Study in the European Union

Study at BME

Your future career begins at the Budapest University of Technology and Economics
Dear Student,

You are reading the Bulletin of the Budapest University of Technology and Economics. Its direct predecessor, the Institutum Geometricum, was established in 1782 by Emperor Joseph II, as part of the Faculty of Liberal Arts at the University of Buda. During the past 237 years the professors of the university have striven to provide an outstanding quality of education. This has earned the university an international reputation, attracting students and also professors from all over the world.

Our university has eight faculties. They are, in order of foundation: Civil Engineering, Mechanical Engineering, Architecture, Chemical Technology and Biotechnology, Electrical Engineering and Informatics, Transportation Engineering and Vehicle Engineering, Natural Sciences, Economic and Social Sciences.

“Education is the most powerful weapon which you can use to change the world.”

This is the quotation from Nelson Mandela. It is unquestionably true and especially applicable for engineers who have the power to make a better world:
Sustainable energy, clean water, safe transport on roads and on bridges, producing less pollution, buildings for comfortable living and working, machines and robots for work and for amusement, fast and reliable communications, medical equipment that assure a good quality of life for the individual and can be financed by society, and healthy food for us all. All of these goals need engineering solutions to make the world a safer, better and more exciting place to be. This is also your responsibility. You can acquire the necessary knowledge and skills to make your own contribution. As a graduate you will certainly do your best for your colleagues, company and society.

Two components are decisive for a good diploma: good teachers and a good student. I can say our university provides you with excellent teachers – you must be good students! I am sure it is worth being so.
Besides, you will love it: the university years will be your best memory, the engineering profession will provide you the joy of creation.
Hungary is a member of the European Union. As a student in Budapest you will find general European as well as particular Hungarian cultural customs: food, fashion, folk art, music and dance.

Use this bulletin to help you consider our programs. Come to visit our campus. Better yet, come to study with us for one or two semesters or for an entire degree program. Should you decide to stay for only one semester, this bulletin will also help you choose from among the different semester programs.

The Budapest University of Technology and Economics extends a special welcome to students from abroad.

Károly Veszprémi
vice-rector for education
### Available study programmes for 2019/2020 academic year

<table>
<thead>
<tr>
<th>BSc programmes</th>
<th>Faculty</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chemical Engineering</td>
<td>Faculty of Chemical Technology and Biotechnology</td>
</tr>
<tr>
<td>Civil Engineering</td>
<td>Faculty of Civil Engineering</td>
</tr>
<tr>
<td>Computer Engineer</td>
<td>Faculty of Electrical Engineering and Informatics</td>
</tr>
<tr>
<td>Electrical Engineering</td>
<td>Faculty of Electrical Engineering and Informatics</td>
</tr>
<tr>
<td>Mathematics</td>
<td>Faculty of Natural Sciences</td>
</tr>
<tr>
<td>Mechanical Engineering</td>
<td>Faculty of Mechanical Engineering</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>MSc/MA* programmes</th>
<th>Faculty</th>
</tr>
</thead>
<tbody>
<tr>
<td>Architecture (Five-year Integrated Master Program and Master in Architecture Program)</td>
<td>Faculty of Architecture</td>
</tr>
<tr>
<td>Chemical Engineering</td>
<td>Faculty of Chemical Technology and Biotechnology</td>
</tr>
<tr>
<td>Computer Engineer</td>
<td>Faculty of Electrical Engineering and Informatics</td>
</tr>
<tr>
<td>Electrical Engineering</td>
<td>Faculty of Chemical Technology and Biotechnology</td>
</tr>
<tr>
<td>Environmental Engineering</td>
<td>Faculty of Chemical Technology and Biotechnology</td>
</tr>
<tr>
<td>Finance*</td>
<td>Faculty of Natural Sciences</td>
</tr>
<tr>
<td>Management and Leadership*</td>
<td>Faculty of Economic and Social Sciences</td>
</tr>
<tr>
<td>Regional and Environmental Economic Studies*</td>
<td>Faculty of Mechanical Engineering</td>
</tr>
<tr>
<td>Mechanical Engineering Modelling</td>
<td>Faculty of Mechanical Engineering</td>
</tr>
<tr>
<td>Physics</td>
<td>Faculty of Natural Sciences</td>
</tr>
<tr>
<td>Structural Engineering</td>
<td>Faculty of Civil Engineering</td>
</tr>
<tr>
<td>Autonomous Vehicle Control Engineering</td>
<td>Faculty of Transportation Engineering and Vehicle Engineering</td>
</tr>
<tr>
<td>Transportation Engineering</td>
<td>Faculty of Transportation Engineering and Vehicle Engineering</td>
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<tr>
<td>Vehicle Engineering</td>
<td>Faculty of Transportation Engineering and Vehicle Engineering</td>
</tr>
<tr>
<td>Logistics Engineering</td>
<td>Faculty of Transportation Engineering and Vehicle Engineering</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>PhD programmes</th>
<th>Faculty</th>
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<tr>
<td>Architecture Engineering</td>
<td>Faculty of Architecture</td>
</tr>
<tr>
<td>Architecture (DLA program)</td>
<td>Faculty of Architecture</td>
</tr>
<tr>
<td>Business and Management</td>
<td>Faculty of Economic and Social Sciences</td>
</tr>
<tr>
<td>Chemistry</td>
<td>Faculty of Chemical Technology and Biotechnology</td>
</tr>
<tr>
<td>Chemical-Bio- and Environmental Engineering</td>
<td>Faculty of Chemical Technology and Biotechnology</td>
</tr>
<tr>
<td>Civil Engineering Sciences and Earth Sciences</td>
<td>Faculty of Civil Engineering</td>
</tr>
<tr>
<td>Computer Engineer</td>
<td>Faculty of Electrical Engineering and Informatics</td>
</tr>
<tr>
<td>Electrical Engineering</td>
<td>Faculty of Natural Sciences</td>
</tr>
<tr>
<td>Mathematics and Computer Science</td>
<td>Faculty of Mechanical Engineering</td>
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<td>Physical Sciences</td>
<td>Faculty of Mechanical Engineering</td>
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<tr>
<td>Mechanical Engineering Science</td>
<td>Faculty of Mechanical Engineering</td>
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<tr>
<td>Autonomous Vehicle Control Engineering</td>
<td>Faculty of Transportation Engineering and Vehicle Engineering</td>
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<tr>
<td>Transportation Engineering</td>
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<td>Logistics Engineering</td>
<td>Faculty of Transportation Engineering and Vehicle Engineering</td>
</tr>
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</table>

### Tuition Fees for 2019/2020 academic year

<table>
<thead>
<tr>
<th>Course</th>
<th>Semesters</th>
<th>For EU citizens</th>
<th>For non-EU citizens</th>
</tr>
</thead>
<tbody>
<tr>
<td>Preparatory Course and General Course in Architecture</td>
<td>2</td>
<td>EUR 3,200 / semester</td>
<td>EUR 3,200 / semester</td>
</tr>
<tr>
<td>Undergraduate Tuition Fees, leading to B.Sc. degree</td>
<td>6 or 7</td>
<td>EUR 2,250 / semester</td>
<td>EUR 3,200 / semester</td>
</tr>
<tr>
<td>Undergraduate Tuition Fees, leading to B.Sc. degree in Civil Engineering</td>
<td>8</td>
<td>EUR 3,200 / semester</td>
<td>EUR 3,200 / semester</td>
</tr>
<tr>
<td>Graduate Tuition Fees, leading to M.Sc. degree for graduates of external higher education institutions</td>
<td>4</td>
<td>EUR 3,200 / semester</td>
<td>EUR 3,500 / semester</td>
</tr>
<tr>
<td>Graduate Tuition Fees, leading to M.Sc. degree for graduates of BME</td>
<td>4</td>
<td>EUR 2,850 / semester</td>
<td>EUR 3,200 / semester</td>
</tr>
<tr>
<td>Graduate Tuition Fees, leading to M.Sc. degree in Structural Engineering</td>
<td>3</td>
<td>EUR 3,800 / semester</td>
<td>EUR 3,800 / semester</td>
</tr>
<tr>
<td>Graduate Tuition Fees, leading to M.Sc. degree in Architecture</td>
<td>10</td>
<td>EUR 2,850 / semester</td>
<td>EUR 3,200 / semester</td>
</tr>
<tr>
<td>Postgraduate Tuition Fees, leading to Ph.D. or DLA degree (Depending on the character of the research and course programs)</td>
<td>8</td>
<td>EUR 4,500 / semester</td>
<td>EUR 4,500 / semester</td>
</tr>
<tr>
<td>Tuition Fees for special students (courses leading to no degree)</td>
<td>EUR 110/credits (min. 12 lessons/week)</td>
<td>EUR 110/credits (min. 12 lessons/week)</td>
<td></td>
</tr>
<tr>
<td>Tuition Fees for special students (courses leading to no degree) in Civil Engineering</td>
<td>EUR 2,000 / semester minimum</td>
<td>EUR 2,000 / semester minimum</td>
<td></td>
</tr>
</tbody>
</table>
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White rabbit educational consultancy
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The Faculty of Architecture at the Budapest University of Technology and Economics focuses on training highly professional experts in architectural engineering who are aware of the social and cultural implications of their profession. Versatility is emphasised so that students will gain fundamental knowledge and abilities in every possible field of architecture and be able to find work in a highly competitive job market, and in any building- or design-related area of consulting, construction, and management. The Academic Programs of the Faculty of Architecture in English are as follows:

1. Integrated MSc Program, which is a five-year (10 semester) long training and leads directly to an MSc degree in Architecture and Architectural Engineering (Dipl. Ing. Arch.),
2. Masters’ Program, which is a two-year (4 semester) long training and leads to an MSc in Architecture. Students who have earned BSc degrees in other schools of architecture can join the Master’s Program.
3. PhD, DLA. The Faculty of Architecture offers graduate studies in its two graduate schools. The program of the Doctoral School of Architecture leads to the PhD-equivalent degree Doctor of Liberal Arts (DLA). The four year long curriculum strongly focuses on creative architectural design supported by project-based research. Studies in Csonka Pál Graduate School cover a wide range of scientific and engineering topics related to architecture and building such as history of architecture or applied mechanics. The focus of this school is independent research under personal supervision.

Graduates of the Faculty of Architecture are qualified for a broad spectrum of architectural occupations:
- Design, construction and maintenance of residential, public, industrial and agricultural buildings;
- Reconstruction and the preservation of historical monuments;
- Urban design and settlement planning; and
- Administration of all these activities.

The curricula were organised on Swiss and German models. The Faculty has maintained these traditions for the last 40 years but provides additional European and international dimensions through guest lecturers from abroad, topical short courses, workshop seminars and exchange programs.

The Academic Programs of the Faculty of Architecture taught in English are in full conformity with the Integrated MSc and MSc programs provided in Hungarian, which after two years practice and experience are accepted for access to EUR-ING title.

General course – Preparatory Course

The year program in English, called the General Course precedes the Degree Program. It is designed to develop the skills of students from abroad so they will be at no disadvantage in meeting the Faculty’s exacting educational standards. Students are introduced to various aspects of the profession they have selected, and they concentrate on studying English and basic technical subjects such as mathematics and freehand drawing. The whole, or partial fulfilment of the General Course doesn’t replace the Placement Test. Only students who successfully pass the Placement Test can automatically (immediately) start the Integrated MSc program.

Academic Program of the Faculty of Architecture

- For integrated MSc degree (10 semesters) students have to accumulate min 300 credit points.
- For MSc degree (4 semesters) students have to accumulate min 120 credit points.

Both Programs require to accomplish obligatory subjects and elective subjects too.

Students, both International and Hungarian, who have a command of both languages can choose from either program. The participation of Hungarian students in the program given in English has obvious advantages. It eases the integration of international students into the society, which surrounds them during the years of their studies. It also attracts students from European, American and other universities worldwide to study in
Budapest within the framework of the International Student Exchange Program and other agreements.

Hungarian students likewise gain the opportunity to study at schools of architecture abroad. These exchanges will become a powerful factor in achieving real convertibility among educational systems worldwide and, eventually, mutual international recognition of degrees.

**Master’s Program**

Students who have earned BSc degrees in other schools of architecture can join the Master’s Program. In the program, students can choose after the first semester from the following specialisations:

- Real-Estate Development and Facility Management
- Architectural and Interior Design
- Urban Design
- Structural Design

*Note: The Faculty of Architecture reserves the right of changing the Curricula. Specialisations have a minimum required number of students to start.*

**Graduation**

Graduation from the University is based on the successful completion of examinations in all subjects and on the successful defence of a diploma project in front of a Final Examination Board. The examinations are public and the Board consists of professors and eminent specialists in the profession. Diploma projects are prepared in the last semester under departmental guidance and can be submitted only by students with an “absolutorium” (university leaving certificate). The diploma project is expected to reflect its author’s familiarity with technical and aesthetic knowledge fundamental to architectural practice, and his/her creativity in applying it. Currently, international agreements make it possible for certain Hungarian students to prepare and defend their diploma projects in the university of another country. Students from abroad can correspondingly prepare and defend their thesis projects under the guidance of the Faculty of Architecture at the Budapest University of Technology and Economics.

**Departments**

- Department of Architectural Geometry and Informatics
- Department of Construction Technology and Management
- Department of History of Architecture and Monument Preservation
- Department of Building Energetics and Building Service
- Department of Building Constructions
- Department of Industrial and Agricultural Building Design
- Department of Public Building Design
- Department of Residential Building Design
- Department of Graphics, Form, and Design
- Department of Mechanics, Materials and Structures
- Department of Urban Planning and Design
- Laboratory of Building Acoustics
- Laboratory of Thermal Physics
# General (Preparatory) Courses in Architecture

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a) can be taken parallely in the same semester. For students of BME Faculty of Architecture only criteria subjects (no credit points)
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### Curriculum of Integrated MSc Program

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a) can be taken parallelly in the same semester
s) signature only
Minimum number of credits for M. Sc. Degree: 300
## Curriculum of Masters’ Program

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*: For Real-estate Development and Facility Management
**: For Architectural and Interior Design
***: For Urban Design
****: For Structural Design

a) can be taken parallelly in the same semester
s) signature only

Minimum number of credits for MSc degree: 120
The education of chemical engineers and chemists has a long-standing tradition in Hungary dating back to the 18th century. Chemical engineering curricula, separating from that of mechanical and civil engineers, reach back to the 1863/64 academic year. In the 1960s chemical engineering studies were extended to the master level and introduced the range of specialised studies already. A doctoral school having a pioneering PhD program has also been established which was developed to be one of the most successful one in Hungary. Studies in English at the Faculty of Chemical Technology and Biotechnology began in the 1985/86 academic year. Currently bachelor (BSc, 7 semesters), master (MSc, 4 semesters) and doctoral (PhD, 8 semesters) studies are offered. Although the education profile in Hungarian includes chemical, biochemical and environmental engineering at each level, pharmaceutical and polymer and textile engineering at MSc level, the English curricula are only offered in chemical engineering (all levels), in environmental engineering (master level) and as doctoral studies. However, elective courses are available in English in all areas of our education. All programs are organised in the credit system providing a relatively high degree of freedom in subject selection, but prerequisites have to be taken into account when the individual study program is set.

Further information on the Faculty can be found at our website: http://ch.bme.hu/en/
the principles needed for their optimal operation, and develop expertise in a more specific technology within the chemical, food and light industries. Furthermore, our chemical engineering branch, compared to the typical curricula internationally, is highly synthetic and analytical chemistry focused resulting in an excellent understanding of chemical processes and their monitoring. Specialisations start in the fifth semester and are available to students depending on the number of applicants (minimum 6):

- Analytical and Structural Chemistry
- Chemical and Process Engineering
- Industrial Pharmaceutics
- Materials Science
- Plastic and Textile Technology

The studies are completed by performing an individual bachelor thesis project and submission of the thesis. Graduation is completed, after all required credits are gained, by a successful defence of the thesis and a final examination before the Final Examination Board of professors and eminent industrialists.

**Master in chemical engineering**

Chemical engineering MSc students get a high level knowledge in natural sciences, engineering, informatics and economics as well as in humanities. On an international comparison our curriculum is chemistry focused, and it is especially suitable for motivated applicants having carrier plans in research and development or project management.

Applicants of holding chemical engineering bachelor degree (or related) are welcome to widen their knowledge and skills in technological scientific fields of the chemical industry. Entrance exam includes chemical engineering. A B2 level (according to CEFR) of English is required.

Graduates will be versed in:

- operations and personnel involved in chemical processes on an industrial scale,
- development of the technology and products of industrial chemical processes,
- design of industrial chemical processes,
• how a chemical product or application is introduced into the national economy, and
• innovation of chemical processes, operations and technologies.

The newly reformed specialisation program offers a wide selection of courses grouped in five modules: analytics, materials science, biotechnology, pharmaceuticals and technology. Those, who completely gain the credits of any of these modules, will receive an extra certificate at their graduation. It is also possible to select the most interesting ones from the listed courses to gain a wide knowledge of the most important fields of the modern chemical industry.

The studies are completed by performing an individual master thesis project and submission of the thesis. Graduation is completed, after all required credits are gained, by a successful defence of the thesis and a final examination before the Final Examination Board of professors and eminent industrialists.

Master in environmental engineering

Protection of the environment is a major global issue and all nations have their task to ensure the availability of pure air, drinking water and rich soil for our and for the next generation. Obviously, industrial production is required to fulfil the needs of our societies. Thus engineers are required in each sectors of industry having deep knowledge both in their sector and in the environmental protection field. One of the biggest and most reputed institutions of this kind in Europe, the Budapest University of Technology and Economics has educated generations of engineers since its foundation in 1782. Its eight faculties of different engineering disciplines, sciences, economics and humanities actively participate in environmental education granting among others postgraduate degrees from 1974 onwards. The University has excellent training facilities: laboratories, pilot plants, computer network and a wide system of international relations.

Environmental engineering graduates are able to
• understand technologies especially be involved in developments aiming emission minimization
• select the best technique for environment protection and has a good understanding on the role of optimization
• evaluate and use analytical data and make decisions based on evidence
• are practiced in using the management tools of environmental protection
• communicate efficiently with professionals of various fields and with the public as well.

Environmental engineers find jobs in all industrial sectors since the environmental protection has profound importance in the modern industry. Environmental engineers graduated at BME are excellent in understanding chemical pollution, chemical analytics and chemical processes.

Applicants of holding any engineering degrees are welcome to widen their knowledge and skills in technological and managements fields of environmental protection. Good knowledge in chemistry, mathematics and engineering are required, since the aim of the curricula to top up an instantly applicable knowledge in all areas of environmental protection. Entrance exam includes basic chemistry. A B2 level (according to CEFR) of English is required.

The environmental engineering curricula is offered with a completely reformed program from September 2017 to ensure, that we meet the needs and challenges of students planning their career either in developed or in developing countries. For the actual study program please visit our website. Two specialisations are available (min 10 applicants): environmental technology and environmental management. All environmental engineers are trained in both fields, but selecting a specialization gives the possibility to focus on the more preferred area.

Environmental technology especially focuses on applied environmental science and technological aspects of environmental protection, pollution evaluation, data evaluation, reduction of waste formation and primary energy requirement of various processes and pollution removal. The specialization offers a large selectivity among specialized courses. Environmental management aims to develop the theoretical and soft skills required to actively and efficiently coordinate activities for the protection of the environment, to manage financial, technical and human resources for the sake of protecting air and water and reducing or reusing waste.

The studies are completed by performing an individual master’s thesis project and submission of the thesis. Graduation is completed, after all required credits are gained, by a successful defence of the thesis and a final examination before the Final Examination Board of professors and eminent industrialists.
Doctrinal studies

The George Oláh PhD School is eligible to issue PhD degrees from:
• Chemistry
• Chemical- bio- and environmental engineering

We are proudly having the allowance of Nobel Laureate George Oláh, a former student and faculty mem-
ber, to use his name. “Nomen est Omen”, in accordance with the high expectations our PhD School has
strong requirements at an internationally highly competitive level (see also PhD minimum requirements).
The PhD program lasts for 2+2 years. After the first two years, the prerequisite for the continuation is a suc-
cessful completion of a “complex examination”. During this evaluation the examining board investigates if
the PhD candidate has made an appropriate progress in the PhD work within the time frame of the first two
years, and whether the continuation will predictably result in the successful completion of the PhD work
within the next two years.

The basic requirement for the enrollment is an MSc (or equivalent) degree from chemistry, chemical
engineering or a related topic. For the enrollment the previous results during the BSc and MSc studies,
documents about any scientific activities (papers, scientific presentations etc.) should be presented, and an
interview (personally, or via skype, or by any other possible means) should be carried out in the presence
of the prospective supervisor and two other members of the examining committee. The decision about the
enrolment of a PhD candidate will then be made by the Council of the Doctoral School upon the suggestion
given by the examining committee.

The list of the approved PhD research projects to be offered are renewed two times a year (next update
is on November, 2018). The research projects offered can be modified with the agreement of the supervisor.
All projects are subject to approval by the Council of the Doctoral School to ensure that they are likely to
result in a successful completion with the expectedly devoted work of the applicant.

The most important part of the PhD curriculum is the research work carried out by the guidance of the
supervisor. The supervisor is a key person during the PhD process, and a thorough cooperation between the
PhD candidate and the supervisor is of utmost importance. The research project must be worked out by the
supervisor, since the necessary background (laboratory facilities, specific instruments etc.) determines the
success of the entire PhD project. To obtain information on the supervisor it is advised to study the approved
PhD research projects offered, the personal home page, as well as the scientific publications in the Web of
Science database if available, or alternatively in Google Scholar, which is free of charge.

Additionally to the research work itself, which is the core of the PhD studies, some PhD courses from the
basic disciplines of chemistry, as well as from highly specialized topics should be completed. The “directed
teaching” is an integral part of the curriculum as well, aimed at broadening the knowledge of the PhD student
by teaching undergraduates. This teaching activity is maximized in four hours per week during a semester.

The PhD degree can be awarded upon the decision of the Doctoral Council of the University, provided
that certain “minimum requirements” among others of a (i) completion of the “complex examination” (ii)
publication of at least three peer reviewed scientific papers in journals with SCI impact factors with domi-
nating (more than 50%) contribution of the applicant (iii) successful defence of the thesis are fulfilled. In
spite of these strict minimum requirements more than 70% of our enrolled PhD students obtain the degree.
A detailed description of the PhD requirements is available upon request.

For further information please contact Ms. Evelin Bell, via e-mail (bell.evelin@mail.bme.hu) and visit our
dedicated website (http://www.ch.bme.hu/en/education/PhD)

Departments

- Department of Inorganic and Analytical Chemistry
- Department of Physical Chemistry and Materials
  Science
- Department of Organic Chemistry and Technology
- Department of Chemical and Environmental
  Process Engineering
- Department of Applied Biotechnology and Food
  Science

Budapest University of Technology and Economics
Faculty of Chemical Technology and
Biotechnology
Faculty Office:
Building R, ground floor, room 1.
Mailing Address: Műegyetem rkp. 7-9.
H-1111 Budapest, Hungary
Phone: (+36-1) 463-4604
Fax: (+36-1) 463-2550

Dean of the Faculty: Dr József Nagy
Course Director: Dr. Zoltán Hell
Program Coordinator: Mrs Nóra Gáspár
### Curriculum of BSc Subjects

#### General Subjects

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<th>Subject</th>
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<th>Credits 2</th>
<th>Credits 3</th>
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## Curriculum of BSc Subjects of Specialization

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<td>Radiochemistry and Nuclear Energetics</td>
<td>BMEVEKFM502</td>
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<td>Inorganic Chemistry Laboratory Practice</td>
<td>BMEVESAM502</td>
<td>3</td>
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<td>Analytical and Structure Determination Laboratory</td>
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<td>5</td>
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<td>Chemistry and Technology of Biomaterials</td>
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<td>3</td>
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<td>Methods in Molecular Biology</td>
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<td>3</td>
<td>2/0/0e</td>
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Description of BSc Courses

Analytical Chemistry

BMEVEASA302
Dr. Róbert E Gyrscsányi
To provide thorough understanding of the fundamental principles, main methods and applications of chemical analysis (volumetric, gravimetric and instrumental analysis), as well as their tools of trade. The subject aims to provide a basis for later subjects including the Analytical Chemistry Laboratory and other advanced analytical chemistry subjects within Analytical and Structural Chemistry Specialization (5 credits)

Analytical Chemistry Laboratory Practice

BMEVEASA403
Dr. Róbert E Gyrscsányi, Dr. Gergely Lautner
Based on the theoretical background obtained in the analytical chemistry course, the primary objective of the Analytical Chemistry Laboratory Practice is to gain hands-on experience in the various analytical techniques, i.e., volumetric analysis and instrumental methods of analysis. During laboratory practices the students will learn the workflow of quantitative and qualitative analysis gaining insight in the main parts and practical operation of analytical instruments. (4 credits)

Biochemistry

BMEVEBEEA301
Dr. András Szarka
The subject (biochemistry) is not intended to provide the students with a comprehensive biochemistry knowledge. Instead, it offers a short overview of the biochemical pathways and their connections. Its first part covers basic knowledge from the field of cell biology. The second part focuses on the fundamental principles of enzymology and bioenergetics which additionally serves as the basis for the third part that concentrates on metabolic processes including the energy production pathways of oxidative phosphorylation and photosynthesis. Finally, the fourth part discusses the basics of molecular biology. (4 credits)

Business Law

BMEGT55A001
The problems of the area will be treated in two major parts. Part One introduces students to the general topics, for example the concept of law, the functions of the law in the socioeconomic life. Some basic legal problems, like the conception, characteristics and functions of the modern state and, in a comparative view, the characteristics of the Anglo-Saxon and continental systems of business law and the development of the Hungarian business law will be also discussed. The emphasis of Part Two is on the questions of company law and competition law presented in a European context. The lectures of this part outline not only the regulations of the Hungarian Company Act and Company Registry Act but they cover EU directives and regulations on companies and competition as well. (2 credits)

Chemical Engineering Practice

BMEGEVGAV04
All drawings are made only on the practice hours and are made with free hand used the half ready worksheets. Fundamental rules of technical drawing. Arrangement of views by the European projection system. Sections. Threaded parts. Drawing of welded joints. Fits and tolerances. Reading and detailing training of assembly drawings by free hand sketches. Laboratory exercises: measurement of revolution per minute, measurement of pressure, of flow rate and velocity. Fan measurement. Friction losses in pipes and pipe fittings. Sieve analysis. (3 credits)

Chemical Process Control

BMEVEKFA203
Dr. Géyörgy Pátzay, Dr. Katalin Koczka, Tibor Nagy
The subject is aiming to teach the students the elementary theoretical and practical knowledge of the control, so that, the engineers of the future will be able to work in a team that designs plants, technologies, devices. And, these items are to be controlled, such a work needs also control knowledge for the chemical and biochemical engineers. (5 credits)

Chemical Technology

BMEVEKFA410
Dr. Endre Rév
Chemical unit operations are basic building units of chemical processes. This first course provides an introduction to hydrodynamic and thermal processes only. This includes material and heat balance, momentum balance, fluid mechanics, concepts of fluid behaviour, Bernoulli equations, transportation of fluids, hydrodynamic models, flow in pipes and channels, steady flow, rheology, viscosity, boundary-layer formation, friction factor, pressure flow through equipment, pressure drop across packed towers. Hydrodynamic unit operations: flow in pipes, mixing, sedimentation (settling), filtration, fluidization. Thermal operations: heat

Chemical Unit Operations II

BMEVEKFA512
Dr Edit Székely
This is an introductory course on separation processes and on basic calculations of chemical reactors. Topics cover the basic methods of mass transfer calculations and principles of different mass transfer processes. Mass, component and heat balance equations are used throughout the course. Distillation, extraction and absorption are discussed in details including equipment and short-cut calculations. Simple estimations for chemical reactors are included. (6 credits)

Chemical Unit Operations Laboratory Practice

BMEVEKFA613
Dr Edit Székely
The aim of the course is to introduce engineer students into the chemical unit operation by a detailed laboratory practice. During the course the students meet selected measurements that represent the most important separation processes, reaction kinetic measurements, and modeling of some chemical units. (3 credits)

Colloid chemical approach to nanotechnology

BMEVEFA409
Dr Zoltán Hörvölgyi, Dr Emőke Albert
The main objective of the course is to provide a strong colloid chemical background for the preparation, characterization and application of nanomaterials. (3 credits)

Computing

BMEVESAA103
Dr Gábor Csonka
Basic IT support for engineering computations and presentation of the results (Excel, Word, ChemSketch). Programming in Visual Basic for Excel. (2 credits)

Design of Experiments

BMEVEVMA606
Péter Kunovszki
To teach the basic principles and methods of mathematical statistical treatment of measurement data.
To teach the design and analysis of most basic full factorial experimental designs. (3 credits)

Environmental Chemistry and Technology

BMEVEKFA403
Dr Andrea Nagy-Szabó, Dr Gábor Bajnóczy
Understanding the formation, possible reactions of environmentally polluting materials. Students becomes familiar with the chemistry of pollutants in the air, water and soil. They get to know main chemical and physico-chemical processes in the atmosphere, hydro-sphere, lithosphere and biosphere will be discussed. Chemical basis and the effects of the en-vironmentally harmful materials on the living and non-living objects will be presented as well. The students will be able to identify contaminants emitted by technological processes. They learn about modern technological processes reducing the harmful emissions decreasing the environmental degradation. (4 credits)

General Chemistry

BMEVESAA101
Dr Gábor Csonka, Dr László Nyulászi
To get a basic overview of the principles of Chemistry, providing introductory information, including definitions etc. which can be used in later specific subjects. The course consists of three parts. In the first one the macroscopic properties of the matter are discussed, including phase transitions. In the second part basic chemical principles as acid-base and redox processes, chemical equilibria, electrochemistry and chemical kinetics will be covered briefly. In the third part the atomic and molecular structure, the chemical bonding and the rules in the periodic table are explained. (5 credits)

General Chemistry Calculations for Chemical Engineers

BMEVESAA104
Dr Gábor Csonka, Dr Zoltán Benkő
The aim of the subject is to increase the knowledge of the freshman students on chemical calculations to the level which provides competent basis for further chemical and technological disciplines (inorganic chemistry, organic chemistry, physical chemistry, unit operation, chemical technology etc.). The practice is held in small groups, depending on the former skills of the students. (4 credits)

General Chemistry Laboratory Practice

BMEVESAA209
Dr Ilona Kovács
In this subject the basic chemistry procedures are practiced (e.g. distillation, recrystallization, sublimation). Passing these exercises the students acquire knowledge about the basic laboratory equipment as well. Simple measurements are also performed (e.g. measurements of mass and volume, measuring the melting and boiling point, density measurement methods, pH measurement). Simple preparative tasks (e.g. precipitation, dissolution of metals, producing gas in laboratory, calefaction, preparation of complexes, electrochemistry) are also completed. (5 credits)

Hydrocarbon processing

BMEVEKFA506
Dr Ákos Fürcht
The aim of the subject is to discuss the importance of crude oil, as a primary energy source. It presents crude oil processing technologies and discuss the common use of the products and describes the challenges of the oil refining business. (3 credits)

Industrial Safety

BMEVESZA101
Dr István Csomos
The aim of this course is to introduce the students to the concepts related to fire and explosion hazards and the treatment of toxic material, which is essential for engineers. Another goal is to provide the essentials of safe work and management skills through many practical examples. The subject also presents the standard safety concepts and practice used in the EU and in the U.S. (2 credits)
Inorganic Chemistry

Dr László Nyulánszki

Get a basic overview of the field of inorganic chemistry. The most important trends and rules determining the physical and chemical properties of the elements and simple chemical compounds, such as the periodic system, redox properties, complexing abilities, acid-base properties are discussed. Physical and chemical properties of the elements and basic inorganic compounds (hydrides, halides, oxides, common inorganic acids and bases) and the chemistry of industrially important inorganic systems are explained. (3 credits)

Inorganic Chemistry Laboratory Practice

Dr Ödön Wagner

The aim of this laboratory practice is to increase the knowledge of the students on the topic of inorganic chemistry. The properties of inorganic compounds and the methods of qualitative analysis are explained. (3 credits)

Macro- and Microeconomics


Management and Business Economics

This course introduces the essentials of management as they apply within the contemporary work environment and gives a conceptual understanding of the role of management in the decision making process. It particular attention is paid to management theories, corporate finance, leadership, teamwork, quality management, management of technology, economics calculation and operations management. For problem formulation both the managerial interpretation and the mathematical techniques are applied. (4 credits)

Mathematics A1a - Calculus

Dr. László Ketskeméty, György Richlik


Mathematics A2c

Dr László Ketskeméty, György Richlik


Mathematics A3 for Chemical Engineers and Bioengineers

Dr Mártá Lázi

Outcomes, events, and probability, conditional probability and independence, discrete and continuous random variables, distribution function, density function, expected values and variance, binomial, geometric, poisson, uniform, exponential, normal distribution, joint distributions, and independence, covariance and correlation, the law of large numbers, central limit theorem, exploratory data analysis, graphical and numerical summaries, estimators, unbiased estimators, the linear regression model, confidence intervals, testing hypotheses (4 credits)

