOGY I. (PhD, PhD Final exam)**

Responsible: Dr. Vad, János
Lecturer: Dr. Partí, Mihály

ENVIRONMENTAL TECHNOLOGY II. (PhD Final exam)  BMEGEÁT4A15  3 cp
Responsible: Dr. Vad, János professor
Lecturers: Dr. Parti, Mihály; Dr. Suda, Jenő Miklós


*Students may select among A, B or C part according to the research topic of the PhD.*

LARGE EDDY SIMULATION  BMEGEÁT4A34  3 cp
Responsible: Dr. Kristóf, Gergely
Lecturer: Dr. Lohász, Márton Máté


COMPUTATIONAL FLUID DYNAMICS  BMEGEÁT4A14  3 cp
Responsible, lecturer: Dr. Kristóf, Gergely

Turbulence and its Modelling


Department of Energy Engineering

THERMODYNAMICS (PhD Final exam) BMEGEEN907D 3 cp
Lecturer: Dr. Imre, Attila R.

HEAT TRANSFER (PhD Final exam) BMEGEEN007D 3 cp
Lecturer: Dr. Gróf, Gyula

ENERGY MANAGEMENT I (PhD Final exam) BMEGEEN8344 3 cp
ENERGY MANAGEMENT II (PhD Final exam) BMEGEEN834S 3 cp
Lecturer: Dr. Ősz, János
Power supply (primary, secondary fuels, sectors, end users) and sustainable development (competitiveness, security of supply, environmental protection). Energy efficiency in the field of fuel, heat and electricity utilization. Primary and secondary energy supply of the World, Hungary and EU. Hydrocarbons (oil, natural gas, generation, transmission, processing, storage and distribution). Stand alone, central and district heat supply (heating, cooling). Electricity generation in thermal power plants (fossil fueled power plants, gas and combined gas-steam power plants, fuel cells), pressurized water and boiling water nuclear power plants. Low-carbon emission coal-based electricity production. Combined heat and power generation (steam power plants, gas turbine and gas engine combined gas-steam power plants, heat pumps). Renewable energy sources (hydro, wind, solar, biomass (waste), geothermal heat and power generation). Grid (natural gas, electricity, district heating) power systems (demand, process, operational models, security of supply). Energy policy: prices, internal and external costs, ownership, operation models in a globalized world.

THERMAL POWER PLANTS I. (PhD Final exam) BMEGEENHDS1 3 cp
THERMAL POWER PLANTS II. (PhD Final exam) BMEGEENHDS2 3 cp
Lecturer: Dr. Bihari, Péter
Power balance of electrical power system, importance of back-up power plants in the system and defining their required size. Economic evaluation of heat and electricity production. Utilisation of renewable energies in heat and electricity production and their effects on the system grid. Optimal supply allocation in the energy production. Handling and describing the externalities in the energy production. Technologies in power generation, tri- and polygeneration systems. Smart and microgrids in the electricity production. Production planning during operation of power plant. Relation between greenhouse effect and production of electricity in thermal power plants. Development trends in power plant technology. Advanced combined cycle power plants (CCPP), role of the coal in CCPP. Complex systems for environmental protection in fossil fuel fired thermal power plants.

HEAT ENGINES I. (PhD Final exam) BMEGEKG8306 3 cp
HEAT ENGINES II. (PhD Final exam) BMEGEKG8307 3 cp
Lecturer: Dr. Bereczky, Ákos

Introduction of the theoretical and real working cycles of the boilers and steam generators, cooling and heat pump systems, steam and gas turbines and internal combustion engines. The interaction of the real working cycle and design of the mechanisms and the systems will be presented too. Modeling procedures started from theory to real process analysis will be shown, including the load control and control loops of the systems. Also will be presented the safety and environmental protection requirements; reduction of emissions and methods of application of these techniques. Validation of the energy and economic aspects of the construction, in planning and in operation.