Medicines

Dr Ervin Kovács, Dr Ferenc Faigl

The subject gives a brief introduction to the medicinal chemistry and pharmacology. The fundamental pharmacological definitions and concepts as well as the historical background of drug discovery and design are presented. Selected examples of drug activity at some common target receptors demonstrate the importance of the specific receptor-drug interactions and the importance of chemical modifications of the lead molecules to produce highly selective medicines. Concepts related to pharmacokinetics are introduced, such as absorption, distribution, metabolism and excretion. (3 credits)

Organic Chemical Technology

Dr László Hegedűs, Dr György Keglevich

The subject discusses the main fields of organic chemical industry through many suitable examples. (3 credits)

Organic Chemical Technology Practice

Dr István Csontos

The development of practical engineering approach through the presentation of the elements and characteristics of the chemical technologies. (3 credits)
Organic Chemistry I.
**BMEVESZAZ01**
Dr Lődő Mőczár, Dr József Kupai, Dr Tünde Tóth
Providing up-to-date basics for chemical engineering students in the field of natural sciences. During this course the students should learn the basics of organic chemistry, they should develop an organic chemistry approach and gain proper theoretical and practical foundation for their further studies on material sciences, organic chemistry, chemical technology and biochemistry. (5 credits)

Organic Chemistry II.
**BMEVESZAZ04**
Dr József Kupai, Dr Lődő Mőczár, Dr Tünde Tóth
Providing up-to-date basics for chemical engineering students in the field of natural sciences. During this course the students should learn the basics of organic chemistry, they should develop an organic chemistry approach and gain proper theoretical and practical foundation for their further studies on material sciences, organic chemistry, chemical technology and biochemistry. This subject is the completion of the subject Organic Chemistry I. (4 credits)

Organic Synthesis Laboratory Practice
**BMEVESZAZ02**
Dr László Poppe, Dr Gábor Hornyánszki, Dr Tünde Tóth
Basic laboratory practice for chemical engineering students to acquire the skill of performing laboratory tasks and new laboratory methodologies of organic chemistry. During this course the students learn the basics of synthetic laboratory work, safe work methods, simple and rapid identification of the synthesized materials, and the use of the literature of organic chemistry, deepen their knowledge in this field, and gain substantial knowledge on the properties of organic compounds. (4 credits)

Physical Chemistry I
**BMEVEFKA304**
Dr Mihály Kállay, Dr Krisztina László
The course is part of the compulsory curriculum. A theoretical and practical introduction to the physico-chemical phenomena related to equilibrium. Topics covered include: Definition of thermodynamic state functions and demonstration of their use in chemical engineering and biochemical engineering practices; Interpretation of multicomponent phase equilibria and chemical equilibria with the help of chemical potential. The rate of processes is covered in Physical Chemistry II. (5 credits)

Physical Chemistry II
**BMEVEFKA405**
Dr András Szilágyi, Dr Mihály Kállay
The course provides theoretical and practical knowledge on the chapters of physical chemistry related to change. The rates of processes, as well as equilibrium electrochemistry are discussed. The three main chapters of Physical Chemistry II are Reaction Kinetics, Transport Processes and Electrochemistry (4 credits)

Physical Chemistry Laboratory Practice
**BMEVEFKA506**
Dr Benjámin Gyarmati, Dr János Bődiss
Further deepening of the knowledge gained in Physical Chemistry (I-II) and Colloid Chemical Approach to Nanotechnology by the introduction of basic experimental meth-

Physics 1 - Electrodynamics
**BMEETE14AX04**
Physics Laboratory  
**BMEETE14AX05**

Introduction: Evaluation of measurement data; DC and AC circuits. Measurements, practices: nonlinear curve fitting; mechanics: elastic force, periodic motions; DC circuit: control of electric current and voltage; geometrical optics: lenses, prism, refractory index; physical optics: diffraction, wave length, Brewster angle, polarization; AC circuit: resonance in series RLC circuit; semiconductor diodes; temperature measurement; logical circuits; dynamical systems (2 credits)

Plastics  
**BMEVEFAA306**

*Dr Béla Pukánszky, Dr János Móczó*

To supply basic information about plastics for chemical engineering students. Encountering plastics is unavoidable these days both in everyday life and in engineering practice. The course provides the necessary basic knowledge for engineering practice, teaches ways to recognize the main sources of actual problems and offers methods to remedy them. The individual classes discuss the production, processing, behaviour and properties of plastics, as well as related environmental issues. (5 credits)

Quality Management  
**BMEVEKFA615**

Péter Kunovszki, Bálint Bedzsula

To learn the philosophy and fundamental techniques of quality management. To learn the most important statistical tools of quality engineering. (4 credits)

**Description of BSc Courses - Specializations**

Analytical and Structural Chemistry

Analytical and Structure Determination Laboratory  
**BMEVESAA604**

*Dr Imre Miklós Szilágyi*

During the laboratory practices the students will become familiar with the state-of-the-art analytical and structural chemistry instruments at the disposal of the Department of Inorganic and Analytical Chemistry (and at the Faculty of Chemical Technology and Biotechnology). They will learn the basics of advanced and coupled instrumental measurement methods of quantitative analysis, as well as of the study and elucidation of the molecular structure. (5 credits)

Chemical and Biosensors  
**BMEVEAAA708**

*Dr Róbert E Gyurcsánayi*

The course covers the principles, materials, methods and selected applications of chemical and biosensing devices and systems. It presents the main modalities to integrate molecular recognition with various forms of signal transduction, such as electrochemical, optical, mass, and acoustic. The performance characteristics of the sensors are linked to their design, type of receptors, materials and signal transduction, identifying strategies for enhanced selectivity and sensitivity. The topics emphasize state of the art medical diagnostic, environmental and food safety applications of chemical and biosensors. Upon successful completion of the course, students are expected:

a) to understand chemical and biosensing and the motivation behind sensor development
b) to understand the performance characteristics and applicability of chemical and biosensors
c) to become familiar with synthetic and biological origin receptors and the basics of molecular recognition mechanisms.

d) to understand transduction mechanisms and the modalities of coupling with selective molecular recognition

e) to be able to extend the principles of chemical and biosensing towards developing biosensing devices. (3 credits)

Chromatography  
**BMEVEAAA611**

*Dr Blanka Tóth*

The subject lays emphasis on the basics and applications of chromatographic analysis: theoretical background and practice will be discussed in order to develop skills for method development and application of hyphenated techniques. (3 credits)

Elemental Analysis  
**BMEVESAA701**

*Dr János Madarász, Dr Lászl Bezur*

This introductory course deals with the modern instrumental analytical methods used for element analysis, trace element analysis. Topics like the basic principles of atomic absorption methods, ICP-OES method and ICP-MS method, the construction principles of instrumentation, the characteristic analytical parameters of the methods, and the principles of analytical method development are discussed (3 credits)

Elucidation of Organic Structures  
**BMEVESAA512**

*Dr András Simon*

Introduction into the theory of ultraviolet/visible, infrared, mass and nuclear magnetic resonance spectroscopy. Interpretation of ultraviolet/visible, infrared, El-mass as well as one-dimensional $^1$H and $^{13}$C NMR spectra. Presentation of their application for the solution of practical problems. Presentation of their joint application in the elucidation of the structure of simple unknown compounds. (3 credits)
Organic Chemistry III

Dr László Poppe, Dr Gábor Hornyánszki
Based on the knowledge of subjects Organic Chemistry I and II, this subject puts major emphasis on all aspects of chemical problems associated with chiral compounds. By systematic classification of all major stereochemical terms and stereoselective syntheses, this subject adds solid knowledge to the previously acquired bases in organic chemistry for the future chemical engineers of pharmaceutical and fine chemical industry (2 credits).

Theory of Testing Methods in Material Sciences

Dr Mihály Kállay
Introduction (the models of molecules, crystals, liquids, amorphous materials; interaction of materials with electromagnetic radiation); infrared and Raman spectroscopy; absorption UV-Vis spectroscopy; optical and electronic properties of solids; photoelectron spectroscopy (UPS, XPS, AES); NMR spectroscopy (molecular and solid state), X-ray diffraction (crystal, liquid, small angle); microscopy (SEM, TEM, AFM). (4 credits)

Chemical and Process Engineering

Chemical Production Control

Dr Péter Mizsey
Process control gives funded knowledge about control theory and practice. Currently, computers are used everywhere, including in process control. Computers help, however, not only with controlling but also with designing of control structures. It enables the engineer to calculate controllability features and also modelling both steady state and dynamic processes. (3 credits)

Computer Process Control

Dr Endre Rév
Introduction into the theory of ultraviolet/visible, infrared, mass and nuclear magnetic resonance spectroscopy. Interpretation of ultraviolet/visible, infrared, EI-mass as well as one-dimensional 1H and 13C NMR spectra. Presentation of their application for the solution of practical problems. Presentation of their joint application in the elucidation of the structure of simple unknown compounds (3 credits)

Environmental Benign Chemical Processes

Dr Edit Székely
The course gives an overview of possibilities to be evaluated, understood and of the environmental impact of various technologies to be taken into account. Besides, thorough case studies the best available technique concept is demonstrated and discussed in details. Concepts and typical applications of separation methods from high vacuum to high pressure techniques is explained. (4 credits)

Hydrocarbon Technology and Catalysis

Dr Ákos Fürcht
To provide specialised knowledge about crude oil processing. To discuss the ecopolitical importance of crude oil, as one of the most important raw materials. To present crude oil producing technologies and discuss the refinery flow scheme. To describe the catalyst management options, which may affect the profit possibilities. (5 credits)

Process Engineering

Dr Gábor Hornyánszki
This Process Engineering course for BSc students targets three main clusters of basic Chemical Process Modelling knowledge, namely (i) flowsheeting, i.e. calculating steady state of complex chemical processes usually with recycling streams, (ii) practical selection and use of physico-chemical models for calculating phase equilibria and phase distribution, and (iii) basic numerical methods indispensable for engineers. An outlook to process synthesis problems and techniques is also provided. (5 credits)

Radiochemistry and Nuclear Energetics

Dr György Pátzay

Industrial Pharmaceutics

Elucidation of Organic Structures

Dr András Simon
Introduction into the theory of ultraviolet/visible, infrared, mass and nuclear magnetic resonance spectroscopy. Interpretation of ultraviolet/visible, infrared, EI-mass as well as one-dimensional 1H and 13C NMR spectra. Presentation of their application for the solution of practical problems. Presentation of their joint application in the elucidation of the structure of simple unknown compounds (3 credits)

Organic Chemistry III

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Organic Chemistry Laboratory Practice II

Dr Gábor Hornyánszki
Students are to acquire a mastery of the methodology of lab-
Pharmaceutical Technology I.

Dr Zoltán Hell

This subject gives an overview on the characteristic methods for the industrial synthesis of active pharmaceutical ingredients (API) based on the known technologies of Hungarian and other producers. The discussed fields are the following: choice of the synthesis strategy, continuous development of the industrial technology from different aspects such as the environment protection, the quality assurance, the safety, the thrift and the protection of the copyright. The criteria of choosing the appropriate equipment, the technologies of the separation of APIs and their intermediates from natural raw materials (plants, animals) are presented. Aspects of the diminution of the waste products, waste treatment are also discussed. (2 credits)

Project Work

Dr Antal Gajáry, Dr Alajos Grün

The aim of the subject is to present the research and development processes that result in industrial scale production. In the first half of the semester the elements and aspects of a development process are discussed. After that the students are given the opportunity to prove their skills in this field by working on a project divided into small groups (3 credits)

Technology of Pharmaceutical Materials

Dr György Marosi

The aim of the subject is to introduce the students to the technology of pharmaceutical products including the relevant theory and practice. The characteristics of the applicable pharmaceutical excipients and drug delivery systems are also discussed. Understanding of the relevant structure-activity relationships are initiated based on the characteristics of the most important manufacturing methods of different types of pharmaceutical products. The analytical methods serve the understanding of this field are also introduced. After the successful completion of the subject one should be familiar with the theoretical bases of the medicine formulation and have a basic knowledge about each step of the manufacturing of pharmaceuticals and capable of discussing with the specialists of those fields. The subject is supposed to serve as a good basis for deeper research in the relevant field or can be a core of a BSc thesis. (3 credits)

Unit processes in Industrial Drug Synthesis

Dr Ferenc Faigl

The subject deals with the typical chemical transformations, isomer separation techniques and scale-up processes of the pharmaceutical and fine chemical industries. Among the unit processes the special N-, O- and C-alkylations, C-C bond forming reactions (Claisen-, Dieckmann-, Knoevenagel- and Darzens-condensation, Vilsmeier-formylation, reactions of polar organometallics, cross-coupling reactions), and selective reductions with inorganic and organic hydrides are discussed. The theory and methods of the separation and enrichment of optical isomers, as well as the application of dry technologies are discussed and illustrated through industrial examples (2 credits)

Unit processes in Industrial Drug Synthesis Laboratory Practice

Dr Ferenc Faigl, Dr Zoltán Hell

In the framework of the practice typical industrial scale synthetic technologies and processes are presented for the students. The theoretical background of the unit processes applied in the presented technologies has been discussed in the lectures of “Unit Processes in Drug Synthesis” which is highlighted again during the practices. (4 credits)

Unit Processes of Organic Chemistry

Dr György Keglevich

Presentation of the chemical transformations most commonly used in the chemical industry. The environmentally friendly aspects and implementations are given special emphasis. (2 credits)

Materials Science

Material Science Laboratory Practice

Dr Emília Csizsár

Introduction; Characterization of plastics; Fracture mechanics; Determination of mechanical properties of plastics (tensile and bending tests); Thermal characterization of polymers; Fibre reinforced polymers; Characterization of fibrous materials; Investigations of layers; Electrochemical investigation of galvanic corrosion; Investigation of diffusion kinetics; (3 credits)

Metals and Metal Matrix Composites

Dr Kornél Májlinger, József Hári

During both their everyday life and professional work chemical engineers often meet a variety of traditional and modern metallic materials. The course provides important knowledge in the fields of natural science and engineering related to the production, processing and application of metallic functional materials. A further aim of the course is to present – from the perspective of materials science – the ability of metals, alloys and complex metallic matrices, as well as their associated systems, to satisfy the demands of the modern economy. (2 credits)

Modern Engineering Ceramics

Dr Alfréd Kállay-Menyhárd

During both their everyday life and professional work chemical engineers often meet a variety of traditional and modern ceramic materials. The course provides important knowledge in the fields of natural science and engineer-
Nonconventional Materials

BMEVEFAA707

Dr András Szilágyi, Dr Krisztina László, Dr Zoltán Hórvölgyi

Metal foams, Shape memory alloys and polymers, special ceramics. Complex fluids. Gels and their application in drug delivery. Self-assembly. Responsive and other special nanocoatings. Aerogels. Materials with ordered porosity. Nanotubes. The course includes laboratory work; there are 4 compulsory laboratory practical classes in the aforementioned topics. (2 credits)

Physical Chemistry of Surfaces

BMEVEFAA603

Dr Krisztina László


Polymer Physics

BMEVEMGA511

Dr Béla Pukánszky


Project Work

BMEVEFAA777

Dr Alfréd Kállay-Menyhárd

The integration and application of the knowledge obtained by the students during their university studies through the design of a plant or factory manufacturing a given product. Demonstration of the complexity of problems related to the design and operation of a manufacturing plant. The course calls attention to problems rarely or not at all mentioned during other courses. The course helps students develop their ability to solve problems, make decisions and to present their results. (3 credits)

Testing Methods in Material Sciences

BMEVEMGA502

Dr Béla Pukánszky

Methods using the excitation of the electronic structure: XPS, UPS, AES, SIMS, absorption spectroscopy of solids; Methods using the excitation of the lattice: Thermal analysis, IR and Raman spectroscopy; Methods for studying the structure: XRD, SEM + EDX, SPM ((EC)-STM, (EC)-AFM, nanoindenter) (3 credits)

Theory of Testing Methods in Material Sciences

BMEVEFAA708

Dr Mihály Kállay

Introduction (the models of molecules, crystals, liquids, amorphous materials; interaction of materials with electromagnetic radiation); infrared and Raman spectroscopy; absorption UV-Vis spectroscopy; optical and electronic properties of solids; photoelectron spectroscopy (UPS, XPS, AES); NMR spectroscopy (molecular and solid state), X-ray diffraction (crystal, liquid, small angle); microscopy (SEM, TEM, AFM). (4 credits)

Polymer Technology

Machines and Moulds for Polymer Processing

BMEVEFAA705

Péter Müller

Introduction; Extrusion: components of an extruder, operation of an extruder, extruder screws; choosing the proper screw for a polymer; Characteristics of an extruder screw and its optimal operating point, film blowing, sheet extrusion; Wire coating, profile extrusion, filament extrusion, coextrusion; Injection moulding: Tool designing, simulation software; Special injection moulding techniques: Gas and water injection, Injection moulding on films, Injection moulding on textiles; Compression moulding machines and tools; Thermoforming machines and tools; Practical work: Visits in manufacturing plants. (4 credits)

Polymer Additives

BMEVEMGA610

Dr János Móczó

Introduction; Changes taking place during the processing and application of plastics, chemical reactions, degradation, ageing; Degradation and stabilization; Light stabilization; PVC degradation and stabilization; Degradation and stabilization of other polymers; Lubricants; Fillers, surfactants, coupling agents; Polymer additives (impact modifiers, processing aids), their purpose and mechanism; Flame retardants; Blowing agents, colorants; Other additives; Further aspects of the use of additives, Additive packages; interaction of additives – PVC, polyolefins (2 credits)

Polymer Physics

BMEVEMGA511

Dr Béla Pukánszky

Textile Technology

Chemical Technology of Textiles I.

Dr. Emília Csiszár
Preparatory processes: desizing, scouring, bleaching, carbonizing; Mercerization and liquid ammonia treatment; Dyeing processes: fundamentals and methods; Textile printing; Laboratory classes: Identification of textile materials; Preparatory processes: desizing, scouring and bleaching; Dyeing of cellulosic fibres; Dyeing of wool; Dyeing of synthetic-polymer fibres; Textile printing; (7 credits)

Chemical Technology of Textiles II.

Dr. Emília Csiszár, Dr. Judit Borsa
The main goal of the course is to give basic information about the most important chemical treatments for improving functional and aesthetic properties of textiles. The course gives a detailed account of the knowledge related to textile quality, the practical aspects of quality, as well as the environmental impact of the chemical finishing processes of textiles. (4 credits)

Chemistry of Dyes and Surfactants

Dr. András Víg
Demonstration of the classification, production, chemical and technological properties and use of dyes and surfactants applied in the textile and paper industry. Discussion of the application of different dyes and surfactants in the practice by means of industrial examples. (2 credits)

Colorimetry, Colormeasurement

Dr. Sándor Csányi
The main goals of the course are to give basic information about the colours, colour spaces, methods of colour measurement and other related topics; to offer information about the colour measuring instruments and the measurement and evaluation of whiteness. (2 credits)

Fibre Forming Polymers

Dr. Judit Borsa
An introduction to textile chemistry and technology, understanding the various applications of fibres. (2 credits)

Project Work

Chemical Technology of Textiles I.

BMEVEFAA718
Dr. Alfréd Kállay-Menyhárd
Demonstration of the complexity of problems related to the design and operation of a manufacturing plant. The course helps students develop their ability to solve problems, make decisions and to present their results. (3 credits)

Chemistry of Dyes and Surfactants

BMEVEFAA777
Dr. András Víg
Demonstration of the classification, production, chemical and technological properties and use of dyes and surfactants applied in the textile and paper industry. Discussion of the application of different dyes and surfactants in the practice by means of industrial examples. (2 credits)

Colorimetry, Colormeasurement

BMEVEFAA515
Dr. Sándor Csányi
The main goals of the course are to give basic information about the colours, colour spaces, methods of colour measurement and other related topics; to offer information about the colour measuring instruments and the measurement and evaluation of whiteness. (2 credits)

Fibre Forming Polymers

BMEVEFAA512
Dr. Judit Borsa
An introduction to textile chemistry and technology, understanding the various applications of fibres. (2 credits)

Project Work

BMEVEFAA777
Dr. Alfréd Kállay-Menyhárd
The integration and application of the knowledge obtained by the students during their university studies through the design of a plant or factory manufacturing a given product. Demonstration of the complexity of problems related to the design and operation of a manufacturing plant. The course helps students develop their ability to solve problems, make decisions and to present their results. (3 credits)
Theory of Testing Methods in Material Sciences
BMEVEFAA708
Dr. Mihály Kállay
Introduction (the models of molecules, crystals, liquids, amorphous materials; interaction of materials with electromagnetic radiation); infrared and Raman spectroscopy; absorption UV-Vis spectroscopy; optical and electronic properties of solids; photoelectron spectroscopy (UPS, XPS, AES); NMR spectroscopy (molecular and solid state), X-ray diffraction (crystal, liquid, small angle); microscopy (SEM, TEM, AFM). (4 credits)

Description of MSc Courses

Biology, biotechnology
BMEVEBBMB301
Dr. Miklós Pécs
The subject gives an overview of modern biotechnology by focusing on its prominent areas of chemical industrial and engineering interest. After providing an introduction of cell biology and microbiology, the subject concentrates on the possibilities of biotechnology branches termed as white and green biotechnology. Furthermore, it discusses the most important bioindustrial unit operations and environmental bio-solutions. (3 credits)

Chemical Process Design and Control
BMEVEKFM101
Dr. Péter Mizsey
To teach the students the elementary knowledge of chemical process design and control. The process design step is the creative challenge of the chemical engineer. Selection/determination of the proper design alternative is a difficult task. Investigation of the controllability of the process designed is also the part of the creative activity where the mutual effect of process and control should be considered. (4 credits)

Complex and Inorganic Chemistry
BMEVESAM101
Dr. Ilona Kovács
The aim of the subject is to give a general knowledge in the field of the organometallic chemistry (classifications, structure, stability, reactivity) and to give more detailed information about the industrial applications of these compounds. The lectures have been structured in the traditional way – following the periodic table for the main-group element organometallics (alkali, alkali-earth, aluminum, tin, lead and silicon will be discussed in detail) and according to the nature of the ligand in transition-metal complexes. At the end of the course the industrial applied catalytic reactions (Heck, Suzuki, etc.) will be discussed. (2 credits)

Computational Chemistry
BMEVESAM301
Dr. Dénes Szieberth, Tibor Hölzl
The subject gives an overview about the principles used to describe the structure of molecules and bulk phases. The modeling of physico-chemical parameters, chemical processes will be presented together with the usual techniques. Practical examples for the solution of chemical- and physico-chemical problems by computer modeling will be done during the course. (3 credits)
### Organic Chemical Technology II
**BMEVESZM201**

**Dr László Hegedűs, Dr György Keglevich**

Principles of environmentally friendly chemistry and chemical technology, up-to-date methods and techniques including catalytic transformations, sonochemistry and microwave-assisted chemistry, the use of green solvents and ionic liquids, phase-transfer catalysis. All these are shown via applications in industrial syntheses together with cost optimization, up-to-date analytical and separation technologies. (5 credits)

### Organic Chemistry
**BMEVESZM101**

**Dr Péter Huszthy**

The aim of the subject is to get deep insight in organic chemistry at an advanced level. (4 credits)

### Physical chemistry and structural chemistry
**BMEVEFAM201**

**Dr Mihály Kállay**

The course deals with the experimental and calculation methods and the related theoretical background that provide information about the structure and properties of molecules and molecule ensembles. (5 credits)

### Modern Chemical Technology

#### Analytical and structure determination laboratory
**BMEVESAM504**

**Dr Imre Szilágyi, Dr Róbert E Gyurcśányi**

During the laboratory practices the students will become familiar with the state-of-the-art ana-lytical and structural chemistry instruments at the disposal of the Department of Inorganic and Analytical Chemistry (and at the Faculty of Chemical Technology and Biotechnology). They will learn the basics of advanced and coupled instrumental measurement methods of quantita-tive analysis, as well as of the study and elucidation of the molecular structure. (5 credits)

#### Applied Electrochemistry
**BMEVESAM505**

**Dr Lajos Höfler**

This course focuses on two major fields of electrochemistry: sensors and energy storage de-vices. Students can learn about theory, development and the analytical methods of some widely used electrochemical sensors, and batteries. The discussed topics cover the thermodynamics and kinetics of these devices. Various simulation methods to describe the response mechanism are included. (3 credits)

### Biocatalysis
**BMEVESZM704**

**Dr László Poppe**

The aim of the subject is to provide high-level scientific and practical knowledge to the future chemical and bioengineers of chemical and biological industries (pharmaceutical, fine chemical, cosmetic, food, etc.) with special focus on the development of problem solving skills related to chemical problems by using the tools of biotechnology. (2 credits)

### Bioinformatics 2-proteomics
**BMEVESZM501**

**Dr László Poppe**

The aim of the subject is to provide high-level scientific and practical knowledge to the future bioengineers of chemical and biological industries (pharmaceutical, fine chemical, cosmetic, food, etc.) with special emphasis on the development of problem solving skills especially in the field of protein structure-activity relationships in the research and development. The course gives an overview of theoretical issues in proteomics, which is important to promote the practical applications, and provides insight into their applications in specific areas by computer practice. (4 credits)

### Bioinorganic chemistry
**BMEVESAM501**

**Dr Julianna Oláh**

During the course students get acquainted with the combination of inorganic chemistry and biochemistry, the so-called bioinorganic chemistry, which draws great attention as a complete-ly new scientific field. Topics to be discussed: the role of the elements and inorganic com-pounds in biolog-i-cal processes, the formation of metal containing bio-complexes, the toxicity of some inorganic compounds, bioactive compounds with inorganic ions used in pharma-ceutical chemistry. (2 credits)

### Biopolymers
**BMEVEFAM212**

**Dr Emilia Csiszár**

Biopolymers are polymers produced by living organisms (e.g. microorganisms or higher-order plants and animals) or synthesized from bio-based building blocks (e.g. acids, amine acids, carbohydrates, natural triglycerides) in a chemical process. The course provides an introduction to the most significant biopolymers, their chemical structure, properties and most important applications. (4 credits)

### Chemistry and Technology of Biomaterials
**BMEVESZM708**

**Dr György Marosi**

The subject aims at getting the students acquainted with the use of materials in biomedical applications, the excipients of biologically active materials, the concepts of the selection and preparation of biocompatible materials, their physical-chemical properties, and their use in the technology of medical products with special emphasis on the controlled release of drugs. The lectures include the classification of biomaterials; chemical and enzymatic reactions in relation to biomaterials (synthesis, modification and decomposi-tion), macromolecular systems of envi-ronmental technolo-gies, the relevant biodegradable polymers, macromolecular bases of pharmaceutical technologies (such as the prepara-tion of nanocapsules, implants and their appli-cation). Special emphasis is put on the manufacturing technologies of biocomposites. All of these topics are established by the relevant basic summary regarding the considerations of material science, surface modification and analytics as well as physical chemistry of smart biomaterials. The seminars promote the understanding of the interactions between differ-ent classes of materials and many tissues of the human body. Topics such as soft tissue replace-ment, biosensors, bio-devices and pharmaceuticals are included in the lectures as well. (2 credits)
Chromatography
BMEVESAM503
Dr György Horváth, Dr Viola Horváth, Dr Blanka Tóth
The basics and application fields of chromatography are presented in order to enable the students to learn method development and the use of hyphenated technics. (3 credits)

Conventional and Modern Forms of Energy Production
BMEVEKFM302
Dr György Pátzay
The aim of the subject is to introduce the theory and practice of energy production technologies, conventional and modern forms of energy production to students. They will be informed about fossil, fission and renewable energy sources and energy production technologies as well as about future fields of modern energy production, storage and distribution. (4 credits)

Environmental Toxicology
BMEVEMBM501
Dr Mónika Molnár, Dr Viktória Feigl
Environmental toxicology as part of the risk-based environmental management plays an increasingly important role. The main aim of the subject is to give an overview on the effect-based tools of the modern environmental risk management. The course covers both the theoretical background and the detailed practical aspects of environmental toxicology together with its applications in the risk assessment, risk management and in the environmental decision making. The topics discussed throughout the course are the following.
• The basics of environmental toxicology, qualitative and quantitative assessment of the toxicity effects of chemicals.
• The measurement of toxicity and other adverse effects, the classification of the test methods according to different aspects e.g. test-organism, size and type of tests, duration, and endpoints.
• The introduction of the most widespread related methodologies, their evaluation, statistics and interpretation. The use of ecotoxicity enables generic and site-specific risk assessment of chemicals; site- and land usage-specific assessment of contaminated land; integrated environmental monitoring; establishment of environmental quality criteria and priority setting as well as risk-based environmental management and decision making.
• Soil and soil-specific tests with emphasis on the importance of the Soil Testing Friad.
The typical applications of the environmental toxicity testing are discussed in details and are illustrated with interactive case studies. (3 credits)

Environmentally Benign Chemical Processes
BMEVEKFM501
Dr Edit Székely, Dr László Mika, Katalin Koczka, Illdikó Kmecz
The course gives an overview of possibilities to evaluate, understand and take into account the environmental impact of various technologies. Furthermore, through case studies the best available technique concept is demonstrated and discussed in details. Concepts and typical applications of separation methods from high vacuum to high pressure techniques are explained. (4 credits)

Hydrocarbon Technology
BMEVEKFM503
Dr Iván Gresits, Dr Ákos Fürcht
To discuss the importance of crude oil, as primary energy source. To present the crude oil pro-refining technologies and discuss the common use of the products. To describe the challenges of the oil refining business (3 credits)

Inorganic Chemistry Laboratory Practice
BMEVESAM502
Dr Zoltán Benkő, Dr Dénés Szieberth
During laboratory exercises, physical and chemical properties of metallic and non-metallic elements and simple inorganic compounds are reviewed. Students also gain knowledge on the solubilities of the elements and inorganic salts/compounds in water, acids and bases. Typical reactions of inorganic ions are studied via simple and complex qualitative analytical exercises. (3 credits)

Medicines
BMEVESZM502
Dr Ferenc Faigl, Ervin Kovács
The subject gives a brief introduction to the medicinal chemistry and pharmacology. The fundamental pharmacological definitions and concepts as well as the historical background of drug discovery and design are presented. Selected examples of drug activity at some common target receptors demonstrate the importance of the specific receptor-drug interactions and the importance of chemical modifications of the lead molecules to produce highly selective medicines. Concepts related to pharmacokinetics are introduced, such as absorption, distribution, metabolism and excretion. (3 credits)

Modern separation technologies
BMEVEKFM104
Dr Edit Székely, Dr László Mika, Katalin Koczka, Illdikó Kmecz
The subject gives an overview of environmentally friendly processes and unit operations of the chemical, biochemical and food industries. It deals with widely applied and currently re-searched technologies as well. During the course we will focus on how the development, selection and optimisation of a novel technology are influenced by environmental aspects be-sides selectivity and improved yield. By new separation technologies, adding different modifiers, solvents, etc. are not favoured and toxic adducts are one by one substituted to less harmful analogues. Modelling and design aspects will be also considered and explained through detailed description and evaluation of main application examples. (3 credits)

Nonconventional Materials
BMEVEFAM503
Dr András Szilágyi, Dr Krisztina László, Dr Zoltán Hórvölgyi
This course covers the following topics: Metal foams. Shape memory alloys and polymers. Special ceramics. Complex fluids. Gels and their application in drug delivery. Self-assembly. Responsive and other special nanocoatings. Aerogels. Materials with ordered porosity. Nanotubes. (3 credits)
Organic Chemical Technology

BMEVESZM503

Dr György Keglevich, Dr László Hegedűs
The subject discusses the main fields of organic chemical industry through many suitable ex-amples. (3 credits)

Petrochemistry

BMEVEKFM402

Dr Ákos Fürcht, Dr Iván Gresits
To provide specialised knowledge about the further processing of crude oil refinery products. To provide insight to the daily operation of petrochemical companies via several site visits. (6 credits)

Physical Chemistry of Surfaces

BMEVEFAM501

Dr Krisztina László

Plastics

BMEVEFAM502

Dr Béla Pukánszky, Dr János Móczó
To supply basic information about plastics for chemical engineering students. Encountering plastics is unavoidable these days both in everyday life and in engineering practice. The course provides the necessary basic knowledge for engineering practice, teaches ways to recognize the main sources of actual problems and offers methods to remedy them. The individual classes discuss the production, processing, behaviour and properties of plastics, as well as related environmental issues. (5 credits)

Process Engineering

BMEVEKFM211

Dr Endre Rév
This Process Engineering course targets ideas and basic techniques of Process Structure Design, also called Chemical Process Synthesis. The most important problems and solution methods of process synthesis are presented. Included are detailed discussion of energy recovery networks and mass exchange networks, distillation sequencing, energetically efficient continuous rectification variants, continuous distillative separation processes applicable to azeotropic and near boiling mixtures. Optionally, depending on progress, feasibility methods applicable in assigning batch distillation of azeotropes, as well as the most important heuristics of scheduling are also discussed. (4 credits)

Radiochemistry and Nuclear Energetics

BMEVEKFM502

Dr György Pátzay, Tibor Nagy, Dávid Havasi

Unit Processes of Organic Chemistry

BMEVESZM207

Dr György Keglevich, Dr Nóra Kiss
Presentation of the chemical transformations most commonly used in the chemical industry. The environmentally friendly aspects and implementations are given special emphasis. (2 credits)
## Environmental Engineering
### Curriculum of MSc Subjects - Environmental Management Spec.