HEAT ENGINES BMEGEKG8308 3 cp
Lecturer: Dr. Bereczky, Ákos

Students will be introduced the real procedures in heat engines and energy conversion systems by reaction kinetics, flow- and thermal-dynamical analysis. The real operation and structures of different equipment and evaluation procedure will be demonstrated. Through the examples the operation will be presented in the aspects of energy efficiency and environmental protection. Modeling procedures started from theory to real process analysis will be presented too.

COMBUSTION TECHNOLOGY I. (PhD Final exam) BMEGEKG8315 3 cp
COMBUSTION TECHNOLOGY II. (PhD Final exam) BMEGEKG8316 3 cp
Lecturer: Dr. Lezsovits, Ferenc


COMBUSTION TECHNOLOGY BMEGEKG9315 3 cp
Lecturer: Dr. Lezsovits, Ferenc

Thermodynamics of combustion process, reaction kinetics, ignition procedures. Flame propagation in laminar and turbulent flow. Possible structures and stability of flames and parameters having effect on them. Modelling of combustion procedures. Procedures in combustion procedures including chemical reaction,
fluid flow, heat transfer and correlations among them. Integration possibilities of catalytic procedures. Reduction of pollutant emission and environmental effects. Evaluation of different firing solutions of solid, liquid and gaseous fuels. Explosion and firing safety questions of firing and fuel technologies.

**INTERNAL COMBUSTION ENGINES**  
BMEGEK8621  3 cp  
Lecturer: Dr. Bereczky, Ákos

The topics of the lectures are the follow: main elements and definitions, theoretical and real cycles of the engines, losses and main related parameters. Introduction of the mixing systems, ignition systems and abnormal combustion processes of spark ignition engines. The subject covers in detail of the combustion process and mixing and control systems of the compression ignition engines. Presentation of the down-sizing technologies and environmental protection requirements and reduction of emissions.

**GAS AND STEAM TURBINES**  
BMEGEK8622  3 cp  
Lecturer: Dr. Sztankó, Krisztián


**COOLING MACHINES AND HEAT PUMPS**  
BMEGEK8625  3 cp  
Lecturer: Dr. Maiyaleh, Tarek


**THERMODYNAMIC WORKING FLUIDS**  
BMEGEENDTDM  3 cp  
Lecturer: Dr. Imre, Attila R.


**FLUIDIZED BED CONVERSION**  
BMEGEENDFAK  3 cp  
Lecturer: Dr. Szentannai, Pál


**NONEQUILIBRIUM THERMOMECHANICS OF SOLID CONTINUA**  
BMEGEENDSKT  3 cp  
Lecturer: Dr. Fülöp, Tamás


Department of Building Services and Process Engineering

BUILDING SERVICE SYSTEMS I. (PhD Final exam)  BMEGEÉP8305  3 cp
BUILDING SERVICE SYSTEMS II. (PhD Final exam)  BMEGEÉP0305  3 cp
Lecturers: Dr. Garbai, László; Dr. Bánhidi, László; Dr. Barna, Lajos; Dr. Kajtár, László; Dr. Szánthó, Zoltán


COMFORT THEORY I. (PhD Final exam)  BMEGEÉP8309  3 cp
COMFORT THEORY II. (PhD Final exam)  BMEGEÉP0309  3 cp
Lecturers: Dr. Bánhidi, László; Dr. Kajtár, László


HEATING (PhD)  BMEGEÉP9531  3 cp
Lecturers: Dr. Bánhidi, László; Dr. Csoknyai, István


VENTILATION SYSTEMS I. (PhD)  BMEGEÉP8533  3 cp
Lecturer: Dr. Kajtár, László

Ventilation system and their alignment, classification from design aspects. Determination of supply airflow rate for continuous and periodic ventilation. System requirements. Designing ventilation systems in closed

**VENTILATION SYSTEMS II. (PhD)**

Lecturer: Dr. Kajtár, László


**AIR-CONDITIONING (PhD)**

Lecturer: Dr. Kajtár, László


**AIR-CONDITIONING SYSTEMS (PhD)**

Lecturer: Dr. Kajtár, László

Systems with central air handling units. Air-conditioning systems with local intervention design. Multi Zone Air Conditioning Systems. VAV and VRU systems. Indoor Air Quality providing, effect of air exchange and air distribution. Types of air-conditioning systems, comfort spaces, clean rooms, operating rooms, air-conditioning for different technologies.

**PROCESS INSTRUMENTATION AND CONTROL I. (PhD Final exam)**

Lecturer: Dr. Balázs, Tibor


**PROCESSES AND EQUIPMENT I. (PhD Final exam)**

Lecturers: Prof. Láng, Péter; Dr. Örvös, Mária


**PROCESS EQUIPMENT DESIGN I. (PhD Final exam)**

Lecturer: Dr. Nagy, András
Construction of storage tanks, mixers, heat exchangers, and columns used in chemical and food industry. Design guidelines, engineering materials, shape and size, manufacture process and economic issues, reliability, transport and installation guarantee. The creation of a structural, load and calculation models. The appropriate strength, sufficient stiffness, heat or low temperature and corrosion resistance and ensure economically exploitable life. Typical structural solutions, flanged joints, gaskets, nozzles and joints, force-insertion site and design of support structures. Static and dynamic control of pipelines. Corrosion protection aspects of the design. Vacuum devices and high-pressure equipment design. Design of hybrid structures made of reinforced plastic and metal equipment and special composite systems. Optimization and computer-aided design.

TRANSPORT PHENOMENA I. (PhD Final exam) BMEGEVÉ611S 3 cp
TRANSPORT PHENOMENA II. (PhD Final exam) BMEGEVÉ611Z 3 cp
Lecturer: Prof. Láng, Péter

Description of heat, mass and momentum transport with non-equilibrium thermodynamic methods and phenomenological equations. Relation between thermodynamic and phenomenological equations. Similarity of laminar and turbulent transports. Similarity and generalisation of boundary layer equations. Problems of simultaneous transports, their interactions and solution facilities.

MODELLING OF FOOD INDUSTRIAL PROCESSES BMEGEVÉ626D 3 cp
Lecturers: Dr. Örvös, Mária; Dr. Both, Kinga


PROCESS SIMULATION (PhD) BMEGEVÉ623D 3 cp
Lecturers: Prof. Láng, Péter; Dr. Balázs, Tibor


GREEN TECHNOLOGIES BMEGEVÉ619D 3 cp
Lecturers: Dr. Örvös, Mária; Dr. Láng, Péter; Dr. Both, Kinga


Department of Machine and Product Design

ENGINEERING DESIGN I. (PhD Final exam) BMEGEGE014D 3 cp
ENGINEERING DESIGN II. (PhD Final exam) BMEGEGE015D 3 cp
ENGINEERING DESIGN BMEGEGE004D 3 cp
Lecturers: Dr. Bercsey, Tibor; Dr. Horák, Péter

**NUMERICAL METHODS IN MACHINE DESIGN (PhD Final exam)**

**BMGEGE003D  3 cp**

**Lecturers:** Dr. Váradi, Károly; Dr. Goda, Tibor

General techniques of structural analysis. Generating the structural and FEM models (truss, beam, shell, 2D and 3D models). Producing combined structural and FEM models. Loading models. Advanced preprocessing and postprocessing.