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<th>Name</th>
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* Specialization elective subject: 12 credits has to be collected
Description of MSc Courses

Environmental Engineering

Environmental Management

Specialization

Applied Chemistry

BMEVEKFM103
Dr Andrea Nagy-Szabó, Dr Krisztina László, Dr Gábor Bajnóczy
Upgrading course in general chemistry, physical chemistry environmental chemistry and calculations.
(4 credits)

Environmental Economics

BMEGT42M410
Dr. Gábor Bartus
The course unit aims to achieve two main goals. Firstly, to teach students the economic theory governing the efficient allocation of environmental and natural resources, based on their scarcity and renewability. Secondly, to offer an insight into the practical use-related questions of the various types of environmental and natural resources, with an overview of best practices currently available.
(3 credits)

Environmental Management

BMEGT42M411
Dr Kálmán Kósi
The aim of the course is to highlight that the activities of organisations ought to be managed through the system of processes, or, in other words, highlighting the process oriented approach. This approach may be applied for all processes, for management functions, in other words, to the entire PDCA cycle. The course unit aims to empower students to understand and to be capable the integration of environmental protection in the management functions.
(3 credits)

Environmental and Remediation Processes

BMEVEKFM107
Dr László Mika
The course aims to provide theoretical and practical knowledge of operations and devices of environmental and remediation processes, furthermore planning and direction of remediation projects. Detection and treatment of soil, oil, air, industrial pollution and disasters in focus with chemical industries. Basic knowledge of waste treatment and management.
(4 credits)

Mathematics M1c - Probability Theory and Statistics

BMETE90MX61
Dr Mártaa Lázi
(4 credits)

Engineering Ecology

BMEEOVMKM1
Ferenc Szilágyi
The aim of this course is to provide basic knowledge and practical experiences to the MSc students who are going to deal with solution of environmental problems in their future work. The main goal is to give alternative and ecologically more acceptable practical practices which are based on self-regulatory behaviour of natural ecosystems. The methods of ecological engineering can often replace the commonly used artificial engineering solutions and they can more suitable to society point of view. The phasing of the needs of ecosystems and the society is also a goal of the subject showing the relevant practical measures.
(3 credits)

Economic Analysis of Technology

BMEGT40M401
Dr László Vígh
(3 credits)

Water Environmental Monitoring and Assessment

BMEEOVMKM6
Adrienne Clement
The course aims to provide theoretical and practical knowledge in the field of environmental monitoring systems, assessment of environmental hazard and the status evaluation. During the theoretical lectures and practical exercises students learn design and operation of environmental monitoring systems, become familiar with sampling theory, data collection and information systems with special focus on water and aquatic ecosystem. Practical skills will be obtained through monitoring network design, introduction of sampling methods and instruments, analytical methods, biomonitoring, data processing and evaluation.
(3 credits)

Bioengineering: unit operations and processes

BMEVEMBM214
Dr Áron Németh
The main object of these lectures are to introduce operations and procedures in biotechnological industry for students with special attention to their quantitative relationships. This object applies the toolbar of mathematic modeling for description of processes and for simulation of optimal operations.
(3 credits)

Environmental Analysis

BMEVEMAM207
Dr Viola Horváth
The course aims to provide a theoretical and practical knowledge in the analysis of air, water and soil contaminants and that of waste. During the lectures and group projects the student will learn the most up-to-date sampling and analytical measurement techniques. In addition they acquire information about the quality assurance of such measurements. They will learn how to setup air, water and soil monitoring systems. Practical skills will be taught in environmental sampling, sample pretreatment and the determination of contaminant concentrations with various analytical techniques.
(5 credits)
Case Studies in Environment Assessment and Audit
BMEKOVM953
Dr Gergely Tulipánt
The students should acquire, from environmental point of view, those modern knowledge which have significant effect on investments and activities for making environmental influence examination and for the environment protecting re-examinations of these activities concerning those up-to-date knowledge that relate to audition via working out case-studies. They should familiarize themselves with those ruling environmental protecting elements which are used for overall examination of the environmental status. (3 credits)

Environmental Planning
BMEGT42M412
Dr Tamás Pálvölgyi
The main objective of the course is to present the theory and practice of environmental planning at EU, national and municipal level, as well as to introduce the use of major planning and regulatory tools. Secondly, to offer an insight into methodology of environmental strategy-making, with a strong emphasis on best practices of strategic environmental assessment. (3 credits)

Environmental Management Systems
BMEGT42M413
Dr Kálmán Kósi
The aim of the course is to introduce the benefits and underlying opportunities of the implementation of system-oriented management in the environmental protection efforts of businesses. (3 credits)

Social and Visual Communication
BMEGT43M401
Zsolt Bátori
The course aims to provide students with theoretical knowledge in the field of communication and visual communication regarding the role and the goals of communication in the human society. In addition to the theoretical discussions students are given practical skills for communicating and presenting complex professional ideas and reasons to expert or layman audience. Students learn about different language, rhetorical and visual tools that can be used in presentations and participatory situations. (3 credits)

Technology Management
BMEGT20M410
Dr Béla Pataki
The program to show the role of technology and engineering work in the successful operation of organizations, to help the deeper understanding of the competitive nature of technology, to introduce some proven methods of technology management, to qualify the students to effectively cooperate with the business side of the organization (e.g. with the marketing department). (3 credits)

Conventional and New Technologies of Energy Production
BMEVEKFM304
Dr György Pálzay
(3 credits)

Environmental microbiology and biotechnology
BMEVEEMBM308
Dr Mónika Molnár
The main aim of the subject is to help the students develop a bio and eco-engineering view when dealing with environmental biotechnologies; furthermore to get familiar with the natural biological – microbiological and plant-assisted processes substantiating these technologies. The subject includes the theoretical background of environmental bio- and eco-technologies, their practical implementation and evaluation even via case studies targeting amendment of degraded soils and remediation of contaminated (environmental) elements, primarily contaminated soil, ground water, wastewater. Within this topic the focus will be on the ecosystem, especially on microorganisms and primarily on the multilevel interaction between the chemical substances and the environment, especially the chemical substances contaminating the soil and ground water, on the utilisation of the microbiological processes in the environmental technologies, mainly in the bioremediation of contaminated environmental elements and amendment of degraded soils, as well as in biological wastewater treatment. (4 credits)

Modelling of Environmental Systems
BMEEOVKMKM5
Dr László Koncsos
The course aims to introduce the core steps of environmental modelling including problem and model identification, calibration, validation and sensitivity analysis. The course provides theoretical and practical knowledge about key concepts of different modelling techniques such as the integrated simulation of multimedia environmental processes as well as the description of point and non-point source pollutant and nutrient transport. Surface-subsurface water and material transport and air pollution is introduced. Evaluation of various environmental risks is also a relevant part of the material. During the course various mathematical methods will be presented including statistical and analytical approaches, numerical solution of differential equations and soft computing techniques. (5 credits)

Environmental Efficiency Evaluation
BMEGT42M414
Dr Kálmán Kósi
The aim of the course unit is to introduce environmental performance assessment techniques and methods. The course unit introduces macro level performance assessment methods, and the necessity and aims of the application of such methods, and the practical applicability of methods and their findings in organisational practice. (3 credits)

Circular Economy
BMEGT42M416
Dr Gábor Bartus
The material throughput increased significantly in the last century, the societies are using more and more natural resources as input materials for manufacturing goods and services in order to enhance well-being of the humankind. The increased material throughput has caused the loss of biodiversity and environmental problems. The goal of the concept of the circular economy is to manage the material use, to decrease the natural resource input, to prevent the environmental harms from material use. The circular economy concept evaluates the technical and logistic alternatives of material use decrease and waste management.
circular economy is also about the economic evaluation of the governmental action in order to create relevant incentives and regulations. (3 credits)

**Risk Evaluation and Risk Management**

BMEGT42M417

Dr Noémi Nagypré-Csige

The course aims to provide knowledge about the theoretical background of environmental valuation, the reasons for the special approach of environmental valuation and the methods available. The students gain knowledge about the classification of valuation methods, the steps of application of each method, as well as their advantages and limitation. The students will learn why it is important to manage environmental risk in a complex way, the social aspects of risk management and various approaches and the steps of cyclic risk management. (3 credits)

**Environmental Marketing**

BMEGT42M418

Dr László Valkó

To present the role of marketing among environmental management techniques-methods. To highlight the position and role of environmental marketing in case of market oriented organisations. To prepare the student to system integrative way of thinking. To gain experience in the formulation of organisational environmental marketing concept. (3 credits)

**Occupational Health and Safety, Fire Protection, Noise and Vibration Protection**

BMEKOMVM951

Dr Mária Koch

The course aims to provide theoretical and practical knowledge in both fire protection and occupational safety while highlighting the most important obligations of the employer towards the field of action. They must be clear on what specific fire protection or occupational safety tasks they need to solve while working under organized circumstances, but also need to know which of these is a complex problem, that requires the handling of a professional. Another focus of the course is to provide a basic knowledge in the field of noise and vibration protection. This will help students understand the basic requirements in the industry. (4 credits)

**Environmental Technology Specialization**

**Applied Chemistry**

BMEVEKFM103

Dr Andrea Nagy-Szabó

Upgrading course in general chemistry, physical chemistry environmental chemistry and calculations (4 credits)

**Environmental Economics**

BMEGT42M410

Dr Gábor Bartus

The course unit aims to achieve two main goals. Firstly, to teach students the economic theory governing the efficient allocation of environmental and natural resources, based on their scarcity and renewability. Secondly, to offer an insight into the practical use-related questions of the various types of environmental and natural resources, with an overview of best practices currently available. (3 credits)

**Environmental Management**

BMEGT42M411

Dr Kálmán Kösi

(3 credits)

**Environmental Technology Project**

BMEVEKFM108

Dr Zsolt Csikor

The course aims to provide a general view on the range of technological solutions applied in environmental problems and their future potentials. With this knowledge, the students can estimate the role of technological solutions, their potential results and their limitations when trying to solve the world's sustainability problems. (3 credits)

**Environmental and Remediation Processes**

BMEVEKFM107

Dr László Mika

The course aims to provide theoretical and practical knowledge of operations and devices of environmental and remediation processes, furthermore planning and direction of remediation projects. Detection and treatment of soil, oil, air, industrial pollution and disasters in focus with chemical industries. Basic knowledge of waste treatment and management. (4 credits)

**Mathematics M1c - Probability Theory and Statistics**

BMETE90MX61

Dr Márta Lázi

(4 credits)

**Engineering Ecology**

BMEEOVKMKM11

Ferenc Szilágyi

The aim of this course is to provide basic knowledge and practical experiences to the MSc students who are going to deal with solution of environmental problems in their future work. The main goal is to give alternative and ecologically more acceptable practical practices which are based on self-regulatory behaviour of natural ecosystems. The methods of ecological engineering can often replace the commonly used artificial engineering solutions and they can more suitable from society point of view. The phasing of the needs of ecosystems and the society is also a goal of the subject showing the relevant practical measures. (3 credits)

**Economic Analysis of Technology**

BMEGT30M401

Dr László Vígh

(3 credits)

**Water Environmental Monitoring and Assessment**

BMEEOVKMKM6

Adrienne Clement

The course aims to provide theoretical and practical knowledge in the field of environmental monitoring systems, assessment of environmental hazard and the status evaluation. During the theoretical lectures and practical exercises students learn design and operation of environmental monitoring systems, become familiar with sampling theory, data collection and information systems with special focus on water and aquatic ecosystem. Practical skills will be
Bioengineering: unit operations and processes

**BMEVEMBM214**  
**Dr Áron Németh**

The main object of these lectures is to introduce operations and procedures in biotechnological industry for students with special attention to their quantitative relationships. This object applies the toolbar of mathematic modeling for description of processes and for simulation of optimal operations. (3 credits)

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Environmental Analysis

**BMEVESAM207**  
**Dr Viola Horváth**

The course aims to provide a theoretical and practical knowledge in the analysis of air, water and soil contaminants and that of waste. During the lectures and group projects the student will learn the most up-to-date sampling and analytical measurement techniques. In addition they acquire information about the quality assurance of such measurements. They will learn how to setup air, water and soil monitoring systems. Practical skills will be taught in environmental sampling, sample pretreatment and the determination of contaminant concentrations with various analytical techniques. (5 credits)

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Case Studies in Environment Assessment and Audit

**BMEKOVJM953**  
**Dr Gergely Tulipánt**

The students should acquire, from environmental point of view, those modern knowledge which have significant effect on investments and activities for making environmental influence examination and for the environment protecting re-examinations of these activities concerning those up-to-date knowledge that relate to audition via working out case-studies. They should familiarize themselves with those ruling environmental protecting elements which are used for overall examination of the environmental status. (3 credits)

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Social and Visual Communication

**BMEGT43M401**  
**Dr Zsolt Bátori**

The course aims to provide students with theoretical knowledge in the field of communication and visual communication regarding the role and the goals of communication in the human society. In addition to the theoretical discussions students are given practical skills for communicating and presenting complex professional ideas and reasons to expert or layman audience. Students learn about different language, rhetorical and visual tools that can be used in presentations and participatory situations. (3 credits)

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Technology Management

**BMEGT20M410**  
**Dr Béla Pataki**

The program to show the role of technology and engineering work in the successful operation of organizations, to help the deeper understanding of the competitive nature of technology, to introduce some proven methods of technology management to qualify the students to effectively operate with the business side of the organization (e.g. with the marketing department). (3 credits)

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Database systems*

**BMEEOFTM51**

The course aims to provide theoretical and practical knowledge in the field of data analysis. During the semester basic concept of efficient and consistent data management will be presented. In addition students get knowledge how to build a complex database system as a project with teamwork. (3 credits)

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Energy Efficiency and Certification*

**BMEEÉÉMKK3**  
**Dr Tamás Csoknyai**

The course aims to provide theoretical and practical knowledge in the field of energy efficiency of large energy systems and buildings. It covers fundamental meteorological aspects, energy balance of buildings, calculation frameworks, energy efficiency measures and building integrated renewable energy systems, energy performance and environmental indicators. Energy performance certification schemes will also be discussed such as life cycle assessment of buildings. (3 credits)

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Conventional and New Technologies of Energy Production

**BMEVEKFM304**  
**Dr György Pátzay**

(3 credits)

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Waste Management*

**BMEEÉÉMKK2**  
**Dr Orsolya Molnár**

The course introduces main sources and types of industrial and communal waste, waste hierarchy and up-to-date directives regarding to waste management. Insight is gained into waste disposal and treatment processes, main equipment and processes of waste management are taught. During the theoretical lectures and organized field trips students become familiar with environmental and sustainability problems regarding to thermal treatment and disposal of hazardous and municipal wastes. The course aims to intensify engineering skills and to train professionals focusing on environmental and sustainability aspects of waste management. (3 credits)

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Environmental microbiology and biotechnology

**BMEVEMBM308**  
**Dr Mónika Molnár**

The main aim of the subject is to help the students develop a bio and eco-engineering view when dealing with environmental biotechnologies; furthermore to get familiar with the natural biological – microbiological and plant-assisted processes substantiating these technologies. The subject includes the theoretical background of environmental bio- and eco-technologies, their practical implementation and evaluation even via case studies targeting amendment of degraded soils and remediation of contaminated (environmental) elements, primarily contaminated soil, ground water, wastewater. Within this topic the focus will be on the ecosystem, especially on microorganisms and primarily on the multilevel interaction between the chemical substances and the environment, especially the chemical substances...
Modelling of Environmental Systems

Dr László Koncsos

The course aims to introduce the core steps of environmental modelling including problem and model identification, calibration, validation and sensitivity analysis. The course provides theoretical and practical knowledge about key concepts of different modelling techniques as well as the description of point and non-source pollutant and nutrient transport. Surface-subsurface water and material transport and air pollution is introduced. Evaluation of various environmental risks is also a relevant part of the material. During the course various mathematical methods will be presented including statistical and analytical approaches, numerical solution of differential equations and soft computing techniques. (3 credits)

Operation of chemical processes*

Dr Kinga Komka

The course aims to teach the basics and methods of mathematical statistical treatment of measured data and to teach the design and analysis of the most basic full factorial designs. During the theoretical lectures and practical exercises students learn the theoretical background of the statistical analysis of data and the most important statistical methods including hypothesis testing, parameter estimation, correlation and linear regression. Practical skills will be obtained through design of experiments and the statistical analysis of measured data. (3 credits)

Dr Mónika Molnár

Environmental toxicology is one of the most important tools in the modern, risk-based environmental management, as it is the study of the impacts of chemical substances upon the structure and function of ecological system. This subject explains the principles and practice of environmental toxicology and its application in environmental risk management, risk assessment, risk reduction and decisions concerning the protection of the environment. At the laboratory practice we get familiar with laboratory test methods applied in environmental toxicology and the most important testorganisms used in aquatic and terrestrial ecotoxicology. (3 credits)

Occupational Health and Safety, Fire Protection, Noise and Vibration Protection

Dr János Gábor Vad

The course aims to provide theoretical and practical knowledge in both fire protection and occupational safety while highlighting the most important obligations of the employer towards the field of action. They must be clear on what specific fire protection or occupational safety tasks they need to solve while working under organized circumstances, but also need to know which of these is a complex problem, that requires the handling of a professional. Another focus of the course is to provide a basic knowledge in the field of noise and vibration protection. This will help students understand the basic requirements in the industry. (4 credits)

Dr Alajos Grán

The aim of this subject is to show the principles of environmentally friendly chemistry, methods, equipment and techniques, along with the application of the green chemical tools in the organic chemical industry and in syntheses of practical importance. Criteria of up-to-date technologies, and point of views of economical and environment protecting operations are also discussed via case studies. (3 credits)

Dr Mónika Molnár

Environmental toxicology is one of the most important tools in the modern, risk-based environmental management, as it is the study of the impacts of chemical substances upon the structure and function of ecological system. This subject explains the principles and practice of environmental toxicology and its application in environmental risk management, risk assessment, risk reduction and decisions concerning the protection of the environment. At the laboratory practice we get familiar with laboratory test methods applied in environmental toxicology and the most important testorganisms used in aquatic and terrestrial ecotoxicology. (3 credits)

Planning of Studies*

Dr Kinga Komka

The course aims to teach the basics and methods of mathematical statistical treatment of measured data and to teach the design and analysis of the most basic full factorial designs. During the theoretical lectures and practical exercises students learn the theoretical background of the statistical analysis of data and the most important statistical methods including hypothesis testing, parameter estimation, correlation and linear regression. Practical skills will be obtained through design of experiments and the statistical analysis of measured data. (3 credits)
The Faculty of Civil Engineering is the oldest faculty of the Budapest University of Technology and Economics and can trace its history back to the University’s predecessor, the Institutum Geometricum, founded by Emperor Joseph II in 1782. Since then, thousands of engineers have graduated from this Faculty to work worldwide as educators, international researchers and engineering project managers.

The most essential service of the Faculty – education linked closely to research and engineering work – is reflected in the scientific activities of nearly 110 lecturers in 9 departments. They have contributed significantly to a professional, scientifically sound solution of diverse engineering problems. Out of the approximately 1200 students who study at this Faculty, 100 students from abroad participate in the English language program annually.

The BSc engineering program in English leads to a BSc degree in four years. Two specialisations are offered: Structural Engineering and Infrastructure Engineering. Graduates from the BSc Specialization in Structural Engineering are able to design, construct and organize the investments of mechanically, structurally and technologically complex structures in close cooperation with architects as well as transportation and hydraulic specialists. These structures include bridges and underground passages for transportation networks; power stations, cooling towers, craneways, transmission and telecommunication line structures; warehouses, industrial plants, and multi-storey buildings as well as hydraulic and water utility structures. Graduates from the BSc Specialization in Infrastructure Engineering are able to design and construct urban and regional infrastructure, such as roads, railways, water and wastewater utilities, hydraulic constructions, and organize engineering activities in these fields.

The Faculty offers an MSc programme in Structural Engineering with a duration of 1.5 years. The MSc programme has three specializations: Specialization in Numerical Modelling, Specialization in Structures, and Specialization in Geotechnics and Geology. Specialization in Numerical Modelling provides advanced knowledge of structural analysis using contemporary computer techniques, including the theoretical background of the methods. Specialization in Structures provides thorough knowledge in structural design, skills enabling to carry out independent project coordination and to execute special design, construction and development procedures. The main goal of the Specialization in Geotechnics and Geology is to provide enhanced knowledge and skills in the field of engineering geology, geotechnics modelling, underground structures and foundations. These specializations are useful for research oriented students pursuing a doctoral degree in a PhD programme, as well as for the next generation of practicing leading engineers, who will solve special structural problems and innovate the construction procedures.

The doctoral school of the Faculty offers a 4-year PhD programme in Civil Engineering and Earth Sciences.

Departments

Geodesy and Surveying
Construction Materials and Technologies
Photogrammetry and Geoinformatics
Engineering Geology and Geotechnics
Structural Engineering

Structural Mechanics
Highway and Railway Engineering
Hydraulic and Water Resources Engineering
Sanitary and Environmental Engineering

Budapest University of Technology and Economics
Faculty of Civil Engineering
Dean: Dr. László Dunai
Course-director: Dr. Olivér Fenyvesi
Program coordinator: Ms. Nóra Gáspár

Faculty Office:
Building K, 1st floor, room 128
Mailing Address: Műegyetem rkp. 7-9,
H-1111 Budapest, Hungary
Phone: (+36-1) 463-3531
Fax: (+36-1) 463-3530
Web: www.epito.bme.hu
### Curriculum of BSc in Civil Engineering

#### Core subjects (8 semesters)

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## Curriculum of BSc in Civil Engineering
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*Refers to external requirements.*
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<td>Tunneling</td>
<td>BMEEOGMMG61</td>
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<td>Hydrogeology</td>
<td>BMEEOGMMG62</td>
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<td>Numerical Methods in Geotechnics</td>
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<tr>
<td>Engineering Geology of Hungary</td>
<td>BMEEOGMMG64</td>
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Description of BSc Courses
Civil engineering BSc - Major in Structural Engineering

Compulsory English 1.
BMEGT63A3E1
The course is designed to enable students to communicate fluently and effectively in study environment. Receptive, productive and interactive activities and strategies are included in the curricula. (4 credits)

Surveying I.
BMEEOAFAT41

Chemistry of Construction Materials
BMEEOEMAT41

Civil Engineering Representation and Drawing
BMEEOEMAT42
3 main parts of the subject: 1. Descriptive geometry. 2. Engineering drawing. 3. Freehand drawing. 1. Basics of descriptive geometry course modules: Students gain knowledge and skills in regularities and techniques of descriptive geometry, developing spacial reasoning. Topics: basic constructions in planes of projections, transformations, tasks of intersections, intersections and interpenetrations of plane and curved solids, cast shadows, construction in scale, special revolution solids and skew surfaces. Additional representation systems: dimensioned representations, orthogonal axonometry, perspective projection. 2. Engineering drawing course modules: Students gain knowledge and skills in engineering drawing, specific notations, proportions and scale, magnification, minification, construction of ground plans and sections. 3. Engineering free-hand representation course modules: develop free-hand drawing in scale. (4 credits)

CAD for Civil Engineers
BMEEOFTAT41
Besides an overview on CAD systems and application fields, students will learn the 2D drawing commands that enable carrying out basic design tasks. Layer management, block definition and applying annotations and dimensions are discussed in detail. Learning printing options and parameters supports further design works in the BSc civil engineering program. The aim of the course is to let students understand the potential and capabilities of CAD systems and their applications. The course introduces the basic spatial drawing solutions providing bases for high level courses involving 3D constructions, BIM applications. (2 credits)

Geology
BMEEOGMAT41
The geology provides the characterisation of geological formations and materials from a civil engineering point of view. It describes the processes and the interactions between the engineering works and the geological environment. The dynamics of the Earth, the description of raw materials and geo-materials used in engineering practice (minerals and rocks), the geological risks such as earthquakes, volcanism, landslides and their effect, characterisation of surface and subsurface waters and related geological problems. (3 credits)

Basis of Statics and Dynamics
BMEEOTMAT41

Mathematics A1a - Calculus
BMETE90AX00
Algebra of vectors in plane and in space. Arithmetic of complex numbers. Infinite sequences. Limit of a function, some important limits. Continuity. Differentiation: rules, derivatives of elementary functions. Mean value theorems, l’Hospital’s rule, Taylor theorem. Curve sketching for a func-
tion, local and absolute extrema. Integration: properties of the Riemann integral, Newton-Leibniz theorem, antiderivatives, integration by parts, integration by substitution. Integration in special classes of functions. Improper integrals. Applications of the integral. (6 credits)

Physics for Civil Engineers

BMEET11AX13


Compulsory English 2.

BMEGT63A3E2

The courses are designed to enable students to communicate fluently and effectively in study environment. Receptive, productive and interactive activities and strategies are included in the curricula. By the end of the semester the overall language ability of the students is at level B2 (by the Common European Framework of Reference (4 credits)

Surveying II.

BMEEOAFAT42

Properties of analogue and digital maps, the application of maps in engineering practice. Traversing, the types of traverse lines. Localizing blunder in traverse lines: the linear and angular error. Offset surveys. The determination of the horizontal and vertical positions of detail points: the tacheometry. The contact potential, its application in surveying. Topographic surveys: reconnaissance, sketch, detail survey and mapping. Free stationing. The principles of computational adjustments, the law of error propagation, Construction tolerances and the fundamental of geometrical quality control. Horizontal and vertical deformation monitoring. Setting out straight lines, curves, transition curves and points in a given elevation. The global navigation satellite systems (GPS, GLONASS, Galileo, ...) and their application in surveying. Building surveys. The localization of underground public utilities. Mapping public utilities and the public utility register. (4 credits)

Construction Materials I.

BMEEOEMAT43


Civil Engineering Informatics

BMEEOFTAT42

The course gives an overview on the major areas of informatics, on the components of information technology systems. Besides supporting the labs, some practical problems and particular tasks are also discussed on the lectures. On the labs, students use spreadsheet application to solve different tasks, then learn the basics of numerical and non-numerical methods in mathematical software environment. Students also learn the basics of programming; most of the tasks have to be solved by own scripts, routines, programs. Civil engineering informatics discusses 2D and 3D computer graphics and the basics of database management that supports high level courses involving spatial construction and database systems. (5 credits)

Soil Mechanics

BMEEOGMAT42

Origin of soils, soil exploration, soil samples. Components of soils (phase relationships, grain size distribution, consistency limits), soil classification, compaction. Stresses in the soil (under static conditions, conditions of steady vertical flow). Flow of water through soil due gravity (Darcy’s law, coefficient of permeability, flow nets). Compressibility of soil (reasons and types of compression). Shear strength of soil (Mohr-Coulomb failure criterion, determination of shearing strength). (4 credits)

Introduction to Strength of Materials

BMEEOITMAT42

Internal forces and internal force diagrams of planar and spatial structures (revision, generalization). Moments of inertia and principal directions of planar figures. Strength properties of materials. Concept of stresses and deformations. Material models: linearly elastic material and linearly elastic and perfectly plastic material. Beam element, beam model composed of elastically connected cross-sections. Computation of normal stresses in beams for centric tension/compression, simple bending, skew bending, and tension/compression combined with bending. Computation of shear stresses in beams for pure shearing, torsion, and shearing combined with bending. Eccentric compression of cross-sections of no tension materials. Shear centre of thin-walled cross-sections. Displacements of bent beams with straight axis. Principal stresses and principal directions. (6 credits)

Hydraulics I.

BMEEOVVAT42

Mathematics A2a - Vector Functions


Surveying Field Course

Using the theoretical background of the courses Surveying 1 & 2 students are required to: assess the existing datasets used for mapping; define the necessary surveying activities; practice the surveying observations, planning, data processing and documentation; practice profile boarding, setting out of roads; learn to use modern surveying instruments (total stations, GPS/GNSS receivers, electronic levels, digital photography). (3 credits)

Building Construction Study


Geoinformatics

The aim of Geoinformatics is to introduce the principles and potential application fields of geographic information systems (GIS) in the civil engineering practice. The course discusses the basic concepts and applications of GIS, the modelling process needed to create GIS, the reference systems of geometric data, the spatial data sources and data acquisition methods, the aspects of data quality, the resources, tools, databases of GIS, the basics of data analysis, visualization and implementation of GIS. Through the lectures and labs students learn the GIS workflow based on desktop and web-based solutions, and tools of spatial process modelling, data management and web integration. (3 credits)

Basis of Design


Structural Analysis I.


Railway Tracks

Basic concepts of the railway tracks and vehicles, most important technical parameters. Features of normal railways, suburban railways, urban railways, classification of different types of railways. Speed, acceleration, changing of acceleration. Horizontal and vertical alignment of the railway tracks, straight, circular curves and transition curves, superelevation, vertical curves. Elements of the substructure and superstructure. Rails, sleepers, rail fastenings, ballast, subgrade, strengthening of the subgrade. Setting out major and detail points of curves and transition curves. Structures and solutions of dewatering and drainage of railway tracks. Basic concepts of conventional and continuously welded rail tracks. Types of turnouts and simple track connections. Basic concepts of railway stations, platforms, passenger access. (3 credits)

Basics of Environmental Engineering

The aim of the course is to provide basic scientific and engineering background for further studies in environmental engineering by giving introduction to the following subjects: basics of ecology, the natural cycle of ecologically important elements and substances, the environmental effects of human activities, the ecological footprint, energy consumption patterns and energy production technologies, renewable energy sources. Selected environmental problems associated with civil engineering activities (water, air and soil pollution), with focus on the urban environment. Tools and methods for conducting environmental impact assessment. (3 credits)
Public Works I.  
**BMEEOVKAT42**

The main goal of the subject is to provide information about the most important features of the public works. The subject is also including the connections between the different public works and other establishments. Further aim is to provide knowledge for the future general designers and technical managers to make the right decisions on the underground infrastructure of settlements. Main scopes are: system knowledge and design of different public work types like water acquisition, drinking water supply, waste water networks, storm water networks and public works asset management. (3 credits)

Hydrology I.  
**BMEEOVVAT41**


Mathematics A3 for Civil Engineers  
**BMETE90AX07**


Earthworks  
**BMEEOGMAT43**


Steel Structures  
**BMEEOHSAT42**

Lectures of Steel Structures have the general aim to study the basics of the design of steel structures, which consists of the design of simple structural members, simple joints and the investigation of the basic failure phenomenon, which can occur in steel structures. The program consists of the following topics:

- Steel grades, mechanical properties of the steel material.
- Design of bolted connections. Design of welded connections. Fatigue design and brittle fracture. Plate buckling phenomena, basics of the cross section classification. (3 credits)

Reinforced Concrete Structures  
**BMEEOHSAT43**

Structural safety of reinforced concrete (RC) structures; loads and effects on RC structures, material properties of concrete and reinforcing steel; moment-curvature relation of RC cross sections; Uncracked and cracked cross section; flexural strength theory, strength and ductility; design of RC cross section; eccentric compression; shear failure in beams without and with shear reinforcement; strength in bending and torsion; anchorage and stress development, bar curtailment; deflection and crack width. (3 credits)

Roads  
**BMEEOVVAT42**


Hydraulic Engineering, Water Manag.  
**BMEEOVVAT43**

The tasks, methods and tools of water management. Hungarian and European specialties of water management. Types and tasks of hydraulic engineering structures with the following topics: Watershed management of lowland and hilly areas, regulation of lakes and rivers, reservoirs and storage, flood control and land drainage, inland navigation, water power development, water intake and pumping stations, small hydraulic engineering structures, characteristic environmental impacts of hydraulic engineering structures. During the practical lessons four design works will be elaborated. (3 credits)

Construction Management  
**BMEEPEKAT41**

Curricula, themes, individual projects, tests, subjects of lectures and seminars of the Course are embracing managerial and organizational learnings useful and necessary for all civil engineers, such as:

- jobs and organizational structure of Contracting Construction Trade;  
- jobs and relations of partners collaborating in executing construction projects;  
- time and resource needs of executing construction projects (basic methods and terms of time-, resource- and cost estimates);  
- basics of mechanizing Construction, construction equipments and auxiliary plants, typical applications;  
- organizing construction site (site layout designs).

Individual project: Organizational plans (time estimates, resources calculations and site layout designs) of building a simple linear structure (reinforced concrete retaining wall) well known in practice of all civil engineers. (3 credits)
Business Law
BMEGT55A001
The problems of the area will be treated in two major parts. Part One introduces students to the general topics, for example the concept of law, the functions of the law in the socioeconomic life. Some basic legal problems, like the conception, characteristics and functions of the modern state and, in a comparative view, the characteristics of the Anglo-Saxon and continental systems of business law and the development of the Hungarian business law will be also discussed. The emphasis of Part Two is on the questions of company law and competition law presented in a European context. The lectures of this part outline not only the regulations of the Hungarian Company Act and Company Registry Act but they cover EU directives and regulations on companies and competition as well. (2 credits)

Foundation Engineering
BMEEOGMAT44

Management and Enterprise
BMEGT20A001
Intended for engineering students who would like a better conceptual understanding of the role of management in the decision making process. This course introduces the essentials of management as they apply within the contemporary work environment. Particular attention is paid to management theories, corporate finance, leadership, teamwork, quality management, management of technology, economics calculation and operations management. For problem formulation both the managerial interpretation and the mathematical techniques are applied. (4 credits)

Micro- and Macroeconomics
BMEGT30A001

Communication Skills for Civil Engineers
BMEGT60A6EO
The Communication Skills course is designed to meet the language needs of civil engineering students in academic and professional fields. Special emphasis is on the language of meetings and discussions, oral presentation and summary writing. (2 credits)

Urban and Regional Development
BMEEOUVAT43

Branch of Structural Engineering

Building Construction I.
BMEEOEMAS42
Students gain knowledge and skills during the semester work in the following topics: Flat and deep foundations, relation to sub-soil insulation of buildings. Masonry works, prefabricated panel systems. Plasters and ETICS. Reinforced concrete, steel and wooden beam slab constructions. Stairs. High roofs. Passable and non-passable flat roofs, green roofs. Insulations against functional water. (3 credits)

Timber Structures
BMEEOHSAS44

Strength of Materials
BMEEOOTMAS41
Differential equation of the elastic curve, computation of the deflected shape for various boundary conditions. Virtual displacement systems, virtual work. Theorem of virtual displacements. Computation of external and internal forces of statically determinate structures using the theorem of virtual displacements. Concept of potential energy, theorem of stationarity of potential energy, application of the theorem for the computation of displacements of structures. Concept of complementary potential, theorem of minimum complementary potential energy, using the theorem for the computation of reactions of structures. Revision of common work and energy theorems of mechanics. Characterization
of equilibrium states, concept of critical load. Methods of stability analysis: statical, kinematical, and energy methods. Elastic Euler buckling. (3 credits)

**Construction Materials II.**

**BMEEOMAS41**


**Building Construction II.**

**BMEEOMAS43**


**Steel and Composite Structures**

**BMEEOHSA547**

Design specialities of plated steel girders: plate and web buckling phenomena and design according Eurocodes. Design of steel structural members subjected to bending and axial compression – interaction formulae according EC3. Simple joints in steel structures – structural behaviour and design. Structural behaviour of steel and concrete composite members; design of composite beams and columns according EC4. (4 credits)

**RC and Masonry Structures**

**BMEEOHSA542**

Design principles of reinforced concrete slab and frame structures, exact and approximate design methods, structural details. Bracing systems of reinforced concrete buildings, determination of the forces acting to the individual shear walls, checking of stability. Detailing of reinforced concrete structures (beam end, corbel, frame corner, curved bars, stairs, force transfer between members, expansion joints, etc.). Types and strength characteristics of masonry. Design principles of unreinforced masonry walls according to EC6. Reinforced masonry walls. (4 credits)

**Bridges and Infrastructures**

**BMEEOHSA543**


**Laboratory Practice of Testing of Structures and Materials**

**BMEEOHSA546**

Experimental demonstration the behaviour of the loaded structural members and joints made from different materials (steel, reinforced or prestressed concrete, composite, glass…). Introduction into different experimental and measurement techniques and equipments. Up-to-date building materials and material testing methods. General and specific analytical and diagnostic methods for building materials and structures. (2 credits)

**Structural Analysis II.**

**BMEEOTMAS42**


**Rock Mechanics**

**BMEEOGMAS41**

Petrophysical properties of solid rocks, the characterisation of rock blocks and rock masses, the jointing system in the rock environment. The deformation processes and rheological characters in rock mechanics, the influence of joint spacing. The durability and effect of rock environment on the engineering structures. The evaluation of geological conditions in rock environment at tunnels foundations and rocky slopes. The influence of material properties on the petrophysical properties of rocks. (3 credits)

**Underground Structures, Deep Found.**

**BMEEOGMAS42**

Types and field of application of deep foundations (stone columns, diaphragm walls). Load transfer mechanism of deep foundations. Determination the bearing capacity and settlement by different methods (by theoretical formulas, load tests, sounding). Design and construction of Pedestrian subways, Underground garages. Analysis against uplift. Insulations. (3 credits)
3D construktional modelling of structures

BMEEOHSA545

The aim of the course is to introduce the 3 dimensional detailing of steel-, reinforce concrete- and timber structures to the students. The course intends to develop basic practical skills by real 3D modelling of structures where the model is able to provide drawings and lists automatically for fabrication and construction processes. The course provides insight into the integration of the 3D constructional model of structures with other branches like architectural, mechanical, electrical and plumbing models into a BIM (Building Information Modelling) model. The students will learn the necessary knowledge and also obtain experience for the later project home works and diploma works by the help of presentations, small examples and a modelling home work. (3 credits)

Design of Structures Projectwork

BMEEODHSA41

Students need to accomplish a complex design projectwork that is based on the knowledge gained through the branch courses. The project work is supervised by three lecturers from three areas of structural engineering, (6 credits)

Public Administration and Land Registry

BMEEOUVAT44


Field Course of Structural Geodesy

BMEEOAFA542

The main purpose of the subject is introduce the most modern techniques and methods for students in the field of state surveying and movement detection of civil engineering structures. The students apply the skills and knowledges learned in Surveying I, II and Field Course of Surveying to solve more complex structural engineering projects. Project are solved by students team. During the practises students survey some inner parts of a more levelled building, determine the geometry of axis of an about 30 m high brick chimney. Furthermore they determine the deflections of a slab and the distortions of floor. They determine the deflection of a cable bridge caused by traffic. They are introduced into the applications of photogrammetry, remote sensing and laserscanning in the area of construction engineering. (1 credit)

Dynamics of Structures

BMEEOOTMAS43


Industrial Practice

BMEEODHSA42

20 days of industrial practive at a civil engineering construction company, (0 credits)

Major of Buildings

Steel Buildings

BMEEOHSA-A1


Reinforced Concrete Buildings

BMEEOHSA-A2


Building Construction Methodology

BMEEOEMA-A1

During the semester methodology of planning, methods of design of building constructions are presented. Listing of requirements depend on function of building (building physical, acoustical point of views and fire protection). Designation of structural hierarchy based on the determined requirements. Building constructional relationship and design rules: i) skirtings - connections of load-bearing structures ii) structures of floors (floors on ground, floors of general slabs) - connections of load-bearing structures iii) facade - connections of load-bearing structures iv) thermal insulation and rainwater seepage, soil moisture and waterproofing - connections of load-bearing structures v) special
building constructions (windows, doors, gates), structures of fire protection (skylights, suspended walls against flame spreading). (2 credits)

Engineering Works

**BMEEOHSAS3**
The basis of the design and construction of engineering works is presented. The discussion holds on the waterproofing of reinforced concrete structures with watertight concrete, on the thermal effects and on the description of time-dependent strains of concrete structures. The use of cast-in-place and precast concrete in engineering works is presented. Some other modules: modelling the soil and structure interaction. Design aspects of pools, tanks and tower-like structures. Internal forces and reinforcements of typical structural elements of engineering works: rectangular, circular and ring plates, walls, wallbeams, box-like and shell structures. Dynamics of tower-line structures: wind effects and seismic action, dampers, wind turbines. (3 credits)

Building Design Projectwork

**BMEEOHSAS3**
Students need to accomplish a complex projectwork that is based on the major subjects. Students need to regularly attend consultations and get support from the supervisor(s). (6 credits)

Description of MSc Courses

MSc in Structural Engineering

Advanced Mathematics

**BMETE90MX33**

Physics Laboratory

**BMETE11MX22**

Methods of Engineering Analysis

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

Elective option:

**BMEEOHSA-B3**

Reinforced Concrete bridges


Building Physics

**BMEEOEMMS51**
The aim of the subject is that the students get to know the basics of modern building physics, the theory of the heat conduction, convection, heat radiation, heat transport processes, the technical alternatives of the heat loss reduction of buildings and building constructions, the role of outdoor and indoor environment-related boundary conditions in building physical calculations and the method of determining these parameters, the analytical calculations of the of heat transport, the theory and practical application of non-steady-state, transient, non-linear and multi-dimensional heat transport processes, as well as conjugated heat-moisture and air transport simulations, and basics of city-scale building-physics. (3 credits)

Geodynamics

**BMEEOOGMM551**
The subject focuses on the understanding of dynamic effects that are transferred from the geological environment to the engineering structures. The students are getting familiar with geophysics, rock stress and its interpretation and graphic representation, local and world-scale (Word Stress Map). The deformations caused by seismic waves in igneous, metamorphic and sedimentary rocks also form part of the subject, as well as deformations caused by historic earthquakes. A main topic is the understanding of the Earth's
structural geology and seismicity with special emphasis on
the Carpathian basin. The lectures will help in learning the
detection methods of seismic waves and acquire the in-
formation content of the seisograms. By completing the
course the students will able to determine the parameters
that are necessary for appropriate seismic design. Engineer-
ing seisological approach will help the students to place
the structures in the geological environment allowing the
minimal risk and reducing the cost by proper seismic de-
sign. (3 credits)

Materials’ science for civil engineers
BMEEOEMMS52
Main objective of this subject is to learn a wide range of
special material properties used for structural design.
Within this subject special material properties and material
processes are taught including: definition of performance
based material properties, role of micro-structure of materi-
als to their properties, related physical-chemical processes,
possibilities in modelling, re-lationship of sustainability –
durability – service life, possibilities of nanotechnology
in civil engineering, possibilities in reuse and recycling in
civil engineering. (3 credits)

FEM for Civil Engineers
BMEEOOTMMS51
The goal of the subject is to present the theoretical bases
of the finite element method and its practical application
to typical structural engineering problems. The classic ap-
proach to the finite element method will be followed in pre-
senting the basic idea of the method, the element types, the
applied interpolation functions, the various matrices and the
basic steps of their construction, the resulting system of
equation and the solution techniques of it. All these will
be demonstrated and practiced through examples, show-
ing how the various structure types (trusses, beams, frames,
plates, shells, 3D solids) can be analysed. An introduction
to nonlinearities from various sources will be given, with
special focus on the effect and handling of geometric non-
linearity. Beside the static problems, the application of the
finite element method to some heat transfer problems of
the structural engineering practice will also be discussed.
(5 credits)

Soil-structure interaction
BMEEOGMMSS52
The scope of the subject is to teach the students the funda-
mentals of geotechnics required for structural design, such
as familiarity with and use of EC7. These include geotech-
nical categorization; types and contents of geotechnical
documentations; geotechnical and structural design of piles
for different loading types, design of soil-supported ground
slabs along with the determination of the values of subgrade
reaction modulus; design of pile-supported ground slabs and
“rigid inclusion” slabs; structural design of excavation
support structures, determination of soil reaction moduli
along with their effect on deformations and internal forces;
design of ground anchors; geotechnical questions of bridge
abutments; and the basics of soil dynamics and geotechni-
cal earthquake engineering. (5 credits)

Structures 1
BMEEOHMS51
The objective of the subject is the modelling of beams,
membrans, plates and the simplest circular shell struc-
tures. The most important analytical solutions, the basics
and assumptions of numerical solutions are introduced. It’s
presented that the different structural considerations can
be implemented in the design codes and regulations. The
fundamentals membrane solutions, shear lag effect, effective
width, shear deformation, second-order effects and large
deformations, anisotropy and the vibration of floors are also
analysed. The main focus of the subject is the analysis of
plates and slabs. (5 credits)

Numerical modeling project
BMEEOOTMMS5P
The goal of the subject is that the students solve a civil engi-
neering problem the complexity of which is in accordance
with the level of the MSc course and with the credit and
time-frame of the subject. The problem should be solved
by high level application of some analytical or numerical
method (e.g., finite element method). The problem is solved
by the individual work of the student, helped by a tutor.
(5 credits)

Structures project
BMEEOHMS5SSP
The objective of the course is that the student shall solve a
structure-specific problem, by which his/her problem solv-
ing skills are improved, gains the skill of literature review,
aims the comprehensive thinking. Aim is that the student
becomes able to efficiently solve problems arising during
design or research tasks. The subject of the study can be any
structure-related problem discussed and agreed with the su-
ervisor; not exclusively: modelling, analysis and/or design
of part of or whole structural system, experimental analysis;
research, research and development or expert design task;
based on individual problem statement or joining to ongo-
ing research program. (5 credits)

Geotechnical and engineering geological
project
BMEEOGMMSS5P
The goal of the subject, that the students are getting familiar
with the geotechnical and engineering geological design
process. The students get to know through a project work
the geotechnical, engineering geological data collection,
modelling, design and calculation tasks. Furthermore, they
get familiar with practical application of analytical and nu-
merical design methods. (5 credits)

Decision Supporting Methods
BMEEEPKST4
The aim of the course is to familiarize students with some
practically used or usable mathematical models in the field
of construction management, scheduling and tendering
process. The course covers a wide variety of topics dealing
with least cost scheduling problems, multi attribute deci-
sion models, learning curves. There are two computational
modeling tasks as homework assignments. Final grades will
be based on the two assigned tasks 15-15% and test 70%.
(2 credits)

Accounting, Controlling, Taxation
BMEGT35M014
The main issues of ‘window dressing’ and their interpreta-
tion through financial ratio analysis and interpretation. The
cost volume profit analysis and its relationship with costing
and pricing decision-making. The operational and capital
budgetary process in an international context and its advis-
ory role through the process of variance analysis. The best
international accounting practice both at the functional,
The second important goal is to get to know the theories in the form of a general boundary and/or initial value tensors is analysed, furthermore the origination of the equations. The application of various nonlinear strain and stress values are required for the formulation of nonlinear mechanical problems, and numerical modeling, and the principal equations relevant to the nonlinear mechanics, its variables used in theoretical and practical analysis methods of mass and stiffness matrix of the (finite element method) discretized structures, taking into account the damping, dynamic issues supporting effect of the soil, the mechanical background of earthquake analysis of structures and the effect of wind. (4 credits)

Structural Dynamics

The purpose of the subject is to get students to know the basics of steel structures. The student will learn the terminology of theory of engineering stability and theory of torsion of thin-walled members, as well as their practical importance and applicability. The most relevant modes of instabilities of engineering steel structures will be presented (flexural buckling, flexural-torsional buckling, lateral-torsional buckling, plate buckling). To each instability mode the student will learn the background and mathematical bases, as well as the Eurocode design procedures and their practical applications. (4 credits)

Stability of Structures

The main goal in this subject is, that the students get to know the solution with the finite element method (FEM) of the nonlinear mechanical problems typical in engineering practice, alongside with the mathematical background of the solutions. The specialties of one- and multidimensional problems will be discussed. There will be interpreted the non-linear behaviour of the most important structures (beams, frames, plates, shells) from the practical use, with a focus on the important questions about the effect of large displacements and plastic deformations. Beyond the general non-linearity the students will learn the special techniques (finite strip method, finite volume method, boundary element method, meshfree methods, smooth and finite particle methods, etc.). As an organic part of the course, students will analyze case studies solved by computer simulation, in order to deeper understand the modeling techniques of various nonlinearities and connect theory and practice. (3 credits)

Nonlinear FEM

The main goal of the subject is to get students to know the modeling possibilities of rod structures appearing in the structural engineering practice, the theoretical background of the models. Based on the linear mechanical model of the generalized beam element students will be acquainted with the calculation of the stiffness matrix and load vector of frame structures and their generalizations e.g. trusses, grids, and infilled frames. Higher-order analysis of kinematically indeterminate structures with high importance in engineering practice will be learnt. (3 credits)

Analysis of Rods and Frames

The goal of the subject is to help future engineers be prepared for confronting and resolving ethical issues that they might encounter during their professional careers. It gives an overview of the moral problems engineers face in their different social roles, and it provides conceptual tools and methods necessary for pursuing those issues. Topics include engineering professionalism; social roles of engineers; ethical theories; ethical decision making techniques; social impacts of engineering, professional organizations; code of ethics of engineering societies. Case studies are discussed in a practice oriented approach. The primary goal is to stimulate critical and responsible reflection on moral issues surrounding engineering practice. (2 credits)

Engineering Ethics

The purpose of this course is to help future engineers be prepared for confronting and resolving ethical issues that they might encounter during their professional careers. It gives an overview of the moral problems engineers face in their different social roles, and it provides conceptual tools and methods necessary for pursuing those issues. Topics include engineering professionalism; social roles of engineers; ethical theories; ethical decision making techniques; social impacts of engineering, professional organizations; code of ethics of engineering societies. Case studies are discussed in a practice oriented approach. The primary goal is to stimulate critical and responsible reflection on moral issues surrounding engineering practice. (2 credits)

Stability of Structures

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

Structural Dynamics

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

Structural Dynamics

The purpose of the subject is to get students to know the basics of steel structures. The student will learn the terminology of theory of engineering stability and theory of torsion of thin-walled members, as well as their practical importance and applicability. The most relevant modes of instabilities of engineering steel structures will be presented (flexural buckling, flexural-torsional buckling, lateral-torsional buckling, plate buckling). To each instability mode the student will learn the background and mathematical bases, as well as the Eurocode design procedures and their practical applications. (4 credits)

Nonlinear Mechanics

The main goal of the subject is to get students to know the basics of the concept and methodology of the discrete element methods (DEM) occurring in the structural engineering practice, and allow an insight to the operation of a discrete element software. Students will learn the most important variations DEM, the applied equations of motion, their numeric solution methods with the limits of applicability, advantages and disadvantages. Students will analyse the model of a simple engineering problem. (3 credits)

Discrete Element Method
Structures 2
BMEEOHSMST-1
The objective of the subject is the presentation of the hazards, structural reliability and their role in structural design. The behaviour of complex structures, curved steel and concrete shells, 3D truss structures and their design are introduced. The most important analytical solutions and the basics and assumptions of numerical solutions are presented. Additionally, the design methods of cable and membrane structures are concluded in the subject. (4 credits)

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

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

Applied Fracture Mechanics
BMEEOHSMST61
The objective of the subject is the presentation of the basic theories and methods of fracture mechanics, and their application in the field of civil engineering. The basic definitions of fracture mechanics and their mathematical representation, and the basic calculation methods are also introduced. The design methods in Eurocode based on fracture mechanics are presented. (4 credits)

Prestressing Technologies
BMEEOHSMST62
The objective of the subject is the presentation of the prestressed structures and its design procedures. The main types of prestressed structures, applied materials and prestressing technologies are introduced. The effect of prestressing for the design procedures is discussed. Special prestressed structural systems and prestressing technologies for bridges are also presented. The Eurocode based design procedures and their practical application are showed. (3 credits)

Strengthening of Structures
BMEEOHSMST63
The objective of the subject is the presentation of the diagnostic of existing structures with different materials and structural systems, the possible causes of structural damages, methods of reinforcement and the most common building materials. According to this, the tools and steps of the diagnostic of existing structures, the verification of the structure’s load bearing capacity, the basic principles of qualification, the required content of expertise, the methods of reconstruction and reinforcement, the most common ways of structural damages (direct and indirect) and the different structural systems of existing residential buildings are presented during the semester. Case studies are also introduced. (3 credits)

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

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

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

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

**Tunneling**

**BMEEOGMMG61**

The goal of this course is to teach the most important segments of the tunnel design and the construction. The course is focus on the frequently used tunneling technics and calculation methods in both soil and rock environment. During the semester the student calculates the most important stresses on the tunnel, using both numerical and analytical methods. The tunnel designs are shown in a detailed both the construction and operation system, as well. (3 credits)

**Hydrogeology**

**BMEEOGMMG62**

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

**Numerical Methods in Geotechnics**

**BMEEOGMMG63**

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

**Engineering Geology of Hungary**

**BMEEOGMMG64**

The goal of the subject, that the students getting familiar with the main geological regions of Hungary and gain the required regional and local geological knowledge for engineering design and operate of facilities. Furthermore it is also an important additional part of the course to present knowledge about the main geological structures of Hungary, the location of the most important soils and rocks, the surface-forming processes with anthropogenic effects, the most important relief forms caused by flowing water, wind. Introduces to the students the karstic landforms, and the surface forming effect of mining, road, railway and other civil engineering constructions. Furthermore the subject give comparison between the Hungarian and well-known international geological units and landforms. (3 credits)
The Faculty of Electrical Engineering founded in 1949 has been renowned for excellence in research and education throughout the years of changes in the scope of engineering. Over this period, the faculty has earned a wide-spread international reputation for its high academic standards and scientific achievements. Spearheading the movement to establish a modern education system, it has offered a comprehensive English curriculum since 1984. In 1992 the name of the faculty was changed to Faculty of Electrical Engineering and Informatics in order to give recognition to the growing importance of computer science. The education programmes in English include a 3.5-year BSc, a 2-year MSc and a 4-year PhD programme in the fields of electrical engineering and computer engineering.

This Bulletin describes the curricula and the subjects being available for the 2018/2019 academic year, regarding the BSc, MSc and PhD programmes, respectively.

The undergraduate BSc programme (7 semesters) aims at providing a comprehensive knowledge with sound theoretical foundations in two areas: (1) Electrical Engineering including more specific studies in electronics, control engineering and power engineering; and (2) Computer Engineering dedicated to the major domains of computer science. The major specializations in Electrical Engineering are infocommunication systems, embedded and controller systems and sustainable electric energetics. Studies in Computer Engineering include specialization in infocommunications and software engineering. Each specialization contains four courses focusing on the field of interest followed by a laboratory course and a project laboratory. In order to pursue studies in a given specialization the number of students must exceed a certain threshold, otherwise the interested students are kindly directed to another specialization.

The MSc programme (4 semesters) advances the knowledge in the following fields: (1) Electrical Engineering, offering specializations in (i) embedded systems, (ii) multimedia systems and services, and (iii) electric power systems; and (2) Computer Engineering, offering specializations in (i) applied informatics, and (ii) internet architecture and services.

The post-graduate PhD programme is available in all domains offered in the MSc programme. Since research and development requires innovative engineering expertise, one of the major concerns of the faculty is to endow students with high level mathematical skills in modeling complex engineering systems. This objective implies the use of system and algorithmic theory in addition to a thorough knowledge in physics. The search for optimal solutions in the highly complex architectures of Electrical Engineering and Computer Engineering necessitates not only engineering but economical considerations, as well. As a result, the scope of the programme must include design, research and management expertise at the same time.

Several strategies have been designed to help students develop high level skills in mathematics, physics, and computation. Besides theoretical knowledge they need to carry out design and development activities in the field of communication, instrumentation, and power industries to further perfect their practical skills. The curriculum also includes solving tasks in the fields of production and operation.

Scientific groups are formed to encourage the students to do independent but supervised laboratory work. Project laboratory is one of the core parts of the studies which are dedicated to independent problem solving with the armory of modern work stations and software packages. The expertise of handling these tools are inevitable in pursuing an engineering career.

In order to strengthen the transfer of knowledge and know-how between the university and industry, the faculty maintains close contact with well known multinational companies in the field of communication and computer industry. As a result, many industrial experts offer their experience and knowledge as part-time lecturers, project supervisors, members of examination committees.

Admission policy

To maintain a high educational standard is the basic interest of both the university and the students. Only a constant guard of quality can ensure that tuition fee is traded for a degree of high reputation bearing a competitive value in the global market. Therefore, the priority of our acceptance policy is sustaining the quality of education by selecting those students whose knowledge and previous qualifications are in match with the expertise required by the courses. This rule holds for all applicants, no matter the country or the educational institutions they came from. Only the implementation of this acceptance policy helps us to preserve the value of the degree, which the students rightly deserve in exchange of their tuition fee and in exchange of their continuous effort committed during the course. In order to implement the principles, our faculty has adopted the following terms of acceptance:
Practical guidelines for acceptance to the MSc programme

1. Applicants with BSc studies having a WGAP (Weighted Grade Average Point) equal or better than ‘good’ (more than 3.51 out of 5.00) will receive acceptance to the MSc course.

2. Applicants with a BSc qualification less than ‘good’ (less than 3.50 out of 5.00) are regretfully rejected to enter the MSc program.

3. Applicants should also submit two recommendations given by renowned academic personnel.

Practical guidelines for acceptance to the PhD programme

1. The primary condition of admission to postgraduate studies is that the applicant must hold a Master of Science (or Engineering) degree in Electrical and Electronic Engineering (or in some closely related fields) or Informatics. Admission to postgraduate studies will be considered if the qualification of previous studies is at least of level “good” (more than 3.51 out of 5.00) or equivalent.

2. Applicants are expected to have a definite scope of research in electrical engineering or computer science, where they would like to advance their knowledge. They are requested to present a proposal, specifying a domain of interest with some research objectives, milestones and deliverables during the postgraduate studies. The suggested topic should have sufficient preliminaries in their university studies.

3. Applicants with experience and initial results in the suggested research topic will have preference. A short summary of preliminary research activities together with relevant reports, published papers ... etc. would be of help in the admission process.

4. Applicants should also submit two recommendations given by renowned academic personnel.

Each admission is valid only for the forthcoming academic year (starting right after the letter of acceptance). In the case of commencing studies later than the semester indicated in the letter of acceptance, or returning to studies after a passive semester, the faculty does not take responsibility for ensuring that the students can follow the same specialization which he or she studied prior to the passive semester, and reserves the right to direct the student to other specialization depending on the changes in the number applicants for specializations.

Departments

Automation and Applied Informatics
Electronics Technology
Electron Devices
Networked Systems and Services
Control Engineering and Information Technology
Measurement and Information Systems

Computer Science and Information Theory
Broadband Infocommunications and Electromagnetic Theory
Telecommunications and Media Informatics
Electric Power Engineering
## Curriculum of BSc Subjects in Electrical Engineering

| Subject | lectures/practical lectures/laboratory | | | | | |
|---------|----------------------------------------|---|---|---|---|---|---|
| **Name** | **Code** | **Credits** | **1** | **2** | **3** | **4** | **5** | **6** | **7** |
| **Fundamentals in Natural Sciences (48 credits)** | | | | | | | | |
| Mathematics A1 | TE90AX00 | 6 | 4/2/0/e | | | | | |
| Mathematics A2 | TE90AX26 | 6 | 4/2/0/m | | | | | |
| Comprehensive Exam on Mathematics A1&A2 | TE90AX16 | 0 | 0/0/0/e | | | | | |
| Mathematics A3 | TE90AX09 | 4 | 2/1/0/e | | | | | |
| Mathematics A4 | TE90AX51 | 4 | 2/2/0/e | | | | | |
| Physics 1 | TE11AX21 | 4 | 3/1/0/e | | | | | |
| Physics 2 | TE11AX22 | 4 | 2/1/0/e | | | | | |
| Foundation of Computer Science | VISZAA05 | 5 | 2/2/0/e | | | | | |
| Informatics 1 | VIABAB08 | 4 | | | 4/0/0/m | | | |
| Informatics 2 | VIABAB01 | 5 | | | 3/0/1/e | | | |
| Electronics Technology and Materials | VIETAB00 | 6 | | | 3/0/2/m | | | |
| **Economics and Humanities (20 credits)** | | | | | | | | |
| English | | | 2 | 2/0/0/m | | | | |
| Micro- and Macroeconomics | GT30A001 | 4 | | | 4/0/0/e | | | |
| Management and Business Economics | GT20A001 | 4 | | | 4/0/0/m | | | |
| Business Law | GT55A001 | 2 | | | 2/0/0/m | | | |
| Mandatory Humanities & Economics 1, 2 | | | 2 | 2/0/0/m | | 2/0/0/m | | |
| Mandatory Humanities & Economics 3, 4 | | | 2 | 2/0/0/m | | 2/0/0/m | | |
| **Core Electrical Engineering Knowledge (89 Credits)** | | | | | | | | |
| Basics of Programming 1 | VIHA01 | 7 | 2/2/2/m | | | | | |
| Basics of Programming 2 | VIHA02 | 6 | 2/0/2/m | | | | | |
| Digital Design 1 | VIHA03 | 6 | 3/1/1/e | | | | | |
| Digital Design 2 | VIHA04 | 5 | 3/1/0/e | | | | | |
| Signals and Systems 1 | VIHVAA00 | 6 | 3/2/0/e | | | | | |
| Signals and Systems 2 | VIHVAB01 | 6 | 3/3/0/e | | | | | |
| Electrotechnics | VIHBA00 | 5 | 3/1/1/m | | | | | |
| Introduction to Electromagnetic Fields | VIHVAC03 | 4 | | | 2/1/0/e | | | |
| Electronics 1 | VIHAB02 | 5 | | | 2/2/0/e | | | |
| Electronics 2 | VIHAB01 | 5 | | | 4/1/0/m | | | |
| Measurement Technology | VIHAB01 | 5 | | | 3/2/0/m | | | |
| Control Engineering | VIHAB05 | 5 | | | 2/1/1/e | | | |
| Infocommunication | VIHAB03 | 5 | | | 2/0/1/e | | | |
| Power Engineering | VIHAB01 | 5 | | | 2/1/1/e | | | |
| Microelectronics | VIHAB00 | 5 | | | 2/0/2/e | | | |
| Laboratory 1 | VIMIAC12 | 4 | 0/0/3/m | | | | | |
| Laboratory 2 | VIMIAC13 | 5 | | | 0/0/4/m | | | |
| **Study Specialization Blocks (43 Credits)** | | | | | | | | |
| Specialization subject 1 | | | 4 | | 2/1/0/e | | | |
| Specialization subject 2 | | | 4 | | 2/1/0/e | | | |
| Specialization subject 3 | | | 4 | | 2/1/0/e | | | |
| Specialization subject 4 | | | 4 | | 2/1/0/e | | | |
| Specialization laboratory | | | 4 | | 0/0/3/m | | | |
| Training project laboratory | VI**AL02 | 3 | | | 0/0/2/m | | | |
| Project Laboratory | VI**AL03 | 5 | | | 0/0/4/m | | | |
| Bsc Thesis Work | VI**AT01 | 15 | | | | | 0/10/0/m | |
| **Free electives (10 credits)** | | | | | | | | |
| Free elective 1, 2 | | | 2 | | 2/0/0/e | 2/0/0/m | | |
| Free elective 3 | | | 2 | | | | | | |
| Free elective 4 | | | 2 | | | | | | |
| Free elective 5 | | | 2 | | | | | | |

**Notes:**

- x/y/z/e,ce,m,s: x: contact hours of lectures per week, y: contact hours of classroom practices per week, z: contact hours of laboratory exercises per week, e: examination, ce: comprehensive exam, m: mid-semester mark, s: signature; credit: credit value according to ECTS – 1 credit represents 30 work hours (on average)
- 10 credits of free electives could be substituted by any subjects available
- Students should note that due to the early scheduling of the thesis defense session for students applying to MSc studies, the period for examination could be rather limited in the 7th semester.
Specializations

List of available specialization blocks depends on the number of students wanting to join. In order to pursue studies in a given specialization the number of students must exceed a certain threshold, otherwise the interested students are kindly directed to another specialization.

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<th>Subject</th>
<th>Code</th>
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<td>SUSTAINABLE ELECTRIC ENERGETICS specialization</td>
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<td>Electric Power Transmission</td>
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<td>Electrical Equipment and Insulations</td>
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<td>Industrial Control</td>
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<td>Embedded Operating Systems and Client</td>
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### Curriculum of BSc Subjects in Computer Engineering

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<th>Subject</th>
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<tr>
<td><strong>Fundamentals in Natural Sciences (44 credits)</strong></td>
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**Free Elective Subjects:** a list of these subjects is published on the website.

**Notation:** working hours/week: $x/y/z/r$
- $x =$ lecture hours
- $y =$ practice hours
- $z =$ laboratory hours
- $r =$ requirement ($e =$ exam, $m =$ mid-semester mark)
## Curriculum of MSc Subjects in Computer Engineering

### Internet Architecture and Services Main Specialization

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- x = lecture hours
- y = practice hours
- z = laboratory hours
- r = requirement (e = exam, m=mid-semester mark)
## Curriculum of MSc Subjects in Electrical Engineering
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**Free Elective Subjects:** A list of these subjects is published on the website.

**Notation:** Working hours/week: x/y/z/r
- x = lecture hours
- y = practice hours
- z = laboratory hours
- r = requirement (e = exam, m = mid-semester mark)
## Curriculum of MSc Subjects in Electrical Engineering
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## Curriculum of MSc Subjects in Electrical Engineering
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<td>Intelligent Traffic Systems</td>
<td>BMEVITMA10</td>
<td>4</td>
<td>2/1/0/e</td>
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<tr>
<td>Human-Machine Interface</td>
<td>BMEVITMA11</td>
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<td>Smart City Laboratory</td>
<td>BMEVITMMB04</td>
<td>2</td>
<td>0/0/2/m</td>
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<tr>
<td><strong>Smart Systems Integration Secondary Specialization (14 credits)</strong></td>
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<tr>
<td>Fundamentals of Smart Systems</td>
<td>BMEVIEEMA04</td>
<td>4</td>
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<td>System Level Design</td>
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<td>Circuit Environment</td>
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<td>Smart Systems Design Laboratory</td>
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<td><strong>Optical Communication Secondary Specialization (14 credits)</strong></td>
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<td>Optical Network Elements</td>
<td>BMEVHVMA05</td>
<td>4</td>
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<tr>
<td>Optical Systems and Applications</td>
<td>BMEVHVMA06</td>
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<tr>
<td>Optical Networking Architectures</td>
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<td>Optical Networks Laboratory</td>
<td>BMEVHVMB03</td>
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**Free Elective Subjects:** a list of these subjects is published on the website.