**DESIGN OF POLYMER PRODUCTS**  

**BMGEGE009D  3 cp**

**Lecturer:** Dr. Grőb Péter


**TRIBOLOGY**  

**BMGEGE010D  3 cp**

**Lecturers:** Dr. Kozma, Mihály; Dr. Váradi, Károly


**DRIVE TECHNOLOGY**  

**BMGEGE008D  3 cp**

**Lecturers:** Dr. Kozma, Mihály; Dr. Horák, Péter


**PRODUCT DEVELOPMENT I. (PhD Final exam)**  

**BMGEGET01D  3cp**

**Department of Manufacturing Science and Technology**

**MANUFACTURING PROCESS PLANNING I. (PhD Final exam)**

**BMEGEGT9002 3 cp**

Lecturer: Dr. Horváth, Mátyás


**MATERIAL AND MANUFACTURE ENGINEERING II (PhD Final exam) BMEGEGT0002 3 cp**

Lecturer: Dr. Horváth, Mátyás


**MANUFACTURING ACCESSORY DEVICES I. (PhD Final exam)**

**BMEGEGT9004 3 cp**

Lecturers: Dr. Mátyási, Gyula

The subject extends the tool design knowledge to the manufacturing science oriented PhD students. Hierarchy of manufacturing accessory devices planning, material removal and shaping, functional analysis, manufacturing geometry. Geometric design of cutting tools, and construction planning of them. Advanced tool materials and their application. Principles and methods of position determination. Modern principles of

MANUFACTURING ACCESSORY DEVICES II. (PhD Final exam)
BMEGEGT0005 3 cp
Lecturers: Dr. Markos, Sándor;


MANUFACTURING SYSTEMS I. (PhD Final exam) BMEGEGT9006 3 cp
Lecturers: Dr. Németh, István; Dr. Váncza, István

The subject focuses on the composition and layout of manufacturing systems. Building blocks, layouts, classifications, representations and mathematical models of manufacturing systems. Influence of designing methods (CAD, CAE), production planning methods (e.g. group technology, CAM, CAPP) and production control strategies (pl. just-in-time, lean manufacturing) on the design of manufacturing systems. Evaluation methods of manufacturing system. Systematic planning and design of the resources and layout of manufacturing system. Methodologies and software tools for modelling, simulation, evaluation and optimisation of manufacturing system.

PRODUCTION SYSTEMS II. (PhD Final exam) BMEGEGT0007 3 cp
Lecturers: Dr. Németh, István; Dr. Váncza, István

The course focuses on production networks: it provides an introduction into the design, (re-) organization, and operational planning of production networks. Methods of communication are surveyed along with the issues of coordination and cooperation in networks. Both theoretical and pragmatic methods of coordination are discussed. Mathematical models of integrated production and logistics planning problems are presented by making use of an advanced mathematical programming environment. Finally, an introduction is provided into the simulation of production networks by means of agent technologies.

ROBOTICS I. (PhD Final exam) BMEGEGT9008 3 cp
Lecturers: Dr. Németh, István; Dr. Arz, Gusztáv; Dr. Szalay, Tibor


ROBOTICS II. (PhD Final exam) BMEGEGT0009 3 cp
Lecturers: Dr. Szalay, Tibor, Dr. Monostori, László

PROCESS SUPERVISION AND DIAGNOSTICS       BMEGEGT8563        3 cp
Lecturers: Dr. Szalay, Tibor, Dr. Markos, Sándor; Dr. Monostori, László


THEORY OF MACHINING          BMEGEGT8564        3 cp
Lecturer: Dr. Takács, Márton


DESIGN OF METAL-CUTTING MACHINE TOOLS AND MACHINE SYSTEMS BMEGEGT8565        3 cp
Lecturer: Dr. Németh, István

Kinematics of metal cutting machine tools. Methods of conceiving design variants. Main types of machine tools:
- from the lathe to the turning centre,
- from the milling machine to the machining centre.
Flexible manufacturing cells (FMC) and manufacturing systems (FMS). Structural building blocks and their selection and assembly.
Precision and reliability of machine tools.

CONTROL AND SUPERVISING OF MANUFACTURING SYSTEMS BMEGEGT8566        3 cp
Lecturers: Dr. Monostori, László; Dr. Mezgár, István

Overview the basic tasks of manufacturing control systems and the initialisation and synchronisation its processes. Introduction of the agent-based logical control model. Presentation the layers and SW elements of the ISA-95 domain hierarchy. Introduction the extended command system of NC controls, and the tasks of the controlling computer. Overview the language tools and the applicable communication, and network standards of control (e.g. OPC-UA, MAP).