Notation: working hours/week: x/y/z/r

- x = lecture hours
- y = practice hours
- z = laboratory hours
- r = requirement (e = exam, m=mid-semester mark)
Description of BSc Courses in Electrical Engineering

Mathematics A1

BMETE90AX00

Mathematics A2

BMETE90AX26

Mathematics A3

BMETE90AX09

Mathematics A4

BMETE90AX51

Physics 1

BMETE11AX21

Physics 2

BMETE11AX22

**Foundation of Computer Science**

**BMEVISZAA05**

The objective of the subject is to provide the students with the required theoretical background in combinatorics, algorithms, elementary cryptography, and graph theory for further studies in electrical engineering. Within the subject the students learn about the basic concepts of combinatorics and of graph theory (trees, planar graphs, Euler circuits and Hamilton cycles, colorings of graphs, matchings and some basic algorithms like BFS, shortest path algorithms, maximal flow algorithm, DFS and the PERT method. We also discuss the basic concepts of complexity theory, NP completeness as well as fundamentals of number theory, leading to the concept of public key cryptography and RSA encoding. (5 credits)

**Informatics 1**

**BMEVIIIAAB08**

This course (as a continuation of Digital Design 1 and 2) provides the students with comprehensive knowledge related to the architecture and functioning principles of modern computers and their operating systems. The basic principles and the evolution of most hardware and software concepts used in today’s computer systems are presented through case studies of existing systems and through quantitative example problems. Students successfully satisfying the course requirements will be able to understand the documentation and the functioning of modern computers and operating systems. They will also be able to easily learn the installation, configuration and maintenance tasks of such systems. (4 credits)

**Informatics 2**

**BMEVIUAAB01**


**Electronics Technology and Materials**

**BMEVIETAB00**

The primarily objective of the course is to provide the students with knowledge and practical skills related to circuit modules and systems. The course provides a comprehensive overview of microelectronic devices, components, mechatronic, optoelectronic and other modules and about the structure of electronic equipments including their manufacturing, maintenance and assembly technologies. (6 credits)

**Basics of Programming 1**

**BMEVIIIAAA01**

The main objective of the course is to provide students with appropriate skills in computerized problem-solving and basic use of tools that can be effectively applied during their further studies. A further goal of the course is to teach writing portable programs. Learning a high-level programming language the C language allows students to reach these goals in practice. The classroom practice follows the syllabus of lectures; helps better understand the topics of the lecture through detailed examination of the algorithms. (7 credits)

**Basics of Programming 2**

**BMEVIIUAAB01**

This course, as a basic BSc course based on the previous term, continues the exposition of methods and tools of computational problems. The main goal is an introduction of object-oriented programming. Based on the C programming language skills, the object-oriented techniques are introduced with the help of C++ programming language. The curriculum of computer laboratories continuously follows the lectures. (6 credits)

**Digital Design 1**

**BMEVIIIAA04**

The course (together with the course entitled Digital Design 2) provides the students with all system level hardware knowledge required to the logical level design of digital equipment. The theoretical background is also widened through the solution of design problems during the classroom practices. Obtained skills and expertise: The knowledge acquired in the framework of the course (together with the course entitled Digital Design 2) allows students to solve any logical design problems they may encounter in electrical engineering. (6 credits)

**Digital Design 2**

**BMEVIIIAA02**

The course (together with the course entitled Digital Design 1) provides the students with all system level hardware knowledge required to the logical level design of digital equipment. The theoretical background is also widened through the solution of design problems during the classroom practices. Obtained skills and expertise: The knowledge acquired in the framework of the course (together with the course entitled Digital Design 1) allows students to solve any logical design problems they may encounter in electrical engineering. (5 credits)

**Signals and Systems 1**

**BMEVIIHVAAB00**

The objective of this class is to introduce the basic concepts of signal and system, and to provide computational methodologies applicable to continuous systems. It presents the time domain and the sinusoidal steady state analysis. The practical examples refer to continuous systems represented by Kirchoff type electric circuits. The principles to formulate the models and the methods to solve the resulting equations are discussed. The students fulfilling the requirements of this class will be able to apply the methodologies of system and network analysis in the time domain and in the frequency domain in case of sinusoidal excitation. (6 credits)
Signals and Systems 2  
**BMEVHVA0801**  
The course is a follow-up of Signals and Systems 1. It provides the foundations of analysis methods for continuous time systems in the frequency and complex frequency domains. Furthermore, it presents various system description methods and establishes the connections between these representations. It also deals with analysis methods of discrete time signals and systems both in time, frequency and z domains. The link between continuous and discrete systems is presented by dealing with discrete approximation of continuous time systems, and the basics of signal sampling and reconstruction are shown. The last part introduces analysis techniques for continuous time nonlinear circuits and systems. (6 credits)

Electrotechnics  
**BMEVIVEA000**  

Introduction to Electromagnetic Fields  
**BMEVIIHVAC03**  
The course teaches the fundamentals of classical electrodynamics in an engineering approach. Besides the main principles, the most important fields of engineering applications as well as some analysis methods are discussed. The lectures are complemented with classroom practices. Topics covered: Part I. Fundamental laws: measurable quantities, scalar and vector fields, Maxwell's equations, fields in materials, interface conditions, Poynting's theorem, forces, classification. Part II. Static fields: scalar electric potential, Laplace-Poisson-equation, electrodes, capacitance, electric dipole, method of images, finite difference method; current flow problems, grounding, step voltage; static magnetic fields, Biot-Savart law, self and mutual inductance, induction phenomena. Part III. Transmission lines: telegraph equations, Helmholtz-equation, specific loads, matching, standing wave ration, two-port equivalent. Part IV. Wave phenomena: wave equation, plane waves, transmission line analogy, reflection and refraction, polarised waves, waves in dielectrics and conductors, skin effect, elementary electric dipole antenna, rectangular waveguides. (4 credits)

Electronics 1  
**BMEVHIA0802**  
 Virtually every electronic equipment used today is constructed on the basis of high complexity circuits. All electrical engineers must know the construction and functioning principles of such devices. In order to understand the behavior of complex systems, the elementary design principles and dimensioning procedures should be presented which is the objective of this course. Obtained skills and expertise: The students get acquainted with the definitions and management of the parameters of electrical components and will understand the calculations of the properties of electronic circuits built up of such components. The skills obtained in the framework of this course (together with the course entitled Electronics 2) empowers students with the necessary expertise to understand the courses of the related study specialization blocks. (5 credits)

Electronics 2  
**BMEVIAUAC05**  
The goal of the course is to lay down the basis of the aspects of more complex electronic systems, including their functions, their operation and their structure. This formed basis can be built upon by later specialization courses. The course discusses two main areas of electronics: power electronics and signal level electronics. During the discussion of power electronics, the design and usage of basic power semiconductors (PN junction, diode, BJT, Darlington, MOSFET, SCR, GTO, IGBT) are covered. Diodes and thyristors in rectifiers, grid commutation based converters and AC choppers are also covered. The material includes basic DC-DC converter topologies (buck, boost, buck-boost) and single phase inverters as well. The second part of the course provides a brief introduction into several topics of signal level electronics, including nonlinear circuits, phase locked loops (containing voltage controlled oscillators, phase detectors, analog PI controllers), passive and active filters, and analog modulation techniques. (5 credits)

Measurement Technology  
**BMEVIMIA0801**  
The aim of the subject is to give insight into metrology, measurement theory, measurement technology and instrumentation. Besides the theoretical aspects, the course also prepares students for laboratory practices. Model building and problem solving skills of the students are developed. The subject focuses on the measurement of electrical quantities but also emphasizes the analogies with non-electrical problems. (5 credits)

Laboratory 1  
**BMEVIMIA0112**  
The primary aim of this laboratory course is to improve the skills of the students in the following areas: to get acquainted with the materials, components and instruments in the area of electrical engineering and to practice the designing of measurement setups, setting up the measurement, mea-
suring and using the infrastructure of the laboratory; furthermore, to practice the evaluation and documentation of the measurement results. By the end of the course, the students acquire practical competence and skills at the selected fields of electrical engineering, and become experienced with up-to-date measurement equipment. (4 credits)

Laboratory 2

BMEVIMIA13

This subject is based on the “Laboratory 1” subject and enables the students to gain deeper knowledge and experience along to further improving their skills in the following areas: the materials, components and instruments in the area of electrical engineering; the designing of measurement setups, setting up the measurement, measuring and using the infrastructure of the laboratory; and to evaluate and document the measurement results. These practical competences and skills in the selected fields of electrical engineering are acquired by using up-to-date measurement equipment. (4 credits)

Space Technology

BMEVIVH05

This subject is an overview of engineering, design, construction, testing and operation of electronic systems for space. Nevertheless, this knowledge is well applicable also in design of high reliability terrestrial equipments that are operating under extreme environmental conditions. System concepts of big space structures like satellites and probes and the problems of smaller units are also discussed. The theory and practice of space communications, the design and parts selection for high reliability electronics, the effects of interplanetary space and radiation, the mechanical construction problems and space related analogue and digital electronics are also highlighted. The lectures are extended with practice to deepen the knowledge and resolve practical problems. (4 credits)

Embedded and Ambient Systems

BMEVIMIA06

The aim of the subject is to develop the ability to select components of embedded systems, to design the system and to integrate the components. This includes selection of communication interfaces and protocols, design of information processing algorithms and software structure. The subject presents the principal building blocks of embedded systems, their main requirements and properties. These topics cover (but are not limited to) analog signal processing and signal conditioning, operation and features of processing units (DSP), digital signal processing, basic software architectures and their analyses, signal converters (AD/DA) and the popular communication systems used in embedded systems. (4 credits)

Power Engineering

BMEVIVAB01

The aim of the course is to lecture basic knowledge of power systems, which are necessary for all electrical engineers, and are also a foundation for students taking power system engineering major. Introduction of the structure and operation of power systems, organised along the operation principles of elements and subsystems of the network. Representation of power systems, basic methods of examination of symmetrical operation, detailing of the most important questions of asymmetrical operation from the aspect of distribution and consumer networks. Requirements of power quality and security of supply. Health effects and EMC aspects of electric and magnetic fields of the power system. Overview on the paradigm shift of different fields of power system engineering (production, transmission, service, environmental effects), the smart grid concept and other actual trends. (5 credits)

Electric Power Transmission

BMEVIVEA00

The course is intended to provide theoretical knowledge and practical skills in the following fields: structure of the power system, network transformations, process of power transmission and distribution, network elements used for transmission and distribution tasks, interpretation and determination of parameters of transmission network elements used for calculations, representation of the elements, power line and transformer operations, power and voltage conditions of steady state operation, power losses, application of symmetrical components, fundamental effects of short-circuits and switches, calculation, principles of star point earthing, related phenomena, Substation and busbar topologies. (4 credits)

Electrical Machines and Applications

BMEVIVEA01


Control of Electric Drives

BMEVIVEA04

Drive specific and task specific drive controls. Subordinated control structure. Transient equations and block schemes of DC machines. Line-commutated converter-fed DC drives: block schemes for continuous and discontinuous conduction, circulating current and non-circulating current control for quadrant and 2/4 quadrant operation. Adaptive cur-


Microelectronics
BMEVIEEAB00
The basic goal of the course is to deepen the already acquired knowledge in the field of digital electronics through presenting the latest implementation techniques of digital integrated circuits. Further goals of the subject are to provide information on the basics of analogue integrated circuits, components of power electronics and solid-state lightning. Today’s electronics and IT devices are all based on different special discrete semiconductors and complex integrated circuits. Solid knowledge regarding the structure, operation and manufacturing of these devices is among the necessary skills of today’s electrical engineers including basics of IC design at least on the level which allows effective communication with IC design specialists. They have to know how system level design connects with the IC design as well. Special emphasis is put on the corresponding practical skills through simple case studies (calculation examples) as well as computer laboratory practices where the students get acquainted with the basic steps IC design. An important aspect of the course is to bridge the gap between the operation of abstract electronics components and the physical reality: the major components used in ICs (diodes, transistors, etc.) are discussed in detail. A detour is made towards the MEMS and MOEMS, where electrical operation is combined with mechanical and optical effects. (5 credits)

Microcontroller Based Systems
BMEVIAUA06
The course describes the most widespread microcontroller architectures and gives guidance for their selection for the given application. The course provides competences to design and implement the hardware components of microcontroller based systems and to implement the associated low level software system. Design phases are demonstrated by case studies. (4 credits)

Embedded Operating Systems and Client Apps.
BMEVIAUC07
The students will be able to understand and make use of the basic concepts of embedded operating systems. The objective of the course is to present platforms, techniques and tools which are required to create and run both application and system level software for embedded systems. After creating the hardware unit and embedded programs for it, the next natural step is the implementation of a desktop or web application that enables monitoring and parameterizing the hardware unit from a standard PC. Mobile applications are becoming more widely used as well. The course presents the programming of desktop and web based client applications, focusing on user interfaces, graphics drawing tools, multithreaded and network programming. Most modern development platforms follow object-oriented concepts. Consequently, the course provides introduction to object-oriented design, basic UML and a few architectural and design patterns.

Students will be able to develop desktop and thin client applications to access hardware units from PCs, and to create user friendly user interfaces for different client types. Network programming also gets an important role. The topics covered are illustrated by case studies and demo applications. (4 credits)

Network Technologies and Applications
BMEVITMAC05
The goal of this course is on one hand to present the basic principles of the currently used and emerging wired access network technologies, focusing mostly on the data link layer. On the other hand it aims to present the principles of network layer communication both in wired and wireless environments, focusing on routing algorithms in fixed and ad hoc networks, IP multicast technologies as well as mobility handling over IP networks. Then, the course presents different architectures of networking applications, the client-server and the peer-to-peer communication model, and the principles of cloud communications. Finally, the course presents some application scenarios, and touches briefly emerging topics such as the Future Internet and the Internet of Things. (4 credits)

Control Engineering
BMEVIIAB05
The control of technological, economical, and environmental processes belongs to the electrical engineers’ most important professional activities that require both abstract and applied knowledge and competences. Besides its contribution to form an engineering approach of problem solving, the course teaches the fundamentals of control engineering, the main principles of analysis and synthesis of control loops, and the use of the related computational tools. Students successfully satisfying the course requirements are prepared to analyze discrete and continuous time control loops, to design different types of compensators and to later engage courses in more advanced fields in control theory such as optimal control and identification of dynamical systems. Lectures are complemented with classroom and computer laboratory practices. (4 credits)
Description of BSc Courses in Computer Engineering

Calculus 1 for Informaticians
BMETE90AX21
Real sequences. Special limits, number e. Operations on convergent sequences. Monotonic and bounded sequences. Continuity and differentiability of real functions of a single variable. Elementary functions and their inverses, properties of differentiable functions, mean value theorems, L'Hospital rule, sketching graphs, parametric and polar curves. Integral of functions of a single variable. Methods of integration, the fundamental theorem of calculus (Newton-Leibniz formula), applications, improper integrals. (6 credits)

Calculus 2 for Informaticians
BMETE90AX22
Differential equations: Separable d.e., first order linear d.e., higher order linear d.e. of constant coefficients. Series: Tests for convergence of numerical series, power series, Taylor series.

Probability Theory
BMEVISZAB02
The objective of the subject is to learn the basics of stochastic modeling. Within the subject the students learn about the basic concepts of probability and random variables. They get acquainted with various discrete and continuous distributions. Students also learn the notion of expected value and higher moments. The course concludes with theorems of large numbers, the notion of regression and correlation. (5 credits)

Introduction to the Theory of Computing 1
BMEVISZAA03
The objective of the subject is to acquire the fundamental mathematical knowledge (in the area of linear algebra and number theory) necessary for software engineering studies. Within the subject the students learn about coordinate geometry in the space, the vector space $\mathbb{R}^n$ and its various properties, solving systems of linear equations with the Gaussian elimination, determinants and basic properties of linear mappings as well as fundamentals of number theory, leading to the concept of public key cryptography and RSA encoding. (4-490) (5 credits)

Introduction to the Theory of Computing 2
BMEVISZAA04
The objective of the subject is to acquire the fundamental mathematical knowledge (in the area of graph theory) necessary for software engineering studies. Within the subject the students learn about the basic notions of graph theory, trees, planar graphs, Euler circuits and Hamilton cycles, vertex- and edge colorings of graphs, matchings and higher connectivity as well as some basic algorithms like BFS, shortest path algorithms, Kruskal’s algorithm, maximal flow algorithm, DFS and the PERT method. (5 credits)

Coding Technology
BMETE11AX23
Clear understanding of the basic principles, notions, models, techniques in the field of data compression coding, error control coding, and cryptography security encoding, supported by solving a lot of numerical problems. Obtained skills and expertise: Ability to apply basic techniques in communication technologies and solve standard design problems. (4 credits)

Physics 1i
BMETE11AX24
Algebraic and trigonometric functions, complex numbers, vectors. Kinematics, work and energy, potential energy, linear momentum and collisions, rotation of a rigid object about a fixed axis, angular momentum, Kepler’s laws of planetary motion, static equilibrium, accelerating frames, oscillatory motion, waves, special relativity, kinematics, special relativity, dynamics, temperature, heat and the 1st law of thermodynamics, the kinetic theory of gases, heat engines, entropy and the 2nd law of thermodynamics. (4 credits)

Physics 2i
BMETE11AX25
Electric fields, electric potential, capacitance and dielectrics, current and resistance, direct current circuits, electric field, magnetic field, sources of the magnetic field, Faraday’s law, inductance, light and optics, interference of light waves, diffraction and polarization, lasers and holography, introduction to quantum physics, quantum mechanics. (4 credits)

System Theory
BMETE11HVA00
The main objective of the class is to introduce the basic concepts of signal and system theory, mathematical methods. It will be introduced the linear, time invariant system analysis for time continuous and discrete cases. The analysis methods are introduced in time, frequency and complexe frequency domain. Examples for signal processing, telecommunication and also for business processes are discussed. The students fulfilling the requirements of this class will be able to apply the methodologies of system analysis and the basic elements of process control. (4 credits)
Technology of IT devices
**BMEVIEEA00**
The goal of the subject is to present the students the operation of the most important hardware elements of IT devices, the fundamentals of electronics and its manufacturing technology. It is presented what opportunities modern microelectronics assures to computation, what are the physical limits and the trends of development. At the laboratory practices the students experience themselves that hardware and software development occurs with the help of similar methods and tools. (4 credits)

Digital Design
**BMEVIMIAA02**
Digital technology is an important core subject in the curriculum of the Engineering Information Technology. The most important objective of the course is to present the process of engineering and system-oriented approach of problems, and to acquire basic practical skills to for good problem solving. The following topics are discussed: computing systems, the basic elements of the operation of logic circuits, the digital abstraction of the simple tasks and the direct hardware or low-level software implementations of them. The course starts with the introduction of the binary arithmetic, the operations done by basic digital functional units and controllers, and ends by the presentation of the general-purpose microcontroller architectures and its design and applications. Lectures are completed with classroom and laboratory exercises, where the focus is on the mastering of modern computer design methods and on the direct design/development experience. (6 credits)

System Modelling
**BMEVIMIAA00**
The course overviews the design process of IT systems in a model based approach. The goal of this course is to provide solid understanding on the basic modeling tasks and tools, which are important prerequisite for other courses including application specific modeling. (e.g.) Additionally, the course provides opportunity to experiment with conceptually straightforward and easy to learn tools, which can be used for simple application logic development. The participants of the course will learn the basic concepts and modeling aspects of high level, graphical tool supported, process centric modeling, verification, performance analysis and service quality assurance. The course builds on learning experience at digital technology course and you can build competence in systematic system design process. Participants will also gain experience in the process of implementing IT system through the steps of modelling exercises. Finally, they get an overview of simulation based system analysis and visual data analysis of measurement results. The didactical goal of the course is to improve the abstraction skill of the participants and lay the foundations of the upcoming courses on conceptual and motivational level. (4 credits)

Computer Architectures
**BMEVIIHAA02**
The course objective is to present the basic notions of computer architectures and the related application and design methods such that the student can formally solve fundamental software and hardware problems. Obtained skills and expertise: Understand and solve computer architecture related hardware and software problems. (4 credits)

Communication Networks 1
**BMEVIIHIAB01**
The course objective is to present the fundamental principles of the construction, architecture and protocols of computer network. Obtained skills and expertise: Understanding the operating principles, architecture and protocols in computer networks as a basis for later specialized studies. (4 credits)

Communication Networks 2
**BMEVITMAB01**
The aim of this course is to provide both theoretical and practical knowledge about communication networks, and about telecommunication networks in particular. The course starts from the classical wireline telephony networks, including the speech digitalization, and the architecture of telephony exchanges. The next major part is wired IP access networks, including digital subscriber loops (especially ADSL and its variants), cable television-based Internet access, and optical access networks with the focus on GPON systems. Triple-play services, including IP television and Voice over IP (VoIP), are certainly part of this subject, including an introduction to speech codecs. A whole range of mobile cellphone networks are also covered from GSM to LTE. Introduction to backbone transport network technologies (including MPLS and its extensions, optical wavelength- and waveband switching) concludes the course. (4 credits)

Operating Systems
**BMEVIMIAB00**
The subject introduces students to the functions, internal operation, and types of operating systems, and in addition, to the programming model of concurrent, distributed systems. It also demonstrates these concepts using examples, including the task of operating system selection. The lectures and the laboratories, which are inherent part of the subject, concentrate on the relationship of the hardware and the operating system, making it possible for students to use operating systems in practical applications. (5 credits)

Basics of Programming 1
**BMEVIEEA00**
The main objective of this course is to provide students with appropriate skills in computer-based problem solving and basic use of program development tools. These skills are to be effectively applied during further studies. The C language is selected as working language to illustrate how portable programs can be developed and to allow students to gain practice in actual coding. The classroom practice follows the syllabus of lectures; helps better understand the topics of the lecture through detailed examination of the algorithms. The classes are completed with a long-term individual homework assignment to help improve the students’ skills. (7 credits)

Basics of Programming 2
**BMEVIIHAA03**
This semester focuses on leading the students to a deeper understanding of C language, and a special emphasis is also put on the steps of solving very complex programming tasks using an object-oriented approach. The latter is achieved via learning the C++ language, assuming a reliable knowledge of C. The practice classes follow the topics of the lectures and discuss further details of the object-oriented concept and the language elements. First the students learn
how the C++ language derives from C. Inline macros, prototypes, default arguments and function overloading are explained. Dynamic memory allocation process of C++, reference type, visibility and scope of data are discussed. The next object-oriented concept is introduced via the C++ language. The principles and concepts behind the object oriented programming paradigm are shown with the corresponding C++ syntax. Topics include classes, encapsulation, protection; member functions, constructor/destructor, friend mechanism; operator overloading; inheritance, virtual functions; generic classes. Last the students are introduced to essential operating system functions and to development and documenting tools. (6 credits)

**Basics of Programming 3**

**BMEVIIIAB00**

The course, as a continuation of Basics of Programming 1 and 2, aims at further enhancing skills in object-oriented techniques and algorithmic solutions. The course introduces Java syntax and the basic Java class libraries, like IO, utilities, generics, collections. Special topics, like thread handling with synchronization and signaling, GUI concepts and implementation using Swing, unit testing with JUnit, XML handling in SAX and JDOM, and logging via log4j are also covered. The connections between UML and OO implementations, especially in C++ and Java are introduced. The course relies on skills and knowledge of C and C++, that are mandatory for successfully finishing the semester. (5 credits)

**Databases**

**BMEVITMAB04**


**Software Engineering**

**BMEVIIIAB01**

The aim of the course is to examine the overall process of software development, including the analysis and design of information systems and the project management issues. On completion of this course students will be able to understand the economic and managerial implications of software projects, have a global view and understanding of the software development, describe the static and dynamic aspects of a real-world system using appropriate modelling techniques, advise on the selection of an appropriate software architecture for a problem, describe the concepts underlying object orientation, use and create UML models, demonstrate the quality of software products created at different stages of the lifecycle. (4 credits)

**Software Techniques**

**BMEVIAUAB00**

The objective of the course is to present up-to-date techniques used in object oriented and event-based software development. The concepts, the structures and the programming of GUI (graphical user interface) and RAD (Rapid Application Development) are presented together with the most important features of modern supervised execution environments and class libraries (reflection techniques, data binding, displaying figures and text, parallel computing basics with related synchronization techniques, etc.). The widely used architectural and design patterns for software development are also covered. Students satisfying the course requirements will be able to develop software on the most widely used platforms with up-to-date tools and technology, having design patterns incorporated. (5 credits)

**Software Project Laboratory**

**BMEVIIIAB06**

The aim of the course is gaining first-hand experience of working in software projects. The goal is to create an object oriented application with full UML (Unified Modeling Language) description, Java implementation, according to RUP (Rational Unified Process) concepts. The students are working on the project in groups of 3 or 4 that are formed by the supervisor. The students are preparing the documentation and program of the game according to the predefined schedule specified at first week. Documentations must be submitted in a predefined format, usually printed. Good understanding of Java and UML are required for successfully finishing the course. (3 credits)

**Web and Mobile Software**

**BMEVIAUC00**

During the course, students get an overview of the latest model platforms and its capabilities. The course teaches the student to be able to choose the most suitable tool and platform for solving a given problem and give the knowledge to estimate the complexity of a project. Furthermore, the method of developing small application for Java Me platform is presented, as well as the basics of Android platform and usage of the Android emulator. The course also presents the method of quick prototype development method in Python environment. The following techniques will be described: application structure, basic UI, development and usage of the Android emulator. The course also presents modern client based web technologies. Besides the mobile platform, modern client based web technologies are also presented with the method of developing web applications for devices with small screen and using development tools for multiplatform. (5 credits)

**Computer Graphics**

**BMEVIIIAB07**

Fundamental concepts: tasks of the computer graphics and image processing, synthetic camera, image synthesis. Graphical hardware. Analytical geometry: vectors, coordinate frames, points. Implementation of operations on vectors. The equation of lines and planes. Geometrical modeling, Lagrange interpolation, Bezier approximation, B-Splines, NOBS and NORTS. Areas, quadratic and parametric surfaces, polygon modeling, body models. Colors: the light as electromagnetic wave, the model of color perception, color fitting, color systems. Geometric transformation. Virtual world models: hierarchical model, VRML, color space graphs. 2D image synthesis: vectoriza-
Artificial Intelligence

BMEVIMIA01

The aim of the subject is a short, yet substantial presentation of the field of artificial intelligence. The principal presented topics are expressing intelligent behavior with computational models, analysis and application of the formal and heuristic methods of artificial intelligence, and methods and problems of practical implementations. The subject is intended to develop the abilities and skills of the students of informatics in the area of studying novel applications of the computing, developing effective methods to solve computational problems, understanding the technological and conceptual limits of the computer science, and intellectual understanding of the central role of the algorithm in information systems. (3 credits)

IT Security

BMEVIHIAC01

This course gives an overview of the different areas of IT security with the aim of increasing the security awareness of computer science students and shaping their attitude towards designing and using computing systems. The course prepares BSc students for security challenges that they may encounter during their professional carrier, and at the same time, it provides a basis for those student who want to continue their studies at MSc level. We put special emphasis on software security and the practical aspects of developing secure programs. (3 credits)

Management of Information Systems

BMEVITMAC02

The course introduces the students to the tasks of the IT System Administrators. The objective of the course is to teach the maintenance and system administration tasks of computers and networked information systems. The course provides a system level overview about the information systems and about the tasks of system administrators in a broad sense. Among many others, the students will learn basis of the Network and Desktop Management Systems, the data management (data networks, back-up and restore), the virtualization and cloud computing, the service management, the Telecommunications Management Network (TMN), the IT management-related standards, and the security issues. (4 credits)

Integration & Verification Techniques

BMEVIMIAC04

The subject aims to provide an overview of a variety of information integration systems, and introduces the development and verification techniques of such systems. We discuss the most common integration approaches of distributed data, documents and other type of resources available on the Web. The subject deals with the semantic heterogeneity and structural problems, and unveils the necessary technologies. We analyze in this framework the approaches and technologies of the Semantic Web concept. The subject continues with the discussion of the verification processes and the checking possibilities in the typical development phases. Among the several verification tasks, we focus on the static analysis of the specifications and plans for dealing with static controls, the dynamic verification of the components, and with the tests of integration. The subject ends with the overview of the system testing methods. (4 credits)

Industrial Control

BMEVIIIAC03

Industrial control systems are present in fields including packaging, water management, petrochemical processes, manufacturing lines or food and beverage processing. Although seem different, all of these applications share the requirements of accurate measurements and executing appropriate actions based on the state of the process. The first part of the course focuses on sensor technology: methods for temperature, force, pressure, flow, displacement, proximity and level sensing are presented along with transmitters and interfacing signals with control systems. Second part of the course gives a deep overview on PLCs, devices most commonly used in industrial automation systems. Besides the software architecture and programming languages, industrial field bus systems are also presented in details. (4 credits)
Description of MSc Courses

Engineering Management

BMEVITMMBB03


Engineering Information Technology

System Optimization

BMEVISZMA02

The subject introduces some areas of operations research and combinatorial optimization. Besides covering the most relevant algorithms and methods and their limits, it also aims at giving a glimpse into some of their engineering applications. Thus the subject also covers some general algorithmic approaches like linear and integer programming and matroid theory. Furthermore, the course aims at extending and deepening the knowledge formerly provided by the Introduction to the Theory of Computing 1 and 2 and the Theory of Algorithms subjects of the BSc degree program in Software Engineering. (4 credits)

Formal Methods

BMEVIMIMA07

As the complexity of information systems and the costs of potential failures are increasing, it becomes more and more important to prove that the design of the critical system components is correct. One of the typical solutions for the challenge of provably correct design is the application of formal methods. Mathematically precise formal models allow the precise and unambiguous specification of requirements and construction of designs; formal verification allows the checking of design decisions and proof of design properties; while the verified models allow automated software synthesis. The subject provides an overview of the formal background needed for the elaboration and analysis of the formal models of IT components and systems: the modelling paradigms, the widely used formal modelling languages, and the related verification and validation techniques. The subject demonstrates the application of formal methods in the field of requirement specification, system and software design, model based verification and source code synthesis. (4 credits)

Information Theory

BMEVISZMA03

This course offers an introduction to the quantitative theory of information and its applications to reliable, efficient communication systems. Topics include mathematical definition and properties of information, source coding theorem, theoretical bounds for lossless data compression, optimal data compression methods for both known and unknown distribution of the source, the fundamentals of lossy source coding principles, channel encoding and the main types of multiple access channels. The course lays the foundation for doctoral research in the subject of mobile telecommunications. (4 credits)
Languages and Automata

During the course of the semester, we review the basic types of automata and examine their capabilities. Examination of automata is closely related to the examination of formal languages. The objective is the description of the relations between the classic automata and formal languages. Students will learn the theoretical principles to that can be used for the preparation of a compiler. In connection with Turing machines, we examine the algorithmic decidability of some theoretical and practical problems and languages.

(4 credits)

Computer Engineering

Applied Informatics

Software Development Methods and Paradigms

The goal of this course is to teach the software development methodologies, their application possibilities and conditions, practices and tools required and preferred for the design and development of methods. Students become practiced in treating issues of common software architectures and software systems, furthermore, they will have a good knowledge related to software development methods. The course discusses the software development methodologies, the methods and techniques supporting methodologies and development processes, furthermore, practices, architectural requirements and solutions, related to software systems. (4 credits)

Distributed Systems and Domain-Specific Modeling

The goal of this course is to teach component-based technologies, the usage of middleware services, distributed systems, asynchronous communication, reliability, security, scalability, distributed state handling and monitoring. Furthermore, the goal is to teach domain-specific languages and modeling techniques, model processing and using these techniques in creating software. (4 credits)

Service Oriented System Integration

Service-Oriented Architecture (SOA) defines the principles of connecting distributed heterogeneous software components. Web services provide the technology for implementing these principles. Web services are built on open standards. They are based on XML, therefore, they are suitable for connecting different platforms with each other (e.g., .NET and Java). Most platforms provide simple APIs for creating web services. For example, .NET has the library called Windows Communication Foundation (WCF), while Java offers the Java API for XML-based Web Services (JAX-WS) specification. Using these APIs it is very easy to communicate between applications created in different platforms. Enterprise Service Bus (ESB) is a framework for hosting web services, and publishing legacy applications also as web services providing a unified platform for interaction between applications. Business entities can also benefit from SOA, since business processes can also be described as web services through the Business Process Execution Language (BPEL). Business processes can also be defined at a higher level using the Business Process Modeling Notation (BPMN). The goal of this subject is to explain the principles behind SOA and to give a deep understanding in the corresponding standards, APIs and technologies. (4 credits)

Business Intelligence

The goal of the subject is to give a current knowledge to the students about modern data warehouse building, business intelligence system design, data transformation, reporting, charts, dashboards, data visualization, location based data processing, KPI discovery and churn and fraud detection. (4 credits)

Software and Systems Verification

The objective of the course is to present the different verification techniques that can be used throughout the full software and systems development lifecycle. Nowadays, such techniques are used not only in critical systems (where their usage is usually mandated by standards), but quality is a requirement for every system. After completing the course, students will have a general understanding of the whole verification process and will know which techniques are recommended for the different phases. They will be able to identify the various static verification techniques, and will be able to review specifications and designs, and to apply static analysis tools on source code. They will be able to list the different levels and methods of software testing, and to use specification and structure based test design techniques. They will know the techniques for verifying extra-functional properties (e.g., modeling and analyzing dependability) and will be able to describe the techniques for runtime verification. (4 credits)

Distributed Systems Laboratory

The goal of this course is to give a practical knowledge to the materials learned during Distributed Systems and Domain-Specific Modeling and Software Development Methods and Paradigms. (4 credits)

Computer Engineering

Internet Architecture and Services

Agile Network Service Development

The course introduces the students to the Agile development method, which is widely used in software development since it can easily react to the frequent changes. The students will be introduced to Extreme Programming (XP), different Agile methods (Scrum, Kanban). They will learn the Continuous Integration (CI) and the typical environments supporting it. The course also gives an overview about testing methodologies, Test Driven Development (TDD), Behaviour Driven Development (BDD) and Model Based Testing (MBT). During the practical classes, the students form Agile teams that develop a software product in the field of telecommunications. (4 credits)
Cloud Networking

BMEVITMMA02

A cloud platform is a complex system, its architecture consists of many different technological building blocks, where the cloud networking has an important and emerging role. The lectures present the types of cloud computing platforms, the different service models, the applied technologies and management methods focusing mainly on the networking aspects. The networking background of cloud architectures, including network virtualization, tunneling techniques, data center network topologies and the application of Software Defined Networking in clouds are presented. The special requirements of clouds that can provide telecommunication services in the form of Network Function Virtualization are also discussed. (4 credits)

Modeling Seminar for Engineers

BMEVITMMA03

In this course the students face the main engineering challenges and design goals of infocommunication networks from local computer networks to the global Internet. We show through practical examples that how easy to use the algorithmic knowledge they already have for communication network modeling. In specific the course includes examples from the routing and control mechanisms of the Internet, topology design, traffic and bandwidth characterization of networks, some problems from software defined and virtual networks, and shows how the theoretical tools the students already have can be applied for these practical engineering problems. (4 credits)

Internet Services and Applications

BMEVITMMA04

The course will give a thorough overview of application-specific, content-centric and collaborative services, the challenges of the Internet as a service and application development platform, and its service models. The technology foundations necessary for service implementation are also covered, including service quality issues as well. Use cases from different application areas are discussed to show the process of service planning and implementations well as the method to build successful business models. An Internet architect will be able to develop efficient network services satisfying the required service quality. During the course project homework the students will gain experience in practice as well. (4 credits)

Sensor Networks and Applications

BMEVITMMA09

The “intelligence” of the so-called smart environments (smart city, smart office, smart home) is largely depends on the sensors integrated into physical objects (walls, surface of roads, etc.) or carried by the users (e.g., intelligent user devices, wearable devices). Sensors monitor the surrounding physical environment continuously, gather raw measurement data that is communicated towards the application. To do this, an efficient sensor networking environment has to be set up. The course will give a thorough overview of wireless sensor networking, from the physical devices up to the networking and application layers. Application areas that are connected to smart cities and intelligent transport systems are emphasized. (4 credits)

Intelligent Traffic Systems

BMEVITMMA10

The aim of the course is to present the technologies used and current trends in the field of intelligent transport systems. The students will learn the principles of vehicular systems, the technologies deployed in vehicles and the supporting infrastructure. They will understand how these technologies support the Smart Cities. During practical courses the students will have to understand a selected technology and the application built on it, and implement their own services using the publicly available interfaces. (4 credits)

Human-machine Interface

BMEVITMMA11

The aim of the subject is to introduce visual and speech interface technologies to students in Human Computer Interaction. The course will introduce in detail the elements of the user interface, the basic principles of software ergonomics, the evaluation methods of software from an ergonomic point of view. Parallel to introduction to the principles of theory, practical classes are also held. Students will demonstrate the comprehension of the material by solving practical problems. By the end of the course students will learn the basic principles necessary for the design, testing and evaluation of user interfaces. They could employ that knowledge during their future work career. (4 credits)

Cloud Computing

BMEVIIIMA05

The basic objective of the course is introducing the basics of the modern computing cloud systems and cloud based applications. The students learn about the virtualization techniques and software solutions, protocols, standards and interfaces, which advanced the development of cloud-based services can be used in practice. They learn about the cloud-based IT systems design, development, operation, and quality control methods and tools. The students receive comprehensive information on the most commonly used approaches, models, standards related to software quality. Students learn about the characteristics of the software product and the product manufacturing process and should be interpreted taking into account the characteristics of the cloud-based systems can. They understand the similarities and differences between ISO 9001, CMMI, SPICE and auditing structure, will be able to more software quality model is applied in an integrated manner. (4 credits)

High Performance Parallel Computing

BMEVIIIMA06

The basic objective of the course is introducing the very intensive and high-performance computing solutions which are needed of engineering and research tasks. The students will learn about the supercomputing architecture classes, the supercomputer software components and programming languages. The students get acquainted with the subject of networking solutions that use the most powerful machines (TOP500) as well. They learn about the various co-processors and storage systems. The purpose of the object is important to give a comprehensive picture of the use, programming, control and operation of these systems as well. (4 credits)
GPGPU Applications

BMEVISZMA06
The course presents the possibility of general purpose use of the computational power of graphics boards thanks to a generalized model of their GPUs. The hardware architecture of graphical processors is presented together with the general purpose OpenCL software development environment. Algorithms suitable to massively parallel implementation are presented using practical examples. Topics studied in detail include: operations on big amount of data, parallel primitives in the OpenCL environment, solution of a set of linear equations, physical simulation on GPU, hash based parallel algorithms, Monte Carlo methods in GPU, optimization issues of GPGPU algorithms, effective cooperation with graphical APIs, special questions of multi GPU and distributed systems. (4 credits)

Smart City Engineering

BMEVIHMBO04
Smart City Laboratory is a part of the Smart City specialization of the Electrical Engineering MSc. course. The goal of this laboratory subject is to present some interesting and noteworthy elements from the huge set of software and hardware building blocks which support the concept of smart city. Students can learn the programming sensors and sensor networks as well as the usage of microcontrollers to control these sensors and to process data collected by them. Moreover the subject has two exercises about the construction of applications in an Augmented Reality environment and the usage of a gesture control device, respectively. (2 credits)

Physics 3

BMETEITMMB04
The course covers introduction to two disciplines: Quantum Mechanics and Solid State Physics. After the semester students should be able to understand the basic principles behind these two disciplines and solve some simple problems. This will contribute to the understanding of the workings of modern electronics and nanotechnology. (4 credits)

Measurement Theory

BMEVIMIMA17
The subject discusses the theoretical background as well as the qualitative and quantitative characterization of the engineering methods used for studying the physical world around. It gives an overview of the basic methods of signal and system theory, estimation and decision theory, as well as of the most important data- and signal processing algorithms. The main goal of the subject is to show how different tasks such as complex measurement problems, modelling and information processing problems, etc. can be solved using this theoretical background. The knowledge discussed in the subject gives a general basis for solving research and development problems too. (4 credits)

Linear Algebra (Advanced Mathematics for Electrical Engineers)

BMETE90MX54

Combinatorial Optimization (Advanced Mathematics for Electrical Engineers)

BMEVISZMA06
The subject introduces some areas of operations research and combinatorial optimization. Besides covering the most relevant algorithms and methods and their limits, it also aims at giving a glimpse into some of their engineering applications. Thus the subject also covers some general algorithmic approaches like linear and integer programming and matroid theory. Furthermore, the course aims at extending and deepening the knowledge formerly provided by the Foundations of Computer Science subject of the BSc degree program in Electrical Engineering. (3 credits)

Communication Theory

BMEVIVHZRA07
Widespread concepts of and tasks to be solved by telecommunications can be described by a more or less unified theory, that are the objectives of the Communication Theory. Aim of this subject is to present basics of and applied approaches in this theory. Main topics dealt with are information theory, decision- and estimation theory as well as theory of digital communications including source coding, channel coding, modulations, and performance of noisy channels. In this framework students get acquainted with important concepts, methods and procedures. Application of these concepts is presented via a detailed discussion of practical examples taken from the techniques of wireless and optical communication. Lectures, exercises as well as tests are put together so to prepare students for being able to understand and apply these concepts. Thus understanding of new or novel systems is relatively easy for them; also they get the basis for following more specialized subjects in later semesters as well as in solving novel tasks during their career. (4 credits)

Electrical Engineering Embedded Systems

Artificial Intelligence Based Control

BMEVIIIMA09
The goal of the course is to introduce the state-of-the-art soft computing and artificial intelligence methods used in system modeling and control theory. The methods are introduced in the frame of nonlinear identification and control problems.

Students successfully satisfying the course requirements are prepared in system modeling and to design and implement control algorithms for complex systems. In general, they
are able to contribute to the solution system optimization and decision making problems. They obtain skills to apply fuzzy systems, neural networks, genetic algorithms and swarm intelligence on technological and nontechnological areas (e.g. biology, economics). Also, they are able to take part in the development and research of information system with high demand on artificial intelligence techniques. (4 credits)

**SW Technology for Embedded Systems**

*BMEVIMA09*

The subject introduces the students to the modern technologies used in developing embedded software for better software quality. The introduction is both theoretical and practical. The subject shows why modern embedded software systems are complex, it lists the consequences of complexity and details how we handle complexity in this context, and how we define and increase software quality. The subject then iterate through the modern solutions available to keep control over the software development process, and how we can increase software quality. These modern solutions are introduced, and its properties are investigated using both a theoretical and a practical approach by programming examples. (4 credits)

**Computer Vision Systems**

*BMEVIMA07*

Aim of this course is to transfer knowledge about most important techniques of computer vision. This includes simple methods for daily use and more complex ones as well. Theory and Practice are kept in balance. The areas and methods covered by this course are not complete. Our aim is to help the students to be able to understand the alternatives of the discussed methods to the extent necessary for choosing among them in the perspective of theory and praxis. The topics of the course have been separated into three parts as follows: two- and three-dimensional vision and real time image processing covering the right choice of paradigms and image processing hardware components. (4 credits)

**Development of SW Applications**

*BMEVIAU0A09*

The goal of the course is to introduce those software development tools and practices which are essential for larger scale development projects. This includes the higher level class libraries, automatic testing and continuous integration tools, version control and documentation tools. Special configuration options of the compiler and deployment processes, and cloud services for server side applications. Beside these, the course emphasizes the use of these techniques in embedded system development and its special requirements. (4 credits)

**Design & Integration of Embedded Systems**

*BMEVIMA11*

The aim of the subject is the presentation of the basic methods that are needed for the systematic development of embedded systems. First, the following topics are discussed: development life cycle models (e.g., V-model, iterative models), quality assurance, project planning, requirements traceability, version control and configuration control methods. Among system development methods, the subject presents the hardware-software co-design and component integration techniques, based on the previously studied technologies and building blocks, emphasizing also the model-based design approaches. The subject also covers the specific design methods for safety-critical embedded systems in which the malfunctions may lead to hazards, or in case of given environmental conditions even to accidents or damages. Such safety-critical systems are used for example in transportation, vehicles, medical equipment or process control systems. The students will be familiar with the architectural concepts (that are often referred in related standards), the techniques of safety and dependability analysis (that are needed to assess the design decisions), as well as the techniques of systematic verification. The exercises present concrete tools and techniques to support the typical tasks in requirement management, configuration control, source code analysis, unit testing, integration testing, system testing, hazard analysis and model based design. (4 credits)

**Embedded Systems Laboratory 1**

*BMEVIMA12*

The laboratory exercises present the modern, up to date technologies which are used for the design of embedded systems. The student thus get acquainted with FPGA based system design, efficient software development on dedicated digital signal processors and with high level, model-based virtual instrumentation using LabVIEW. The laboratory exercises also consist of setting up and solving real tasks by utilizing the before mentioned techniques. (4 credits)

**Electrical Engineering Multimedia Systems and Services**

**Mobile and Wireless Networks**

*BMEVIMA07*

The objective of this course is to introduce today’s modern wireless and mobile systems to our students. This contain basic knowledge needed to operate and maintain such networks. Further goal of this subject is to show the possibilities and operations of advanced radio and wireless solutions, through practical examples. (4 credits)

**Broadband Wireless Telecommunication and Broadcasting Systems**

*BMEVIVH0A01*

The objective of the subject is to develop design, modeling and analysis skills related to the physical layer of wideband fixed, mobile communications and broadcasting systems of the future. Four major topics are discussed. The first one covers some special aspects of digital communication: spectrally efficient coding methods (high order QAM modulations, CP, OFDM and FBMC), coded modulation systems and spread spectrum systems, as well as multiple access methods (CDMA, FDMA, TDMA, SDMA). The second part of the subject explains the properties of terrestrial and satellite microwave bands, fixed and broadcasting radio channels (WSSUS model), including also (multi)point-to-(multi)point transmissions (e.g. MIMO). The third part of the subject introduces specific terrestrial, cable and satellite broadcasting systems (mainly DAB, DVB and DRM variants), along with BFWA networks. Convergence between cellular and broadcasting networks is also considered (including SDR, LTE, 5G, DVB IP, DVB RCT/RCC/RCS). The fourth part gives in-depth knowledge about the test and measurement techniques of state-of-the-art digital broadcasting and communication systems, covering frequency domain and time domain measurements, modulation analysis and bit error / packet error related tests. The baseband representation of these systems is also discussed along with modeling and
simulation methods, extending also to the generation of real and complex signals featuring specific stochastic characteristics. (4 credits)

**Foundations of Multimedia Technologies**  
**BMEVIIHMA08**
The course gives an overview of modern media communication system architectures, coding and modulation techniques, media service customer behavior and user devices. This course allows students to get acquainted with the capabilities of different media capture, storage, delivery and display solutions. (4 credits)

**Laboratory on Multimedia Systems and Services 1**  
**BMEVIIHMA10**
The aim of this laboratory course is to extend the knowledge learnt in Foundations of multimedia technologies lecture and improve practical skills. Technical methods and solutions for mobile and media communication systems are studied in this course. (4 credits)

**Electrical Engineering**  
**Electric Power Systems**

**Power System Operation and Control**  
**BMEVIVEMA01**
The course is intended to provide theoretical knowledge and practical skills in the following fields: system approach of power system design, operation and control, understanding of related physical phenomena and processes and devices capable of influencing these processes, application of the theoretical knowledge in computer aided design, control and safe operation. (4 credits)

**Electrical Systems of Sustainable Energetic**  
**BMEVIVEMA02**
The purpose of the subject is to give information for the students about the problems of ageing in the power system. Basics of asset management, monitoring and diagnostic methods, live line management (including the economic questions) is also presented. Electric and magnetic field acting on the workers and the protection against their harmful effects are also in the focus. Further topics are also involved in the subject, like special energy converters of renewable energy systems, like double-fed asynchronous generator, motor. Special energy converters of large scale energy storing are also part of the subject as well as the integration of renewables into the renewable energy system. (4 credits)

**Power System Transients**  
**BMEVIVEMA03**
The aim of the course is to provide theoretical knowledge and practical skills for computer based modelling of power system transients including understanding physics of electromagnetic wave propagation on multiphase power lines, being familiar with the origin of transients and their consequences, understanding transients appearing at abnormal system conditions, like switching on or off, during short-circuit or fault clearing. Students will be familiar with design practices and protection principles against overvoltages in order to be skilled about advanced solution methods to reduce the risk of failures. They will have an opportunity to learn how to operate modern power system transient simulation software tools and how to create digital models and evaluate the results obtained by computer simulation. (4 credits)

**Protection Systems and Measurement Technology**  
**BMEVIVEMA04**
The aim of the course is to provide theoretical knowledge and practical skills for understanding principles and settings of protections used for parry of failure in power systems, power plants, industrial and communal systems, being familiar with measurement technology, digital signal processing, as well as intelligent protections and introducing functions and constructions of operational and malfunction automatics which provide reliable operation of the power system. (4 credits)

**Electric Energy Market**  
**BMEVIVEMA05**
The course aims to develop a detailed knowledge and critical understanding of Smart Systems technologies and the physics of MEMS devices. A significant range of principal and specialist skills will be developed in the fields of Smart Systems manufacturing technology, and its applications in MEMS and bio-MEMS devices. During the laboratory work the students are getting familiar with the numerical modelling and analysis by the use of a cutting edge simulation tools. (4 credits)

**Fundamentals of Smart Systems**  
**BMEVIIEM04**
The course is intended to lecture the students the basic principles, stakeholders and their connections, market designs, the technical, legal and commerce rules of the electricity markets that have already been deeply integrated with the operation and control of the electricity power systems, along with the economic principles, price trends of the commodities and services and the investment promoting techniques of the power markets. After successfully completing the course the learnt basics of the methods and approaches applied in the Hungarian and the European energy markets gives the students the possibility to have the required competences to join the workforce of an energy trading, a market oriented services, distribution or system operator corporation. (4 credits)

**System Level Design**  
**BMEVIIEM05**
The subject presents the design, implementation and verification of digital hardware. Various concepts and tools are presented, including alternatives of digital system realization, automation, silicon compilers, simulation methods, system level modelling. The languages hardware modellign languages SystemC, CatapultC, VHDL, Verilog, and Verilog-AMS are introduced. The actual trends are also discussed, e.g. hardware-software co-design, IC and MES co-design, MEMS integration. The subject also includes computer-based design demonstrations and practices. (4 credits)

**Circuit Environment**  
**BMEVIIEM06**
The scope of the subject is to get the students acquainted with the development of the packaged intelligent devices operating environment, the design software, the modern simulation tools. Deals with the design, testing, simulation steps and gives practical knowledge on their industrial appli-
cations. The whole process development flow is described, including basics steps of the developments, test methods, reliability investigations, and the effects of the ambient to the operation of the circuit. The subject also introduces to signal integrity, e.g., plane capacitance, losses, delays, skin effect and proximity effect, wave impedance and passive devices in real parasitic elements. (4 credits)

**Smart Systems Design Laboratory**

**BMEVIEEMB00**

The laboratory practice covers the complete design flow of IC and MEMS co-design. A workgroup of students are designing a Smart System solution including MEMS sensors and actuators and the relevant CMOS circuitry. The laboratory practice is built on the lecture course of System Level Design. Up to date industry standard software CAD tools are utilized thanks to the EU and international support. (2 credits)
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:

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

Budapest University of Technology and Economics
Faculty of Mechanical Engineering
Faculty Office:
Building R, ground floor, room 001.
Mailing Address: Műegyetem rkp. 7-9.
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 BSc Subjects

### Process Engineering Specialization

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<th>Subject</th>
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XX in the Final Project code varies from department to department  e - exam, p - practical mark, ge - global exam
# Curriculum of BSc Subjects

## Engineering Design and Technology Specialization

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| Materials Science and Testing | BMENMTAGK1 | 4 | 2/0/3 | | | | | | | | e |
| Fundamentals of CAD | BMGEVEA3CD | 4 | 2/0/3 | | | | | | | | p |
| Physics A2 | BMETE15AX02 | 2 | 4/0/3 | | | | | | | | e |
| Fundamentals of Machine Design | BMGEVEA3CD | 4 | 2/0/3 | | | | | | | | e |
| Mathematics A2a - Vector Functions | BMETE90AX02 | 4 | 4/2/0 | | | | | | | | e |
| Software Engineering | BMGERIA32P | 2 | 2/0/3 | | | | | | | | p |
| Strength of Materials | BMEGMEMMAGM2 | 5 | 2/0/3 | | | | | | | | e |
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| **3rd Semester, Fall** | | | | | | | | | | | |
| Dynamics | BMEGMEMMAGM3 | 5 | 2/0/3 | | | | | | | | e |
| Materials Engineering | BMENMTAGK2 | 4 | 2/0/3 | | | | | | | | e |
| Physics A3 | BMETE15AX03 | 2 | 2/0/3 | | | | | | | | e |
| Machine Elements 1. | BMGEVEA3CD | 5 | 2/0/3 | | | | | | | | e |
| Environmental Management Systems | BMGT42A003 | 3 | 2/0/3 | | | | | | | | e |
| Mathematics A3 for Mechanical Engineers | BMETE90AX10 | 4 | 2/0/3 | | | | | | | | e |
| Mathematics Global Exam | BMETE90AX23 | 5 | 2/0/3 | | | | | | | | e |
| Analysis of Technical and Economical Data | BMGEVEA3CD | 3 | 2/0/3 | | | | | | | | e |
| Measurement Technology | BMEGMEMMAGM2 | 5 | 2/0/3 | | | | | | | | e |
| **Total credits:** | | | | | | | | | | | 29 |

| **4th Semester, Spring** | | | | | | | | | | | |
| Basics of Electrical Engineering | BMVIAUA007 | 4 | 2/0/3 | | | | | | | | e |
| Machine Elements 2. | BMGEVEA3CD | 6 | 2/0/3 | | | | | | | | e |
| Manufacturing | BMGEVEA3CD | 5 | 2/0/3 | | | | | | | | e |
| Control Engineering | BMGEVEA3CD | 4 | 2/0/3 | | | | | | | | e |
| Engineering Thermodynamics | BMGEVEA3CD | 3 | 2/0/3 | | | | | | | | e |
| Polymer Materials Science and Engineering | BMGEVEA3CD | 6 | 2/0/3 | | | | | | | | e |
| Vibrations | BMGEVEA3CD | 6 | 2/0/3 | | | | | | | | e |
| Mechanics Global Exam | BMEGMEMMAGM2 | 5 | 2/0/3 | | | | | | | | e |
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| Electromechanics | BMVIAUA007 | 4 | 2/0/3 | | | | | | | | e |
| Fluid Mechanics | BMGEVEA3CD | 5 | 2/0/3 | | | | | | | | e |
| Heat Transfer | BMGEVEA3CD | 4 | 2/0/3 | | | | | | | | e |
| Injection Molding | BMGEVEA3CD | 3 | 2/0/3 | | | | | | | | e |
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**Criterion**

Industrial Practice | BMEGEXXBYSSZ

*XX in the Final Project code varies from department to department e - exam, p - practical mark, ge - global exam*
## 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

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### Curriculum of MSc Subjects

#### Mechanical Engineering Modelling - Solid Mechanics Module

<table>
<thead>
<tr>
<th>Subject</th>
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### Curriculum of MSc Subjects

#### Mechanical Engineering Modelling - Thermal Engineering Module

<table>
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<tr>
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#### Mechanical Engineering Modelling - Design and Technology Module

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**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
**Compulsory English I and II.**

**BMET63A301, BMET63A302**

The courses are designed to enable students to communicate fluently and effectively in study environment. Receptive, productive and interactive activities and strategies are included in the curricula. By the end of the 2nd semester the overall language ability of the students is on level B2 (by the Common European Framework of Reference). 4 hours/2 credits.

**Descriptive Geometry**

**BMETE90AX06**


**Introduction to Mechanical Engineering**

**BMGEVGAG01**


**Information Systems**

**BMGERIA311**


**Macro- and Microeconomics**

**BMETG30A001**


**Mathematics A1a - Calculus**

**BMETE90AX000**


**Technical Chemistry**

**BMVEKTAGE1**


**Statics**

**BMGEJMMAGM1**


**Materials Science and Testing**

**BMGEJMTAGK1**


**Fundamentals of CAD**

**BMGEJGEA3CD**


**Physics A2**

**BMETE15AX02**

Properties of electric charges. Insulators and conductors. Coulomb’s law. The electric field, Superposition. Electric field lines of forces. The electric flux, Gauss’s law. Examples: the electric field of some specific charge distribu-
Fundamentals of Machine Design
BMEGEAGM1

Mathematics A2a -Vector Functions
BMETE90AX02

Software Engineering
BMEGERIA32P

Strength of Materials
BMEGMAGM2

Dynamics
BMEGMAGM3

Materials Engineering
BMEGMAGK2

Physics A3
BMETE15AX03

Machine Elements 1
BMEGEAGG1
of shafts and rotors for static combined loads. Fatigue and life of members. Dimensioning on strength at harmonically varying loads. 4 hours/5 credits.

**Environmental Management Systems**

**BMEGT42A003**

The course covers the topics relevant to the protection of environmental compartments, environmental pressures and pollution in a global context. Introduces the concepts, indicators and tools of environmental protection (air, water, noise and soil protection and waste management. Environmental management systems (EMS) at enterprises and other organizations. EMS topics include the assessment of environmental aspects and impacts, environmental audit, reporting, environmental performance evaluation, life cycle assessment and related international standards. 3 hours/3 credits.

**Mathematics A3 for Mechanical Engineers**

**BMETE90AX10**


**Analysis of Technical and Economical Data**

**BMEGEVYAG14**


**Measurement Technology**

**BMEGEMIAMG1**

The measurement of geometric quantities of mechanical engineering. Statistical analysis and data acquisition of the measured values. Systematization of errors, according to their origin, character and form. Measurement methods. Electronic measurement of typical time-dependent non-electric quantities of mechanical engineering and of mechatronics. Structure of the measurement chain, sensor and transducer types, the role of intermediate quantities. Dynamical errors, frequency transfer characteristics. Classification and Fourier analysis of signals. Digital measurement systems for length and angle. Basics of digital measurement of signals, digitization methods and sampling theorem. 3 hours/3 credits.

**Basics of Electrical Engineering**

**BMENVIAUA007**

Basics of stationary and time-varying electric and magnetic fields and their engineering applications. DC and single-phase AC circuit with lumped parameters. Complex quantities, and phasor diagram. Active, reactive and apparent powers. Modeling electromechanical systems. Basic electrical instruments and measurements. 3 hours/3 credits.

**Machine Elements 2**

**BMEGEGEAGG2**


**Manufacturing**

**BMEGEGTAG01**

The basic model of the machining system (WFMT system), introduction to the part modeling, to the fixturing the parts, to the machine tools and robotics, to the cutting tools and to the controlling of the machine tools. Mechanics of cutting; geometry of the cutting edge, chip breaking, stability of cutting. Tool wear and tool life. Tool materials and cutting fluids. Fundamentals of the measuring techniques and quality control. The main measuring devices. Fundamentals of metal cutting machine tools kinematics. Manually operated, cam controlled and computer controlled machine tools. Basic types of machine tools. Flexible manufacturing cells and systems. Manufacturing process planning. Computer-Aided Manufacturing. 5 hours/5 credits.

**Fluid Mechanics**

**BMEGEAATAG11**


**Engineering Thermodynamics**

**BMEGEEAETD**

Polymer Materials Science and Engineering

BMEGEPTAGOP


Vibrations

BMEGEMMAGM4


Electromechanics

BMEVIUAUA008


Control Engineering

BMEGEMIAGEI


Heat Transfer

BMEGEENAEHK


Diffusion Processes

BMEGVEAG02


Measurement at Energy and Environmental Protection

BMEGEENAG51

The role of measurements in maintaining and controlling the energy conversion processes. Hardware and software tools of the control and measurement systems. Laboratory tests of different engines and equipments. Simultaneous determination of system variables (flow rates, pressures, temperatures, etc.). Methods of determination of performance, efficiency, exhaust gas composition. 3 hours/3 credits.

Measurement Technique of Processes

BMEGEVAG03


Fundamentals of FEM

BMEGEMMAGM5

Management and Business Economics
BMEGT20A001
This course introduces the essentials of management as they apply within the contemporary work environment and gives a conceptual understanding of the role of management in the decision making process. Particular attention is paid to management theories, corporate finance, leadership, teamwork, quality management, management of technology, economics calculation and operations management. For problem formulation both the managerial interpretation and the mathematical techniques are applied. 4 hours/4 credits.

Business Law
BMEGT55A001
The problems of the area will be treated in two major parts. Part One introduces students to the general topics, for example the conception of law, the functions of the law in the socioeconomic life. Some basic legal problems, like the concept of law, the functions of the law in the modern state and, in a comparative view, the characteristics of the Anglo-Saxon and continental systems of business law and the development of the Hungarian business law will be also discussed. The emphasis of Part Two is on the questions of company law and competition law presented in a European context. The lectures of this part outline not only the regulations of the Hungarian Company Act and Company Registry Act but they cover EU directives and regulations on companies and competition as well. 2 hours/2 credits.

Marketing
BMEGT201A002

Communication Skills - English
BMEGT63A061
It is designed to meet the language needs of students in academic and professional fields. Special emphasis is on the language of meetings and discussions, oral presentation and summary writing. 2 hours/2 credits.

Technical Acoustics and Noise Control
BMEGEÁTAG015

Fluid Machinery
BMEGEVGAG02
Euler equation, specific work, head, performance characteristics of axial and centrifugal machines. Losses, efficiencies. Non-dimensional parameters, scaling laws, specific speed. Cavitation, NPSH. Operation (parallel, serial) and control of turbomachines. Thrust loads (axial, radial). Axial fan, axial compressor stage. 4 hours/4 credits.

Heat Engines
BMEGEENAEGK

Numerical Simulation of Fluid Flows
BMEGEÁTAG06

Processes and Equipment of Chemical Industry
BMEGEVÉAG03

Air Pollution, Wastewater and Solid Wastes Management
BMEGEÁTAG04
Gaseous and particulate air pollutants. Source control of emissions. Waste gas treatment techniques for volatile organic compounds and inorganic compounds, for gaseous pollutants in combustion exhaust gases and for particulate matter. Wastewater characteristics, pre-treatment. Primary
separation or clarification wastewater treatment techniques. Physical, chemical, and water treatment techniques. Biological treatment techniques for biodegradable waste water. Wastewater sludge treatment techniques, sludge disposal. Types, sources, properties, quantities, and qualities of solid wastes. On-site handling, storage and processing of solid wastes. Collection, transfer and transport of solid wastes. Solid wastes processing techniques. Biological, chemical and energetic resource recovery processes. Ultimate disposal. 3 hours/3 credits.

Independent Study 1
BMEGEVGAG06
One-semester long individual project work. 4 hours/4 credits.

Heating
BMEGEÉPAG61

Manager Communication
BMEGT65A081
It is designed to establish and update basic language skills, and competences required by acting in management fields. 2 hours/2 credits

Crosscultural Communication
BMEGT65A091
It is designed to make students aware of cultural differences, develop their intercultural competencies. Special emphasis is on verbal and non-verbal communication, language diversity, and socio-cultural factors. 2 hours/2 credits.

Fluid Flow Systems
BMEGEVGAG07
Operation of pumps and fans in systems. Selection of the proper turbomachine considering safety, cavitation free operation and efficiency of controlling the turbomachine. Stability of operation of fans and compressors in systems containing large air volumes - an investigation based on a simple linear theory of stability. Computation of the flow rate and pressure distribution in looped pipe networks. Flow in open channels. Optimisation of the operation of water distribution systems containing pumps and reservoirs for minimum electricity cost. Basics of hydraulic transients. 3 hours/3 credits.

Energy Processes and Equipments
BMEGEENGAG71

Volumetric Pumps and Compressors
BMEGEVAG04

Measurement for Chemical and Environmental Processes
BMEGEVAG04
Introduction to instrumentation and measurement systems. Process instrumentation, measurement methods, instruments and techniques of various physical quantities. Online measurement with modular multi-parameter measuring system. Laboratory exercises for monitoring of waste water and air pollutants. Receive practical hands on experience in the laboratory using dryer, filter and heater equipment. 3 hours/3 credits.

Final Project
BMEGEXSA4SD
One-semester long individual project work. 10 hours/15 credits. * XX in the code varies from department to department.

Air-Conditioning
BMEGEÉPAG62
Basis for ventilation, thermal comfort and indoor air quality. Heating and cooling load calculations. Calculation of supply airflow rate for ventilated rooms, pollution and energy balance. Layout of air conditioning systems. Air movement in rooms, air distribution systems. Elements and processes of air handling systems. Filtration of air, filters. Treatments of air, equipment of heating, cooling, heat recovery and humidification. Hydraulic sizing of air duct system. Psychrometric charts. Process and flow diagrams of several air conditioning systems. 4 hours/4 credits

Optional Subjects (upgrade to ECTS 240)

Modeling of Processes and Equipment
BMEGEÉEAG01
Generalized two- and three-phase stage model. Types of equations describing the operation of equipment. Number of degrees of freedom. Design and modeling algorithms. Vapor-liquid and liquid-liquid equilibrium calculations. Simulation of countercurrent separation processes (distillation, absorption, stripping, extraction, extractive distillation) with a professional flow sheet simulator. 2 hours/3 credits.