METROLOGY          BMEGEGT8571        3 cp
Lecturer: Dr. Szalay, Tibor

Theory and applications of both dimensional and process measurements. Processing of measured data, design of experiments and statistical analysis. Coordinate measuring machines and coordinate measurement theory. Laser interferometry and surface digitalisation. Measuring the micro-geometry. Multisensory systems, measurements of the most important process features (force, torque, temperature, vibration …). On-line monitoring techniques.

APPLIED ARTIFICIAL INTELLIGENCE    BMEGEGT9101        3 cp
Lecturer: Dr. Váncza, István
The course is based on the material of the “Basics of Artificial Intelligence” course and provides a deeper insight into some selected fields of Artificial Intelligence (AI). The actual topics fit to the doctoral research themes of the PhD students who may tackle their own problems by making use of up-to-date AI methods, tools and techniques. However, emphasis is put on taking a critical approach to contemporary AI methods. Survey of related literature and learning the application of some selected AI tools is part of the program.

**ARTIFICIAL INTELLIGENCE IN MANUFACTURING**  
BMEEGGT9103  3 cp  
Lecturers: Dr. Monostori, László; Dr. Váncza, István

The design, management, monitoring and diagnostics of modern manufacturing systems call in many cases for the application of artificial intelligence (AI) tools and techniques. The course is aimed at presenting the appropriate AI methods along with their application examples, with a special emphasis on the faculties of handling uncertain information and knowledge, as well as learning. Beyond symbolic AI methods (like rule-based system) so-called subsymbolic methods using artificial neural network (ANN) representation will also be discussed. In fact, the course will center around the hybrid methods that combine the two main approaches.

**NEURAL NETWORKS AND THEIR APPLICATIONS**  
BMEEGGT9104  3 cp  
Lecturer: Dr. Monostori, László

The course is aimed at presenting such methods of artificial intelligence (AI) that are particularly applicable in intelligent manufacturing systems. Theoretical basics will be discussed along with application examples. Specifically, the course introduces artificial neural networks (ANNs), discusses the main models and their main application areas with a special focus on manufacturing engineering. Symbolic methods of knowledge representation and reasoning (primarily, rule-based representation) will be compared with the subsymbolic approach of ANNs. Finally, hybrid models (such as hierarchical and neuro-fuzzy systems) integrating the two approaches will be discussed together with their application in manufacturing.

**Department of Hydrodynamic Systems**

**FLUID MACHINERY AND HYDRODYNAMIC SYSTEMS 1. (PhD Final exam)**  
BMEGEVG930D  3 cp

**FLUID MACHINERY AND HYDRODYNAMIC SYSTEMS 2. (PhD Final exam)**  
BMEGEVG030D  3 cp

**FLUID MACHINERY AND HYDRODYNAMIC SYSTEMS (PhD)**  
BMEGEVG830D  3 cp  
Lecturer: Dr. Kullmann, László


**NONSMOOTH DYNAMICAL SYSTEMS**  
BMEGEVG001D  3 cp  
Lecturer: Dr. Hös, Csaba
The course provides a first insight into the qualitative and quantitative analysis of systems of ordinary differential equations and maps with nonsmooth right-hand sides. The course material covers the analysis of impacting systems, hybrid systems and Filippov systems, stability analysis of orbits and the corresponding numerical techniques. The student projects allow direct application of the techniques on real-life engineering systems.

Department of Mechatronics, Optics and Mechanical Engineering Informatics

METROLOGY I (PhD Final exam)  BMEGEFO9054  3 kp
METROLOGY II (PhD Final exam) BMEGEFO9064  3 kp
METROLOGY  BMEGEFO9074  3 kp
Responsible: Dr. Samu Krisztián
Lecturer: Dr. Huba, Antal; Dr. Samu, Krisztián

The role of technical information obtained by measurement in scientific, technical research. Measurement as a modelling process. Traditional and novel models of measurement. Information theory model of measurement. Information theoretical questions in metrology: amount of information obtained by measurement, entropy of error. Classification of origins of errors, theoretical and technical aspects of error reduction. Selected examples of the state of the art measurement methods of static and dynamic quantities in mechanical engineering. MEMS and MEOMS devices in mechanical engineering measurements, electrical and optical principles, with an emphasis on the application of fiber optics, interferometry and laser technology. Methods for realization of measurements. Organization of typical signals in mechanical engineering. Concepts of signal, message, information. Mathematical and measurement technical apparatus of signal analysis. Set-up and tasks of measurement chains, and their fitting to signals to be measured. Electronic devices of signal processing in mechanical engineering research.