Laboratory
BMEGEÉEAG00
Heat and material balance in spray drier. Overall heat transfer coefficient in tubular heat exchangers. Adsorption of gases (Breakthrough curve). Absorption in packed columns (Mass transfer coefficient, number of transfer units). Air vol-
ume flow rate measurement in an air technology system. The measurement of pressure relations of a ventilator on a Bernoulli bench. Thermal comfort related laboratory measurements. Measurement of combustion parameters and efficiency of gas boilers. 4 hours/5 credits.

**Independent Study 2**

**BMEGEVGAIP2**

One-semester long individual project work. 8 hours/8 credits

**Heating**

**BMEGEEPA6I**


**Manager Communication**

**BMEGT63A081**

It is designed to establish and update basic language skills, and competences required by acting in management fields. 2 hours/2 credits

**Crosscultural Communication**

**BMEGT63A091**

It is designed to make students aware of cultural differences, develop their intercultural competencies. Special emphasis is on verbal and non-verbal communication, language diversity, and socio-cultural factors. 2 hours/2 credits.

**English for Engineers**

**BMEGT63A051**

It is designed to meet the language needs of students in academic and professional fields. Special emphasis is on understanding complex technical texts, as well as producing clear paragraphs and essays on certain technical topics. 2 hours/2 credits.

**Analytical Mechanics**

**BMEGEMMMW01**


**Advanced Fluid Mechanics**

**BMEGEATMW01**


**Advanced Thermodynamics**

**BMEGEENMWAT**


**Motion Control**

**BMEVIAUA016**


**Power Electronics**

**BMEVIAUA017**

Semiconductor devices, the basic power electronics (PE) circuits and their application to such an extent that makes the students capable of understanding the principle of operation of PE equipment, carry out their laboratory tests, diagnosing faults and solving the task of selection as well as operation. Topics: 1. Introduction, Definition of PE; 2. Applications of Power Electronics; 3. DC/DC Converters; 4. Characteristics of Semiconductor Switching Devices; 5. Diodes, Thyristors, Application of Thyristors, 6. Controllable Semiconductor Switches: BIT, MOSFET, IGBT, GTO, Emulating Devices; 7. Converters: Classification, Configurations, Properties; 8. Output Voltage Regulation Methods, Overview of PWM; 9. AC Voltage Controllers: On-Off Control, Phase Control, Applications; 10. DC motor types, DC motor drives, Fields of Application; 11. Characteristics of the DC.
Engineering Design and Technology Specialization

The below courses make exclusive part of the Engineering Design and Technology Specialization.

Metal Forming

To present different processes in the field of cold, hot and sheet metal forming using the base-knowledge about material structure, mechanics and tribology taking into account the deformability of the material and other process parameters. Process design is based on the modeling of plastic deformation. Tools and equipments for the forming also are presented.


Base technologies and raw materials of cold forming processes: upsetting, heading, forward, backward and radial extrusion. Workability of materials. Die and process design of technology.


Laboratory: Flow curve and friction factor determination, testing of cold forming processes, design of die and forming technology, modeling of plastic forming. (4 credits)

Non-Destructive Testing of Materials

The subject gives an experience-oriented overview to the up-to-date non-destructive testing and evaluation (NDT and NDE) methods and technologies applied in mechanical-, electrical- and electronic industries. The subject deals with the basic and special non-destructive material testing methods, equipment and techniques of material defect analysis.

Lectures: Classification of NDT and NDE methods. Visualization, liquid penetration investigation of cracks. Ultrasoni...
Machine Design
BMEGEGEAGMD


CAD Systems
BMEGEGEAGCS

The course prepares the students to resolve complex task in the mechanical engineering with the tools of the computer aided design. Lecture topics: Introduction, using of the intelligifile. 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 modeling. TOP-DOWN design in static constructions. Issuing homework No.1. Overview on 3D assembly modeling. Design of the cast parts. 3D model based technical drafting. SW test (45 min). (3 credits)

Project Work
BMEGEGEAGPW

The course is to introduce the behavior analysis of machine construction and the optimal design using the tools of geometrical modeling and analysis. During the semester a machine design project should be worked out in small groups according to the following schedule. The task involves the conceptual and detailed designing of a machine structure, building a 3D-geometrical model in a CAD-System and, furthermore, the solving of several analysis problems. The main steps and milestones of the project:
Fixing the aim of the project. Project scheduling. Collecting information. Requirements. Developing and evaluating of design concepts. Simplified modeling and analytical calculation of the construction. Building the structural model (simplified geometry, load cases, boundary conditions and material properties). Presentation 1 (in team, max. 10 points). Working out the 3D-solid model of the evaluated design concept. Numerical modeling of the problem (static, dynamic, thermal, kinematic analysis). Evaluating and critic of the first model. Presentation 2 (in team or individually, min. 10, max. 20 points). Finalizing the construction. Preparing the project documentation and the assembly drawing. Presentation 3 (in team and individually, 20 minutes, max. 20 points). Submitting the project documentation and drawings (individually max. 50 points). (3 credits)

Manufacturing Processes
BMEGEGTAG91


Machine Tools and Manufacturing Systems
BMEGEGTAG92

The subject introduces structural elements, structural layout, and various types of the metal-cutting machine tools, their technological and operation characteristics, the basic concepts and layouts of manufacturing systems, and the most important material supply equipment needed to build manufacturing systems. 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 workpiece changing peripheries. Multi-functional machine tools. Parallel and hybrid kinematics machine tools. Methods and tools for design and simulation of machine tools. Types and various layouts of manufacturing systems. Material supply principles. Material supply equipment: conveyors, forklifts, AGVs, robots. Flexible manufacturing systems. Methods and tools for planning, design and simulation of manufacturing systems. (3 credits)
**CAD/CAM Applications**

**BMEGEPTAGE93**

The aim of the subject is to introduce students into computer-aided design and manufacturing systems via industry-proven tasks, application examples. Out through laboratory works they can learn the main principles of computer-aided manufacturing programming techniques, the characteristics, advantages and limits of recent CAD and CAM systems and up to date developments. The focus of the subject is to teach manufacturing oriented computer modeling (preprocessing), applications and programming (post-processing).

Detailed thematic description of the subject: Product and production life cycle: Product, product workflow (lifecycle), production and manufacture, product design and production planning, modeling (models). Computer aided automation of process planning (engineering): manufacturing process planning and engineering models (CAD/CAM models); object and process oriented, integrated planning methods (CIM); manufacturing and manufacturability planning. CAD or/and CAM systems: principles of CAD and CAM system application, design for manufacture and assembly. Feature based design and manufacturing process planning, manufacturing process oriented (generated) surface models and modeling, technology and quality controlled design and planning. CAM items and basic workflows: modeling of parts, assembly, environment (machine, device, tool, control, etc.) and technological process (CIM/CAD systems and elements (modules)); CAM work- and data flows (interfaces, documents); manufacturing dimension; material, tool and technological databases; manufacturing strategies (roughing and finishing, path generation and combination, etc.); manufacturing levels and boundaries: 2.5-3D tasks, cycles, options. >3D manufacturing via CAM systems: manufacturing planning on lathes, mills and wire EDMs, spatial motion strategies, manufacturing sculptured and composed (combined) surfaces, applications of combined strategies, high speed machining (HSM) and special techniques. CAM-CNC interfaces, postprocessors: adaptation and transportation interface drivers (engine, processor), surfaces (HW/SW) and languages (formats), intermediate surfaces, languages, ISO CLDATA, ISO standard and advanced NC program languages, post processing (postprocessors and postprocess- sor generator), DME connections (DMIS) and NC auxiliary functions (in process measure, adaptive feed and/or path optimization, etc.). Surveying knowledge: lecture’s and supplementary labor’s test.

Thematic of laboratories: Subject requirements and thematic. 2.5D multiple hollow part modeling. NASA CAD test laboratory, Test1 (CAD labor work), surface and solid modeling of complex surfaces and combined, assembled block, NASA CAM test milling, 2.5D milling of hollow part in EdgeCAM, 3D-s CAM modeling and manufacturing programming. Test2 (CAM labor work), Homework consulting, check and submission. (3 credits)

**Composites Technology**

**BMEGEPTAGE1**


Laboratory practice topics: Tensile and flexural testing of the specimens. Test data evaluation. Calculating the expected mechanical properties of the specimen types, comparison with the test data, summarizing the results for the required technical report. (4 credits)

**Injection Molding**

**BMEGEPTAGE2**


**Polymer Processing**

**BMEGEPTAGE3**


**Industrial Practice**

**BMEGEEXBYSZ**

One of the requirements to obtain the BSc diploma is to carry out an internship in a company or institution that performs some activities in the field of mechanical engineering. The required duration of the industrial practice is 6 weeks. It is possible to request the place 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 acquisition of the BSc diploma. Industrial Practice can be accomplished after any semester during the specialization period. Upon request an internship made before studies in BME may be also accepted. (criterion)
Basic Subjects

Mathematics Mi - Differential Equations and Numerical Methods

Dr. Péter Moson, Dr. György Paál

Laser Physics

Dr. Emőke Lőrincz

Analytical Mechanics

Dr. Gábor Stépán

Advanced Fluid Mechanics

Dr. Gergely Kristóf

Advanced Thermodynamics

Dr. Balázs Czél

Electronics

Dr. Balázs Rakos

Advanced Control and Informatics

Dr. Péter Korondi, professor
Machine Design and Production Technology

**BMEGE_GEMW01**

**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, constraints, shape and size optimization).

**Production:** Machine-tools and equipment, devices and fixtures, 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).

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**Subjects of the Fluid Mechanics module**

**Special Subjects / Major or Minor Compulsory Subjects**

**Computational Fluid Dynamics**

**BMEGEATMW02**

**Dr. Gergely Kristóf**


**Flow Measurements**

**BMEGEATMW03**

**Dr. János Vad**

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 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.


**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*

Unsteady Flows In Pipe Networks

Dr. Csaba Hős

Building Aerodynamics

Dr. Jenő Miklós Suda

Aerodynamics and its Application for Vehicles

Dr. Jenő Miklós Suda
Introduction, bluff body aerodynamics. Characteristics of atmospheric boundary layer. Basics of car design (in cooperation 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 wood can be freely cho- sen, 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 deter- mined (together with the wheels), in order to determine drag and lift coefficients. There is a possibility to place attach- ments 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 lo- cation 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

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 silenter, and the sound propagation in horns. Sound propagation in duct and higher order modes. The ray theory, sound propagation in non-homo- geneous 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 measure- ment, the microphone array.

Hemodynamics

Dr. György Paál

Flow Stability

Dr. György Paál
Theoretical Acoustics

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

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 work on complex problems proposed in the 3rd semester in course of the Final Project A (BMEGEÁTMWDA). The Final Projects A and B together proposed in the 3rd semester in course of the Final Project B announced also by the Dept. Hydrodynamic Systems (under code BMEGEVGMWDB). The Final Projects A and B together serve as a two-semester project that results in the Master Thesis (in printed and electronic format. Evaluation by the student)

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

Dr. András Szekrényes


Continuum Mechanics

Dr. Attila Kossa

Teamwork Project

BMEGEMMWPA

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

BMEGEMMWDA

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

BMEGEMMW05

Dr. Attila Kossa

Nonlinear Vibrations

BMEGEMMW06

Dr. Gábor Stépán, professor

Coupled Problems in Mechanics

BMEGEMMW07

Dr. Ádám Kovács

MECHANISMS

BMEGEMMW08

Dr. Ambrus Zelei, research associate

Beam Structures

BMEGEMMMW09

Dr. András Szekrényes
Experimental Methods in Solid Mechanics

Dr. András Szekrényes


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 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

BMEGEMMWCT

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 CO2 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 pyrolysis 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, and/or solid fuels, and waste material incineration.

Energy Conversion Units and their Equipment

BMEGEMMWEP

Dr. Ákos Bereczky


Teamwork Project

BMEGEMMWPR

Dr. Tamás Laza

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

Final Project A

BMEGEMMWDA

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 sub-
Special Subjects / Major or Minor Elective Subjects

Measurements In Thermal Engineering

Dr. Ákos Bereczky

Simulation of Energy Engineering Systems

Dr. Pál Szentannai

Thermal Physics

Dr. Balázs Czél

Thermo-Mechanics

Dr. Ádám Kovács

Steam And Gas Turbines

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 evolution, 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 constants. 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

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

Dr. Károly Váradi, professor

Advanced Manufacturing

Dr. Márton Takács
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 Pirov


Materials Science

BMEGEMTMW01

Dr. István Mészáros


Structural Analysis

BMEGEGEMW05

Dr. Tibor Goda


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 wörccieze changing peripherals. 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

BMEGEGTMW02

Dr. Imre Norbert Orbulyov

Final Project B

**BMEGT20MW01**

*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*


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 through engineering 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**

**BMEGEMMWSZ**

*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 acquisition of the MSc diploma.
PhD Degree

The Faculty of Mechanical Engineering (GPK) at the Budapest University of Technology and Economics (BME) offers degree programs in both Hungarian and English. Most students from abroad choose to study in English.

The BME GPK is a strongly research-oriented university that has conferred doctoral degrees since the 19th century in various fields of engineering.

The academic staff of our Faculty are doing research in the most relevant fields of the mechanical engineering discipline, and related applied sciences. PhD candidates are welcome to take part in this research work in order to prepare for the PhD procedure.

PhD at the BME GPK is a degree that can be earned by sufficiently proving the candidate's ability for self-standing scientific work that must be demonstrated by writing a thesis summarising the candidate's research results. Furthermore, it is necessary to pass a set of qualifying examinations in some basic and applied sciences related to the field of the submitted thesis. Candidates are to publish their results prior to the submission of their theses.

Applicants for the PhD program must hold an MSc degree issued by an academic institution and must possess an overall understanding of, and a high competence in, their field of knowledge. They must also be capable of using research techniques. Admission requirements include excellent grades (mainly or exclusively A's), an excellent MSc (or equivalent) final project, and/or the achievement of good initial results in research. Besides their professional achievements, applicants should also demonstrate a sense of responsibility for the advancement of scientific knowledge.

PhD candidates carry out their studies and research on an individual basis under the guidance of a professor or a senior member of the academic staff at the faculty concerned. This research work must contribute to scientific knowledge in general, and it must be recognized as such by the international scientific community. In order to prove this, doctoral candidates must present their research results at national and international conferences and symposia, and they are expected to publish the significant and major achievements of their work in internationally refereed professional periodicals.

Besides the research work, the PhD supervisor usually recommends the participation in various courses related to the research topic. In such a case, the appropriate examinations must be successfully completed, the results of which will be documented in the transcripts of the candidate. Similarly, the advancement in individual study and research will be documented on a semester basis by the supervisor.

Working towards a PhD degree requires at least 4 years (8 semesters) of study. This time might be considerably longer, depending on the topic and the candidate's personal diligence. It is possible to set individual PhD study plans for candidates who spend certain parts of their preparation period at other institution/s, e.g. their own original research-oriented affiliation or another university.

Upon completing all necessary work for the PhD thesis, this dissertation must be prepared according to the formal requirements in the Doctoral Code of the Budapest University of Technology and Economics.

According to the procedural code of our university, every PhD candidate individually must apply to the Doctoral Board of the faculty concerned. However, the recommendation of the supervising professor and department, including the attachment of the protocol of the departmental public presentation of the thesis (with the comments and recommendations of several departmental and/or internal referees, and other professional experts of the field) is a strong expectation.

The doctoral board will appoint an independent examination board for each candidate which consists of the President, two examiners and several jury members. Final decision lies on this board after hearing the public presentation and defense of the thesis work and the subject examination.

The conferred degree is declared and testified by a corresponding PhD diploma at the next solemn ceremony of the university by the Rector of the University concerned.

NOTE:

*Individual research topics and their overall conditions are formulated in negotiations between candidates and supervisors at BME.*
BME GPK guidelines for acceptance to the PhD programme

1. The primary condition of admission to post-graduate studies is that the applicant must hold an MSc-degree in Mechanical Engineering, or in some closely related fields. Minimum requirement is at least “good” (min. 3.51 out of 5.00 or equivalent) qualification of the diploma.

2. Applicants are expected to have a definite scope of research in the following fields:
   - mechanical engineering (materials science and technology, solid or fluid mechanics, thermal engineering, combustion, process engineering, building services, manufacturing, engineering design, polymer science and technology),
   - mechatronics (robotics, system and control technology, optics, measurement, instrumentation technologies, biomechatronics),
   - energy engineering (heat and power generation, energy systems)
where they would like to advance their knowledge. They are requested to present a proposal, specifying a domain of interest with some research objectives, milestones and deliverables during the postgraduate studies. The suggested topic should have sufficient preliminaries in their university studies.

3. Applicants with experience and initial results are asked to submit a short summary of preliminary research activities together with relevant reports, published papers, which give help in the admission process.

4. Applicants should also submit two recommendations given by renowned academic personnel.

5. It is highly preferable when applicants have already agreed with the future supervisor prior to the application.

6. Each admission is valid only for the forthcoming academic year (starting right after the letter of acceptance).

7. Application procedure is as follows:

**Application deadline:** 1st July for Fall semester, 15th October for Spring semester.

**Application fee, processing, postage:** EUR 100 (non-refundable). The application will be considered and communication is assured when application fee has been transferred to the bank account of BME, and submitted all the required documents.

**Documents to submit:**
- application form (online) completely filled (be careful that your personal data appear correctly as are in your passport because they will be the form to appear in your transcripts and degree certificate)
- copy of your passport
- one of the following documents of internationally recognized English language proficiency:
  - a) TOEFL iBT test score of 90, or PBT score 550,
  - b) Cambridge First Certificate “B”,
  - c) IELTS score of 5.0
- official transcripts, degrees/diplomas of any higher education already completed. Notarized English translation
- 4 recent photographs
- curriculum vitae (autobiography/résumé)
- two letters of recommendation
- Study Plan (agreed with the supervisor)

**NOTE:** Notarization is necessary for every school leaving document even if the original is in English. Notification of your acceptance/rejection will be sent to you after your complete application has been reviewed. All necessary further information will be attached to the letter of acceptance.
The Faculty of Natural Sciences, one of the newest faculties at the Budapest University of Technology and Economics, was established in 1998 and now employs 190 full and part time faculty members. The Faculty provides classes in Physics, Mathematics and Cognitive Science and is designed to meet the needs of its own and other faculties.

Courses are offered on BSc and MSc degree levels. The Faculty provides post-graduate scientific training as well. Currently more than 100 PhD students are pursuing personal programs in different areas of sciences. The Faculty also offers short courses on specific topics of current interest.

The Faculty of Natural Sciences administers its own BSc and MSc programs in Physics, Mathematics, Applied Mathematics and Cognitive Science. A continuing educational program is also offered in Reactor Physics and Reactor Technology. For many years the “Eugene Wigner International Training Course for Reactor Physics Experiments” has also been organized on a yearly basis.

The BSc in Physics Program, a traditional curriculum, leads to a BSc degree in 6 semesters. The facilities and scientific-tutorial background of the Institute of Physics and the Institute of Nuclear Techniques offer unique opportunities in areas like low temperature physics, acousto-optics, holography, nuclear techniques or medical physics. A further advantage of our Physics BSc Program is the engineering background provided by the Budapest University of Technology and Economics. From the forth semester students can choose specialized courses in the topic of Advanced mathematics, Advanced physics, Computer programming, Optics, Material science, Nuclear technology, and Medical physics.

In another 4 semesters an MSc in Physics degree can be earned. This program provides comprehensive knowledge, built upon strong theoretical and experimental bases in four areas of specialization. Students who choose the specialization “Physics” get acquainted with theoretical tools of modern physics and with state of the art experimental methods. In addition to the obligatory courses students can choose specialized professional courses in the topic of Quantum physics, Solid state physics, Statistical physics, Nanotechnology and material science, Optics and photonics, Nuclear technology, and Medical physics. A post-graduate PhD programme in Physics is available in all domains offered in the MSc programme.

The BSc in Mathematics Program, a traditional curriculum, leads to a BSc degree in 6 semesters. This program is recommended first of all to those who are interested in a deeper understanding of some branches of mathematics and in doing theoretical research and are probably going to continue their studies in a Mathematics or an Applied mathematics MSc program. Moreover, the BSc program is also recommended to students who are eager to apply their knowledge in industry or finance.
In another 4 semesters an **MSc in Mathematics** or **MSc in Applied Mathematics** degree can be earned. A large variety of subjects are offered in the **MSc in Mathematics Program**, covering the topics algebra and number theory, analysis, geometry, probability theory and statistics, discrete mathematics, operations research. There is a large flexibility in choosing subjects according to the personal interests of the student. From the available subjects we also offer two specializations called “Analysis” and “Optimization”. Currently our MSc in Mathematics program is available only in Hungarian.

Students of the **MSc in Applied Mathematics Program** choosing the “Applied Analysis” specialization will meet applications of mathematical analysis in natural sciences, finance and industry. Graduates from the “Operations Research” specialization are able to create models for problems in controlling systems or optimization. Students who specialized in “Financial Mathematics” can analyze financial processes or insurance problems and are able to interpret the results. Graduates from the “Stochastics” specialization can recognize and study random laws in various phenomena. The language of courses of the specializations “Applied Analysis” and “Operation Research” is Hungarian, but the specializations “Financial Mathematics” and “Stochastics” is English.

**MSc in Computational and Cognitive Neuroscience** (currently available only in Hungarian). The aim of the master program is to train researchers skilled in complex analysis of human cognition and knowledge relying on the methods of science. Students may complete courses in all major domains of cognitive science including cognitive psychology, neuroscience, linguistics and the philosophy of science. Students will be equipped with both theoretical knowledge and practical skills such as statistical analysis and research ethics. Graduates will be able to carry out research in various areas of cognitive science combining theoretical insights and methods of biological (neuroscience, experimental psychology, developmental studies), and formal (mathematics, logic, philosophy of science, linguistics) disciplines. Graduates’ competences allow them to undertake doctoral studies, and to work in a variety of applied domains including medicine, biotechnology and education.

**Continuing educational program** in reactor physics and technology is a four semester program offered to professionals working in the nuclear industry. The subjects include reactor physics, thermohydraulics, radiation protection, radiochemistry, reactor technology, nuclear safety and laboratory experiments.

The Institute of Nuclear Techniques organises - or participates actively in the organisation of - several international courses as well. Worth mentioning are the HUVINETT (Hungarian Vietnamese Nuclear Engineering Train the Trainers) courses, where more than 150 Vietnamese educational professionals attended in 2013 and 2014. Also the participants of the training courses offered by the international EERRI consortium (Eastern European Research Reactor Initiative) perform experiments in the Training Reactor of the BME INT. In this consortium institutes of 5 Eastern European countries cooperate, with the organisatory and financial aid of the International Atomic Energy Agency (IAEA).

Postgraduate program in Operations Research in four semesters is recommended to professionals - with MSc - who often meet problems related to optimization (economists, engineers, etc.). The program includes theoretical classes (bases of discrete, continuous and stochastic optimization) and practice oriented classes as well (modelling, software packages, algorithm implementation, etc.). In the second and third semester students carry out individual projects which help them to obtain the required knowledge and practice for the future.

### Institutes

#### Institute of Mathematics
- Department of Algebra
- Department of Analysis
- Department of Differential Equations
- Department of Geometry
- Department of Stochastics

#### Institute of Nuclear Techniques
- Department of Nuclear Techniques
- Department of Nuclear Energy

#### Institute of Physics
- Department of Atomic Physics
- Department of Physics
- Department of Theoretical Physics
- Department of Cognitive Science

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Budapest University of Technology and Economics  
Faculty of Natural Sciences  
Faculty Office:  
Building K, 1st floor 18.  
Mailing address:  
H-1111 Budapest, Műegyetem rkp. 3.  
Phone: (+36-1) 463-3561  
Fax: (+36-1) 463-3560

Dean of the Faculty: Dr. Miklós Horváth  
Vice-dean (Finance): Dr. Imre Varga  
Vice-dean (Scientific and International): Dr. György Károlyi  
Vice-dean (Education): Dr. István Prok
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<tr>
<th>Subject</th>
<th>Lecture / Practice / Laboratory / Exam type / Credit</th>
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<td>Measurement Techniques</td>
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<td>Radiation Protection and its Regulatory Issues</td>
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<td>Management and Business Economics</td>
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<td>Functional Analysis for Physicists</td>
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Curriculum of BSc in Physics
### Curriculum of BSc in Physics (contd.)

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<td><strong>Classical and Quantum Chaos</strong></td>
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<td><strong>Theory of Relativity</strong></td>
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<td><strong>Computer Programming</strong></td>
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<td><strong>Computer Controlled Measurements</strong></td>
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<td><strong>The Fundamentals and Applications of Finite Element Modeling</strong></td>
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<td><strong>Computer Solution of Technical and Physical Problems</strong></td>
<td>BMETE11AF36</td>
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<td><strong>Monte Carlo Methods</strong></td>
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<td><strong>Optics</strong></td>
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<td><strong>Laser Technique</strong></td>
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<td><strong>Microscopy</strong></td>
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<td><strong>Foundations of Biophysics</strong></td>
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<td><strong>Fundamentals and Applications of Materials Science</strong></td>
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<td><strong>Microtechnology and Nanotechnology</strong></td>
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**Exam type:** v = exam, f = midterm exam, a = signature, s = comprehensive exam

**Subject type:** K = obligatory, KV = elective, V = optional, KR = criterium
# Curriculum of BSc in Mathematics

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Exam type: v = exam, f = midterm exam, a = signature, s = comprehensive exam
Subject type: K = obligatory, KV = elective, V = optional, KR = criterium
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| Optional Courses                      | 9 credits must be completed               |             |     |    |    |    |    |             |

Exam type: v = exam, t = midterm exam, a = signature, s = comprehensive exam
Subject type: K = obligatory, KV = elective, V = optional, KR = criterium
## Curriculum of MSc in Mathematics

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Exam type:  v = exam,  f = midterm exam,  a = signature  
Subject type:  K = obligatory,  KV = elective,  V = optional
# Curriculum of MSc in Applied Mathematics

## Specialization in Applied Analysis

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Exam type:  v = exam,  f = midterm exam,  a = signature
Subject type:  K = obligatory,  KV = elective ,  V = optional
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### Specialization in Operation Research

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**Exam type:** v = exam, f = midterm exam, a = signature  
**Subject type:** K = obligatory, KV = elective, V = optional
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Exam type: v = exam, f = midterm exam, a = signature  
Subject type: K = obligatory, KV = elective, V = optional, KR = criterion
## Curriculum of MSc in Applied Mathematics
### Specialization in Stochastics

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**Exam type:** v = exam, f = midterm exam, a = signature

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Subject type: K = obligatory, KV = elective, V = optional
Description of BSc Subjects in Physics

MATHEMATICS

Mathematical Methods in Physics 1

**BMETE92AF35 – 4/2/0/v/6**

*Dr. Tamás Tasnádi*

The course gives an introduction to mathematical tools used in the Experimental Physics 1-2 courses without giving precise proofs. The aim of the course is to develop the calculation facility of the students and enable them to use mathematical methods in physical problems. One fourth of the lectures and the practices are devoted to practice the subject on specific problems. The course is jointly held by the Institutes of Mathematics and Physics. Themes: Complex numbers, basic laws of algebra, algebraic, trigonometric, and exponential forms of complex numbers, complex operations. Vectors, matrices: operations (scalar, cross, diadic product), determinant and its properties, trace, Levi-Civita symbol, linear system of equations, inverse matrix, Gauss elimination, eigenvalue, eigenvector, characteristic polynomial. Differentiation: definition, basic rules, higher order derivatives, Taylor series, partial derivative, total derivative. Young’s theorem, differentiation of vectors, divergence, gradient, curl, nabla symbol, Jacobian matrix. Integration: definitions, definite, indefinite, partial, u-substitution, multiple integral, path, surface, volume integrals, Gauss, Stokes theorem.

Mathematical Methods in Physics 2

**BMETE92AF36 – 4/2/0/v/6**

*Dr. Tamás Tasnádi*

The course gives an introduction to mathematical tools used in the Experimental Physics 1-2 courses without giving precise proofs. The aim of the course is to develop the calculation facility of the students and enable them to use mathematical methods in physical problems. One fourth of the lectures and the practices are devoted to practice the subject on specific problems. The course is jointly held by the Institutes of Mathematics and Physics. Themes: curvilinear coordinates, covariant, contravariant operations, transformation, cylindrical, spherical coordinates, derivatives. Linear algebra: basis, dual vector space, symmetric operators, similarity transformations, invariants, matrix polynomial, matrix functions, spectral decomposition. Complex analysis: poles, residue theorem, contour integral. Distributions: Dirac delta, operations. Fourier transformation: applications: Fourier-series, convolution, Green’s theorem.

Analysis for Physicists

**BMETE93AF00 – 4/2/0/v/6**

*Dr. Tibor Illés*

Rational and real numbers, sets, convergence of real series. Functions of one variable: continuity, properties of continuous functions, monotonicity, properties of monotonic functions, differentiability, significant limits, elemental functions and their inverse functions, intermediate value theorems, properties of differentiable functions, function analysis. Taylor polynomial, definite and indefinite integral, technique of integration, usage of integration, improper integral, simple differential equations. Infinite series. Convergence criteria.

Multivariate Analysis for Physicists

**BMETE93AF01 – 4/2/0/v/6**

*Dr. Tibor Illés*


Probability Theory for Physicists

**BMETE95AF00 – 2/2/0/v/4**

*Dr. Péter Bálint*


FUNDAMENTAL PHYSICS

Experimental Physics 1

**BMETE13AF02 – 4/4/0/v/8**

*Dr. Péter Vankó*


**Experimental Physics 2**

**BMETE13AF03 – 4/4/0/fv/8**

*Dr. Pál Koppa*


**Experimental Physics 3**

**BMETE15AF21 – 3/2/0/fv/5**

*Dr. Orsolya Újsághy*


**Experimental Nuclear Physics**

**BMETE80AF18 – 2/1/0/fv/3**

*Dr. Rita Dóczki*

Composition of the atomic nucleus, nuclear force, mass defect and stability of the nucleus, binding energy. The liquid drop model and the semi-empirical mass formula. Two ways to release nuclear energy. Types of radioactive decay, exponential decay law, radioactive decay chains; alpha, beta and gamma decay. Types of nuclear reactions, conservation of quantities with nuclear reactions, direct nuclear reactions and compound nucleus reactions. Microscopic and macroscopic cross sections. Types and properties of the neutron induced nuclear reactions. The energy dependence of the cross section of neutron induced nuclear reactions. Neutron slowing-down. Fast neutrons, epithermal neutrons, thermal neutrons. Interaction of radiation with matter: interaction of charged particles (alpha and beta radiation), neutron and gamma radiation with matter, the exponential attenuation of the radiation. Basic properties of the nuclear radiation detectors: gas-filled detectors, scintillation detectors, semiconductor detectors, thermoluminescent dosimeters, solid-state nuclear track detectors. Neutron detectors. Nuclear fission. Fission products, fission neutrons; the energy balance of the fission process. Chain reaction with neutrons, time-behaviour of the chain reaction, effective neutron multiplication factor, the basic constituents of a thermal-neutron reactor. Nuclear reactions capable to produce fissile material. Types of particle accelerators.

**ADVANCED PHYSICS**

**Mechanics 1**

**BMETE15AF23 – 2/2/0/fv/5**

*Dr. Gergely Zaránd*

Quantum Mechanics 1

Dr. László Szunyogh


Electrodynamics 1

Dr. Gábor Takács


Statistical Physics 1

Dr. Gergely Zarand


Introduction to Solid State Physics

Dr. István Kézmárki


Applied Solid State Physics

Dr. Szabolcs Csonka

Band structure of metals and semiconductors, electron transport, electron scattering mechanisms, 2 dimensional electron gases, Si technology (FET, SSD memory), semiconductor heterostructure (semiconductor laser, MEMT), nanoelectronics, single electron transistor. Magnetic materials, origin of magnetic momentum and interaction between moments, magnetic structures. Magnetism of metals, spin polarized bands, spintronics devices (spin valve, MRAM). Spin transistor, magnetic semiconductors.

Optics

Dr. Gábor Erdéi


**LABORATORY WORK, MEASUREMENT TECHNIQUES, ELECTRONICS**

**Introductory Laboratory Exercises**

**BMETE11AF27 – 0/0/2/f/2**

Sándor Bordács

Basic error analysis. Evaluation and plotting of the experimental data, linear regression, non-linear curve fitting. Simple experiments to practice data evaluation and error analysis. Basic functions of multimeters, oscilloscopes, function generators and data acquisition cards are introduced to the students. Students must attend to 6 laboratory practices each of them is 4 hour long.

**Laboratory Exercises in Physics 1**

**BMETE11AF28 – 0/0/3/f/4**

Dr. Péter Vankó


**Laboratory Exercises in Physics 2**

**BMETE11AF29 – 0/0/4/f/5**

Dr. Péter Vankó

Basic instruments, procedures and methods. Evaluation of measurements, error calculation, protocol writing. Measurement of complex electrical, mechanical, optical and thermal quantities. Advanced data collection. Advanced use of power supplies, sound generators, multimeters, oscilloscopes, etc. Measurements related to Experimental physics 1, 2 and 3.