MECHATRONICS I  BMEGEFO6206  3 kp
MECHATRONICS II  BMEGEFO6216  3 kp
MECHATRONICS  BMEGEFO6226  3 kp
Responsible and lecturer: Dr. Korondi, Péter


OPTICS I  BMEGEMIDSO1  3 kp
OPTICS II  BMEGEMIDSO2  3 kp
OPTICS  BMEGEMIDVOP  3 kp
Responsible: Dr. Ábrahám, György
Lecturer: Dr. Ábrahám, György; Dr. Wenzel, Gottfriedné

APPLIED LASER TECHNOLOGY

BMEGEFO8541  3 kp
Responsible: Dr. Ábrahám, György
Lecturer: Dr. Ábrahám, György; Dr. Ujhelyi, Ferenc


ELEMENTS OF PRECISION INSTRUMENTS

BMEGEFO8542  3 kp
Responsible: Dr. Samu Krisztán
Lecturer: Dr. Halmai Attila, Dr. Samu Krisztán


OPTICAL INSTRUMENTS AND MEASURING TECHNOLOGY

BMEGEFO8545  3 kp
Responsible: Dr. Ábrahám György
Lecturer: Dr. Ábrahám György, Dr. Wenzel Gottfriedné


SENSORS AND ACTUATORS

BMEGEMIDVSA  3 kp
Responsible: Dr. Tamás Péter
Lecturer: Dr. Halmai Attila, Dr. Tamás Péter


COLORIMETRY

BMEGEFO8547  3 kp
Responsible: Dr. Samu Krisztán
Lecturer: Dr. Wenzel Gottfriedné, Dr. Samu Krisztán


Department of Applied Mechanics

MECHANICS I. (Fundamentals of continuum mechanics, PhD Final exam) BMEGEMM011D  3 cp
Lecturers: Dr. Béda, Gyula; Dr. Kossa, Attila


MECHANICS II. (Advances in continuum mechanics, PhD Final exam) BMEGEMM021D 3 cp
Lecturers: Dr. Béda, Gyula; Dr. Kossa, Attila


MECHANICS II. (Large elastoplastic deformation, PhD Final exam) BMEGEMM024D  3 cp
Lecturer: Dr. Szabó, László


NUMERICAL METHODS (Numerical Methods in Mechanics, PhD Final exam) BMEGEMM031D  3 cp
Lecturer: Dr. Kovács, Ádám


Material law of anisotropic bodies, stiffness and compliance matrices. Transformation of stresses in orthotropic layers. Classical (Kirchhoff) theory of laminated plates. Extensional, coupling and bending

**Department of Polymer Engineering**

**NANOCOMPOSITES**

Lecturers: Dr. Mészáros, László; Dr. Karger-Kocsis, József

This course focuses on the nanocomposites, their components (nanomaterials and matrix materials), manufacturing methods, characterization and applications. Different types of nanomaterials will be presented, that can influence the mechanical, thermal, electrical, etc. properties of the matrix materials by different ways. The major preparation routes of these nanocomposites are discussed.

**POLYMER STRUCTURES I. (PhD exam)**

Lecturers: Dr. Vas, László Mihály; Dr. Karger-Kocsis, József


**POLYMER PROCESSING TECHNOLOGIES I. (PhD exam)**

Lecturers: Dr. Czvikovszky, Tibor; Dr. Czigány, Tibor; Dr. Karger-Kocsis, József


**POLYMER COMPOSITES I. (PhD exam)**

Lecturers: Dr. Czigány, Tibor; Dr. Vas, László Mihály; Dr. Karger-Kocsis, József