**Electronics**

**BMETE12AF27 – 2/0/0/f/2**

Dr. Gábor Kiss

The primary aim is to teach the operation and planning of the basic circuits used in the experimental and applied physics. This subject is based on the thematics of Experimental physics 2 and Practice in experimental physics 2, giving knowledge in the physical bases of linear electronics (Maxwell-equations, Kirchoff-laws, resistance, capacity, inductivity, complex impedance, transient phenomena, RLC circuits). The detailed physics of semiconductor devices is taught later (Theoretical solid state physics, Applied solid state physics). In Electronics only the phenomenological models of semiconductor devices are treated. Thematics: Brush-up the physical bases of linear electronics. Linear electronic elements: ideal resistor, capacitor, inductor, distributed (parazite) parameters, volt and amper meters, voltage and current sources. Basic AC and DC circuits: bridges, voltage dividers, filter circuits, transformers. Introduction into the calculational methods of complex linear AC and DC circuits. Analysis methods of non-linear circuits. Small-signal models, notion of distortion. Characteristics of diodes, bipolar and fiel-effect transistors, small and large signal models of the devices. Active analogue circuits, bipolar and field effect transistor amplifiers, rectifiers, Feed-back and its application. Parameters of operation amplifiers and their applications. Inverting and non-inverting amplifiers, summarizing, differentiating and integrating circuits, schmitt-trigger circuit, oscillators. Special complex circuits (power supplies, regulators), protection of circuits.

**Laboratory of Electronics**

**BMETE10AF03 – 0/0/2/f/2**

Dr. Gábor Pór

This is a practical course, where students build basics electronics circuits like Smitt trigger, Miller effect and electronics of coincidence measurement. We pay attention mainly to electronics applied in nuclear measuring chains including signal formation differential and integral electronics, analog digital converters, transfer function signal/noise ratio, dead time, and jitter. Students get practice in electronics oscilloscopes, measuring automatically amplitude and spectrum. Using LABVIEW they learn how to build a spectrum analyzer in one day, measuring propagating perturbations to estimate velocity of natural convention in the water. All practice should be reported in form of well formatted measuring report including error estimation as well.

**Measurement techniques**

**BMETE11AF30 – 2/0/0/v/2**

Dr. András Halbritter


**Advanced Laboratory Exercises in Physics 1**

**BMETE11AF32 – 0/0/4/f/5**

Dr. Ferenc Fülöp

Advanced level experiments related to various topics of the modern physics and the current research activities in the
BME TTK: experiments in basic quantum physics; measuring basic physical constants; optical measurements, experiments in wave optics; mastering of modern measurement techniques.

Advanced Laboratory Exercises in Physics 2
BMEET11AF33 – 0/0/4/f/5
Dr. Ferenc Fulop
Advanced level experiments related to various topics of the modern physics and the current research activities in the BME TTK: experiments in solid state physics, material sciences, optical phenomena and nuclear physics; investigations of ionizing radiations and radiation detectors; acquirement of modern measurement techniques.

Advanced Laboratory Exercises in Physics 3
BMEET12AF21 – 0/0/4/f/5
Dr. Ferenc Ujhelyi
Advanced laboratory experiments related to the modern physics and the research fields of BME TTK mainly in the following fields: Semiconductor physics, material science, surface physics, vacuum technologies. Advanced optical measurements. Nuclear measurements. Modern measurement methods.

Computer programming, numerical methods (10 credits)

Programming
BMEVIEEA024 – 2/0/2/f/4
Dr. László Pohl
Synopsis of the subject, requirements, algorithm, data, language, programming languages, why the C? specification, design, coding, testing, documenting, algorithm choice questions in connection with GCD (trial and error, prime factors, Euclidean formula), elements of algorithms: sequence, branching, cycles, n! calculation: algorithm selection, parts, data structure, narrative description of the algorithm, algorithm by block diagram, encoding: a small analysis: mandatory elements of a C program, the frame, the main function, return 0; the purpose and significance of indenting, scanf for reading integer values, printf for writing integer values. Storage units: variables, constants, functions; mandatory declaration / definition, syntax / semantics: Syntax diagram, syntax of an integer value, Basic syntax rules: free writing mode (white spaces), a != A, #preproc, / *, comment /* */, regular identifiers; predefined types, why we use int and double, constant int definition in desc, oct, hex, forms, lack of the logic type, logic value of numbers. Instructions: ; declaration/definition, expression instruction, conditional instruction, cycle (now just the while), control statements (switch/case just mentioned), [], block diagram of if..else and while. Conditions: relational operators (== != / =/=, the dangers), logic operators !, &&, ||. Supplement and deepen the knowledge of the past week. Control structures, instructions, built-in types, number representation. Use of library functions. Basic operators: arithmetic, integer, real, type cast, assignment, sizeof, relational, logical, bitwise, shortcut: /, =. Iterative solutions, =, pre/post ++ --, dangers of post, arrays, 1D, 2D, strings, pointers. 1D dynamic array (example of use), only briefly, at the level of usage: getchar, putchar, EOF, ctrl+s/z+ctrl+d+filter program template, enum type, finite automaton example: writing out the comments from a C code, ly counter. Functions, memory areas allocated in the program, what is/ will be where, the heap, behavior of the stack, the consequences of the differences. Storage classes (for local variables), the function call mechanism, multiple return values: void descan2polardouble(double, double, double*), why forbidden to return local variable address. Struct, ., ->, typedef, direct selection sort, bubble sort, for structure array also, comparing functions, strcmp, sorting by text. Function pointers, usage of quots. Making of string, int and double comparing function (by a structure array sorting example), introducing recursive structure, ONLY drawn. Unidirectional, bidirectional, “arranged according to several criteria” list, binary tree, coded only the search in the list by cycle. Managing lists, insertion, search, deleting functions, the two possible head handling: head=insert(head, ...), and insert (&head, ...), interpretation of recursion by n!, binary tree management, inorder traversal only in code level. /O, FILE fopen, fclose, feof, /O, /O, sscanf, getc/s, Putc/s, parameters of main. In short, what is missed: the comma op, (union, bitfield vararg), the C preprocessor. Backup if there is no need to make up missed lectures then: making programs from multiple source file).

Numerical Computations for Physicists
BMET92AF01 – 0/0/2/f/2
Dr. Sándor Szabó
In this course we use the Matlab and Maple softwares to solve linear algebraic, one- and multivariable analysis problems. We consider the following topics. Linear Algebra: Solution of linear systems, Eigenvalues, eigenvectors, Column space, row space, rank, Gram-Schmidt orthogonalisation process, Inverse, determinant. Analysis: Solution of nonlinear systems by numerical methods, calculating integrals by quadratures, multiple integrals. Interpolation, limit, differentiation, determining potential function. Differential equations: Numerical (Euler, Runge-Kutta methods) and symbolical methods. Matlab: Programming in Matlab, Vectors, matrices, functions, graphics. Maple: Basic commands, LinearAlgebra, DTools, VectorCalculus and plots packages.

Chemistry

Dr. Mihály Kállay
General chemistry (introduction, basic chemical terms, notion of mole, reaction equations, stoichiometry, basics of chemical calculations, types of concentration). Basics of inorganic chemistry (constitution of atoms and molecules, types of chemical bonds, types of chemical formulae, the periodic table, states of matter, properties of the elements, most important inorganic compounds). Basics of chemical thermodynamics (basic terms, internal energy, work, heat, the first law of thermodynamics, enthalpy, heat of reaction, standard enthalpies, Hess’s law, second law of thermodynamics, entropy, free energy, free enthalpy, standard free enthalpies, free enthalpy of the ideal gas, chemical potential, mixtures, activities, equilibria, thermodynamic equilibrium constant). Chemical kinetics (notion of reaction rate, molecularity of reactions and reaction order, first and second order reactions, stepwise reactions, the effect of temperature on the reaction rate). Electrochemistry (properties of electrolytes, electrolytic dissociation of water and the concept of pH, galvanic cells, Nerst equation, types of electrodes, electrochemical power sources, zinc coal cells, batteries, fuel cells, electrolysis). Organic chemistry (hydrocarbons, aromatic compounds, halogen derivatives, alcohols, amines, ethers, aldehydes, ketones, carbonic acids, anhydrides, esters, carbohydrates, proteins, nucleic acids – definition, nomenclature, structure, most important reactions). Colloid chemistry (basics of colloid chemistry, dispersions, macromolecular and micellar solutions, gels, stability of colloids, preparation of colloids, examination methods of colloid systems). Materials science (basics of polymer chemistry, types of polymers, structure of polymers, polymerisation reactions, most important plastics, composites, ceramics, liquid crystals). Chemical examination and analytic methods (spectroscopic methods, classical analytic procedures, chromatography, electroanalysis).

Radiation Protection and its Regulatory Issues

Dr. Csilla Pesznyák

Management and Business Economics

Dr. János Kövesi
The course introduces the essentials of management as they apply within the contemporary work environment and gives a conceptual understanding of the role of management in the decision making process. Particular attention is paid to management theories, corporate finance, leadership, teamwork, quality management, management of technology, economics calculation and operations management. For problem formulation, both the managerial interpretation and the mathematical techniques are applied. Principles of management: Organizational resources. The enterprise as an organization. Functions of managerial processes. Managerial roles. Role of an engineer. Team work, communication in an organization. Lifecycle management and its managerial aspects. Costing: costing, cost effectiveness, traditional costing systems. Break even analyses, standard costing, activity based costing. Quality management: Principles of quality management, the brief history of quality management systems. Overview of quality assurance systems based on ISO 9001:2000. Overview of quality assurance systems based on Total Quality Management System.

ADVANCED MATHEMATICS

Modern Mathematical Methods in Physics

Dr. Péter Lévay

Introduction to Experimental Data Handling

Dr. Dániel Péter Kis
Advanced Physics

Mechanics 2

Dr. Gergely Zaránád


Quantum Mechanics 2

Dr. László Szunyogh

This course conveys advanced knowledge on Quantum Mechanics according to the following topics: The WKB approach, quasi-classical quantization. Scattering theory, scattering amplitude and cross section, Green functions, Lippmann-Schwinger equation, Born series, method of partial waves. Motion in electromagnetic field, Aharonov-Bohm effect, Landau levels. Time evolution and pictures in Quantum Mechanics (Schrödinger, Heisenberg and Dirac pictures). Adiabatic motion and Berry phase. Relativistic Quantum Mechanics, Klein-Gordon equation, Dirac equation, continuity equation, Lorentz invariance, spin and total angular momentum. Free electron and positron. Non-relativistic limit, spin-orbit interaction.

Electrodynamics 2

Dr. Gábor Takács


Fluid Mechanics

Dr. Gergely Krisztóf

Properties of Fluids, Newton’s law of viscosity. Cavitation, description of fluid flow, force fields. Characterisation and visualisation of flows, free (irrotational) vortex, continuity theorem, hydrostatics. Fluid acceleration, Euler-equation, Bernoulli-equation, total, static, and dynamic pressure. Basic examples for the Bernoulli-equation: flow rate measurement using a Venturi-tube, measurement of pressure, ve-

Classical and Quantum Chaos

**BMETE15AF39 – 0/0/0/v/2**

Dr. Imre Varga

Hamiltonian formalism, integrability in general, examples in physics for chaotic behavior in case of continuous and discrete dynamics; Continuous, non-autonomous differential equations; Anharmonic, dissipative oscillator; Mappings, Poincare-mapping; Periodically excited systems; Billiards. For some of these cases: application of techniques introduced for the analysis of chaos: Lyapunov exponent, invariant measures; Frobenius-Perron equation. Stability analysis; Bifurcations, attractors, strange attractors; Kolmogorov-entropy; KAM-theorem; Chaotic dynamics and its traces in quantum mechanics. Semiclassical quantization, WKB method; Gutzwiller-trace formula; Spectral statistics, Loschmidt-echo.

Theory of Relativity

**BMETE15AF38 – 0/0/0/v/2**

Dr. Péter Pál Lévay


COMPUTER PROGRAMMING

Computer Controlled Measurements

**BMETE11AF37 – 0/0/2/f/2**

Dr. András Halbritter

The participants gain experience in computer controlled measurements and in the programming of scientific instruments and data acquisition system. To this end the following topics are covered: communication with the instruments via serial, GPIB, and USB ports. Programming of data acquisition cards. Programming of complex measurement control platforms, plotting and saving the data, programming of time-lines, in situ data analysis. The course consists of 4 hour long computer laboratory exercises every second week. In the first part of the semester fundamental programming skills are obtained through simple example programs. In the second part the participants individually program complex measurement control and data analysis platforms, like nonlinear curve fitting by Monte Carlo method, full computer control of a digital multimeter, digital oscilloscope program using a data acquisition card.

The Fundamentals and Applications of Finite Element Modeling

**BMETE12AF24 – 0/0/2/f/2**

Dr. Szabolcs Beleznai

Summary of theoretical and practical aspects of the finite element method to solve practical physical problems. The most important subjects are: numerical solution of the most common physical problems described by ordinary and partial differential equations: Poisson-Laplace equation, Heat transfer, Particle convection, Diffusion, Helmholtz equation, Wave equation, Eigenvalue problems, Complex problems.

Computer Solution of Technical and Physical Problems

**BMETE11AF36 – 0/0/2/f/2**

Dr. Gábor Varga

In the frame of this course several areas of technical and physical problems (one and many particle problems, Poisson equation, fluid flow, sheet deformation, heat transport, wave equation, Schrödinger equation) are investigated. Investigated problems can be described by ordinary or partial differential equations. For every problem computer program is written. During the computer implementation not only the physical models but the needed numerical methods are analysed. MATLAB program language is applied as a programming tool. The course is complemented at beginning of the semester with optional MATLAB training.

Monte Carlo Methods

**BMETE80AF26 – 2/1/0/f/3**

Dr. Sándor Fehér

OPTICS

Spectroscopy
BMETE12AF28 – 2/0/0/v/2
Dr. Sándor Lenk

Laser Technique
BMETE12AF07 – 2/0/0/f/2
Dr. Ferenc Ujhelyi

Microscopy
BMETE12AF09 – 2/0/0/f/2
Dr. Pál Maák

Foundations of Biophysics
BMETE12AF10 – 2/0/0/f/2
Dr. Attila Barócsi
The aim of the course is to familiarize students with the fundamental physical properties that govern biological (living) systems having higher complexity to inert physical systems and illustrate the physical modelling of such biological systems. Unlike medical courses, the present one aims at providing extensive biological information to the topics of physics with the prerequisite that students are familiar with the basics of classical and modern physics. Detailed topics: Biological basics of biophysics (criteria of life, the cell, descriptive genetics). Material structure and its relation to function (bond types, the water, biological macromolecules, molecular basics of the genetic code). Interaction of biophysical systems with radiation (light absorption in macromolecules, biological impact of optical and X-ray radiations, radiobiology). Thermodynamics of biological processes (thermal homeostasis, irreversible thermodynamics, cellular respiration and photosynthesis). Metabolism and transport (transport phenomena, drift, diffusion and osmosis). Biological membranes (ion transport, electric phenomena, stimulated processes, propagation of stimulus, the patch-clamp measuring technique). Biophysics of sensory organs (receptors): vision and hearing. Collective phenomena (traffic-like motion, ASEP models, fundamental mechanisms of molecular motors).

Fundamentals and Applications of Materials Science
BMETE12AF25 – 2/0/0/f/2
Dr. Ferenc Réti

Microtechnology and Nanotechnology
BMETE12AF08 – 2/0/0/f/2
Dr. Gábor Kiss

Nuclear Technology

Nuclear Physics

BMETE80MD00 – 3/1/0/v/5
Dr. Csaba Sükösd

Nuclear Measurement Techniques

BMETE80MD01 – 1/1/0/v/3
Dr. Imre Szalóki

Nuclear Safety

BMETE80MD05 – 2/0/0/v/2
Dr. Szabolcs Csífius

Radioactive Waste Management

BMETE80MD07 – 2/0/0/v/2
Dr. Péter Zagyvai

Plasma Physics

BMETE80MD02 – 3/1/0/v/4
Dr. Gergő Pokol
Description of BSc Subjects in Mathematics

Basics of Mathematics
BMETE91AM35 – 2/0/0/v/3
Dr. Miklós Ferenczi

Calculus 1
BMETE92AM36 – 6/2/0/v/9
Dr. Miklós Horváth

Introduction to Algebra 1
BMETE91AM36 – 6/2/0/v/9
Dr. Erzsébet Horváth

Introduction to Geometry
BMETE94AM17 – 2/0/0/v/3
Dr. Jenő Szirmai
Euclid’s Axioms and Postulates, Hilbert’s axioms, points, straight lines, planes, distances, angles etc. Euclidean plane: Geometric transformations, synthetically. Vector geometry, linearly dependent, linearly independent vectors, scalar and cross product, Cartesian coordinate system, Lagrange-Jacobi identities. Coordinate geometry, analytic description of planes and straight lines, distances, angles, etc. Euclidean space: Geometric transformations (congruences), analytically. Homogeneous coordinates, uniform treatment of geometric transformations. Affinities, similarities. Spherical geometry: geodesic curves, angles, angle-sum formula for spherical triangles, spherical trigonometry. Definition of polyhedra, Euler theorem. Special polyhedra: convex, regular polyhedra, Archimedean solids, Catalan solids etc. Cauchy’s rigidity theorem, and other interesting polyhedra.

Informatics 1
BMETE91AM42 – 1/0/2/f/4
Dr. Ferenc Wettl
The aim of the course is to study the basic notions of information technology. Basics of hardware (CPU, memory, mass storage, ...), the hardware environment of the Institute. Basics of operating systems: program, process, file, folder, file system of Linux and Windows (bash, mc, Windows Total Commander). Graphic user interface, terminal user interface, bash language. Internet, network, IP address, wifi, Internet security. Data on machine: number representation, character encodings. Computer algebra, symbolic calculation (Sage, Mathematica, ...), variable, recursion instead of iterative programming, deepening the secondary school function concept (factorial, Fibonacci sequence, Euclidean algorithm, exponentiation, quick exponentiation....). Programming paradigms in computer algebra languages. HTML, the markup language concept, homepage. CSS, separation of the content and presentation. Editing mathematical text: TeX, LaTeX, mathematics on the web. Presentation of math (beamer). Basic concepts of graphic file formats, graphics in mathematical text (TikZ).
Calculus 2

Dr. József Pitrik

Introduction to Algebra 2

Dr. Alex Küronya

Combinatorics and Graph Theory 1

Dr. Tamás Fleiner

Geometry

Dr. Ákos G. Horváth
Axiomatic methods, introduction to the absolute geometry, hyperbolic, spherical and projective planes. n-dimensional Euclidean geometry, convex polytopes, regular polytopes. n-dimensional classification of surfaces of second-order.

Informatics 2

Dr. Ferenc Wettl

Physics 1 for Mathematicians

Dr. László Udvardi
Analysis 1

Class No: BMETE92AM38 – 4/1/0/v/7

Dr. Attila Andai


Algebra 1

Class No: BMETE91AM38 – 4/1/0/v/7

Dr. Alex Küronya


Probability Theory 1

Class No: BMETE95AM29 – 2/2/0/v/6

Dr. Péter Bálint


Programming Exercises for Probability Theory

Class No: BMETE91AM46 – 0/0/0/1/1

Dr. Ferenc Wettl

The aim of the course is to maintain the students’ programming skills through programming problems associated with the topics of Probability Theory course helping the understanding of the basic concepts of probability simulations of random events at the same time.

Differential Equations 1

Class No: BMETE93AM15 – 2/2/0/v/6

Dr. Katalin Nagy

Lower bound for the number of comparisons. Other sorting methods: counting sort, bin sort, radix sort. Linear and binary search. The binary search is optimal in the number of comparisons. Notion of search tree, their properties and analysis. Red-black tree as a balanced search tree. The 2-3 tree, and its generalization, the B tree. Comparisons of the different data structures.

Programming Exercises for Theory of Algorithms

BMETE91AM47 – 0/0/0/1/1
Dr. Ferenc Wettl

The aim of the course is to maintain the students’ programming skills through programming problems associated with the topics of Algorithm Theory course helping the understanding of the basic concepts of algorithms.

Algebra 2

BMETE91AM39 – 4/0/0/4/4
Dr. Erzsébet Lukács

Field extensions, construction and uniqueness of simple algebraic extensions, finite and algebraic extensions. Normal extensions, splitting field, separable extension, finite fields, Wedderburn’s theorem, Galois group, irreducibility of the cyclotomic polynomials, Galois groups of radical extensions, Galois correspondence, fundamental theorem of Galois theory. Applications of Galois theory: fundamental theorem of algebra, ruler and compass constructions, solvability of equations by radicals, Abel–Ruffini theorem. Existence and uniqueness of algebraic closure, transcendental extensions, transcendence of e, Gelfand-Schneider theorem. Review of the basic concepts of number theory, Euler \( \phi \) function. Linear congruences and systems of congruences, binomial congruences of higher degree, discrete logarithm, congruences of prime power moduli. Quadratic congruences, Legendre and Jacobi symbol, quadratic reciprocity. Prime numbers: Euclid’s theorem, gaps between primes, Chebyshev’s theorem, harmonic series of primes, Dirichlet’s theorem for \( (nk+1) \). Arithmetic functions: \( \omega(n) \), \( \sigma(n) \), \( \varphi(n) \). Multiplicativity, convolution, Möbius function, the Möbius inversion formula. Prime number theorem, magnitude of the \( n \)th prime, prime tests, Rabin–Miller test, RSA function. Diophantine equations: linear diophantine equations, Pythagorean triples, Fermat’s two squares theorem, Gaussian integers.

Optimization Models

BMETE93AM16 – 2/0/2/4/4
Dr. Boglárka Gazdag-Tóth


Stochastic Processes

BMETE95AM41 – 5/0/0/6/6
Dr. Károly Simon


Creating Mathematical Models

BMETE95AM12 – 0/2/0/1/2
Dr. Domokos Szász

The aim of the seminar to present case studies on results, methods and problems from applied mathematics for promoting. The spreading of knowledge and culture of applied mathematics. The development of the connections and cooperation of students and professors of the Mathematical Institute, on the one hand, and of personal, researchers of other departments of the university or of other firms, interested in the applications of mathematics. The speakers talk about problems arising in their work. They are either applied mathematicians or non-mathematicians, during whose work the mathematical problems arise. An additional aim of this course to make it possible for interested students to get involved in the works presented for also promoting their long-range carrier by building contacts that can lead for finding appropriate jobs after finishing the university.

Micro- and Macroeconomics

BMETE93AMxx – 2/0/2/4/4
Dr. Tamás Tasnádi

Usage of MATLAB (all discussed numerical methods will be introduced and tested in MATLAB ). The discussed topics are: error calculation, direct and iterative solution of linear systems of equations: Gauss elimination, Gauss transform factorizations of matrices, conditionality of linear systems of equations, Jacobi, Seidel and SOR iteration; convergence of the iteration, error estimation, optimization type methods for solving linear systems of equations, estimation of the eigenvalue, power method for the eigenvalue, eigenvector problem of matrices, inverse power method, transforming matrices to special forms, Jacobi method for determining eigenvalues and eigenvectors, QR method for determining eigenvalues, simple interpolation with polynomials, Hermite interpolation, interpolation with third degree spline, approximation according to least squares with polynomials and trigonometric polynomials, trigonometric interpolation, basics of fast Fourier transform, numerical integration,
Newton-Cotes formula and its usage, Gaussian quadrature, solution of non-linear systems of equations, roots of polynomials, numerical solution to the initial value problems of ordinary differential equations, basic terms of one step methods, Runge-Kutta methods, stability, convergence and error estimation of one step methods, multi-step methods.

**Differential Geometry 2**

**BMETE94AM20 – 3/1/0/0/v/4**

Dr. Szilárd Szabó


**BSc Thesis Project**

**BMETE90AM47 – 0/0/10/10**

Dr. Miklós Horváth

This course is for graduate students to prepare their graduate thesis in which they prove that they can use the acquired knowledge independently and creatively.

**Tools of Modern Probability Theory**

**BMETE95AM33 – 4/0/0/v/4**

Dr. Imre Tóth


**Measure Theory**

**BMETE92AM42 – 4/0/0/v/4**

Dr. Miklós Horváth


**Individual Research Project 1, 2**

**BMETE90AM48, 49 – 0/0/0/v/4**

Dr. Miklós Horváth

Under the guidance of a chosen tutor, the student works on understanding a paper or a book chapter about contemporary mathematics. The goal is to get familiar with basic methods and abilities of research like exact understanding of mathematics in English, use of libraries and of the net etc. At the end of the semester the student makes a written English summary in a few pages and gives a short presentation in a seminar talk.

**Partial Differential Equations**

**BMETE92AM45 – 2/2/0/v/4**

Dr. János Karátson


**Convex Geometry**

**BMETE94AM22 – 2/2/0/v/4**

Dr. Zsolt Lángi

Introduction: affine and convex sets, affine dependence, independence, affine and convex combinations, affine hull, isolation theorem, characterization of closed, convex sets as the intersection of closed half spaces. Convex hull, theorems of Radon, Helly and Carathéodory, their applications. Linear functionals and their connection with hyperplanes, Minkowski sum, separation of convex sets with hyperplanes, supporting hyperplanes, faces of a convex body, extremal and exposed points, theorems of Krein-Milman and Straszewicz. Indicator function, algebras of closed/compact convex sets, valuations, Euler characteristic and

**Combinatorics and Graph Theory 2**

**Dr. Tamás Fleiner**

BASIC COURSES

Fundamentals of Photonics

BMETE12MF49 – 2/1/0v/4

Dr. Attila Barócsi


Nuclear Physics

BMETE80MF00 – 3/0/0v/4

Dr. Dániel Péter Kis

This course describes the main chapters of the low-energy nuclear physics building on the experimental nuclear physics knowledge gained while earning a BSc degree in Physics. The following topics are discussed: measurement and systematics of the most important parameters of nuclei in ground state, nuclear models, nuclear forces, nuclear reactions, theoretical description of nuclear decay modes, nuclear fission, nuclear fusion and its use for energy production, nuclear cosmology, nuclear astrophysics.

Nanotechnology and Materials Science

BMETE11MF36 – 3/0/0v/4

Dr. Szabolcs Csonka

This course gives an introduction to state-of-the-art fabrication and measurement techniques of nanotechnology and material science by explaining examples of recent research results. Main topics: Concept of nanotechnology, characteristic length scales, and surprising behaviors observed at the nanoscale. Imaging tools for nano: scanning probe microscopy, electron microscopy. Fabrication of nanostructures by top-down approaches: lithography, layer deposition and special nanofabrication techniques. Fabrication of nanostructures with bottom-up methods: self-assembly. Silicium technology, semiconductor heterostructures, 2D electron gases. Important applications from the field of optics and electronics. New concepts in electronics: spintronics, memristors, molecular electronics and quantum electronics. Mapping the structure of matter by scattering experiments. Optical spectroscopy methods to study electric and vibrational properties of matter. Surface characterization methods. Modern classes of matter (carbon nanostructures, multifunctional materials, 2D crystals, etc.) and their applications.

Particle Physics

BMETE15MF43 – 2/1/0v/4

Dr. Gábor Takács


Statistical Physics 2

BMETE15MF44 – 2/1/0v/4

Dr. Gergely Zaránd


Computer Simulation in Physics

BMETE15MF45 – 2/1/0f/4

Dr. János Török

The course is based on the statistical physics and programming skills learned in the BSc programme gives insight into basic simulation techniques of physics. Main topics: Monte Carlo method (pseudo random numbers, importance sampling, Metropolis algorithm, boundary conditions, ensembles, averages, characteristic time), Phase transitions (finite-size scaling, critical slowing down, optimizations, quantum spin chain), Discrete models (percolation, lattice models, noise, instability), Schrödinger equation (Lánčzos method), molecular dynamics (interactions, solvers, event driven MD), instabilities. Networks and applications (clustering, page rank). Algorithmically defined models (self-organized criticality, game models, Nash-equilibrium).
Investments

BMET13M004 – 2/0/0/f2/5
Dr. Mihály Örmös

Applied Numerical Methods with MATLAB

BMET92Mxx – 4/0/2/i/6
Dr. Róbert Horváth
Usage of MATLAB (all discussed numerical methods will be introduced and tested in MATLAB) The discussed topics are: error calculation, direct and iterative solution of linear systems of equations: Gauss elimination, Gauss transform factorizations of matrices, conditionality of linear systems of equations, Jacobi, Seidel and SOR iteration; convergence of the iteration, error estimation, optimization type methods for solving linear systems of equations, estimation of the eigenvalue, power method for the eigenvalue, eigenvector problem of matrices, inverse power method, transforming matrices to special forms, Jacobi method for determining eigenvalues and eigenvectors, QR method for determining eigenvalues, simple interpolation with polynomials, Hermite interpolation, interpolation with third degree spline, approximation according to least squares with polynomials and trigonometric polynomials, trigonometric interpolation, basics of fast Fourier transform, numerical integration, Newton-Cotes formula and its usage, Gaussian quadrature, solution of non linear systems of equations, roots of polynomials, numerical solution to the initial value problems of ordinary differential equations, basic terms of one step methods, Runge-Kutta methods, stability, convergence and error estimation of one step methods, multi step methods.

ADVANCED GENERAL COURSES

Group Theory for Physicists

BMET11AF40 – 2/0/0/v/5
Dr. Titusz Fehér
The aim of the course is to introduce the principles of group theory to physics students: we learn how the symmetries of a system can be used to describe it, and how the symmetries of nature manifest themselves in laws of physics. We apply the concepts of group and representation theory to practical problems. Theory: Symmetries in nature and physics. Definition and basic properties of groups. Some special groups. Homomorphism, isomorphism. Subgroups, cosets, Lagrange’s theorem. Normal subgroup, quotient group, first isomorphism theorem. Conjugate, conjugacy classes, centralizer. Group action, orbit, stabilizer. Representations and their properties, equivalent representations, irreducible representations. Schur's lemma. Character of representations, properties of characters, character tables. Direct sum of representations and their reduction. Product representations. Lie groups, infinitesimal generators, Lie algebras. Topological properties, universal covering group. Rotation group and its representations. Lorentz group and other matrix groups. Calculations: Description of normal modes, crystals, and quantum mechanical wave functions using group theory. Selection rules.

Electrodynamics 2

BMET15AF34, 42 – 2/2/0/fv/5
Dr. Gábor Takács

Quantum Mechanics 2

BMET15AF36, 43 – 2/2/0/fv/5
Dr. László Szunyogh
This course conveys advanced knowledge on Quantum Mechanics according to the following topics: The WKB approach, quasi-classical quantization. Scattering theory, scattering amplitude and cross section, Green functions, Lippmann-Schwinger equation, Born series, method of partial waves. Motion in electromagnetic field, Aharonov-Bohm effect, Landau levels. Time evolution and pictures in Quantum Mechanics (Schrödinger, Heisenberg and Dirac pictures). Adiabatic motion and Berry phase. Relativistic Quantum Mechanics, Klein-Gordon equation, Dirac equation, continuity equation, Lorentz invariance, spin and total angular momentum. Free electron and positron. Non-relativistic limit, spin-orbit interaction.

Mechanics 2

BMET15AF32, 44 – 2/2/0/fv/5
Dr. Gergely Zaránd

Computer Solution of Technical and Physical Problems

BMET11AF41 – 0/2/0/i/3
Dr. Gábor Varga
In the frame of this subject basic models of different technical and physical applications are investigated (among others: one and many body problems, Poisson equation, flow dynamics, plate deformation, heat conductivity, wave equation, Schrödinger equation). Relating to these problems on computer implemented MATLAB programs are written.
During the computer implementation not only the physical aspects of the models are analyzed but the required numerical methods too. The programming tool is the MATLAB program language.

**Theory of Relativity**

**BMETE15AF46 – 2/0/0/v/3**

*Dr. Péter Lévay*


**Fundamentals and Applications of Materials Science**

**BMETE12AF31 – 2/0/0/v/3**

*Dr. Ferenc Réti*


**Microtechnology and Nanotechnology**

**BMETE12AF33 – 2/0/0/f/3**

*Dr. Gábor Kiss*


**Computer Controlled Measurements**

**BMETE11AF38 – 0/0/2/f/3**

*Dr. András Halbritter*

The participants gain experience in computer controlled measurements and in the programming of scientific instruments and data acquisition system. To this end the following topics are covered: communication with the instruments via serial, GPIB, and USB ports. Programming of data acquisition cards. Programming of complex measurement control platforms, plotting and saving the data, programming of timelines, in situ data analysis. The course consists of 4 hour long computer laboratory exercises every second week. In the first part of the semester fundamental programming skills are obtained through simple example programs. In the second part the participants individually program complex measurement control and data analysis platforms, like nonlinear curve fitting by Monte Carlo method, full computer control of a digital multimeter, digital oscilloscope program using a data acquisition card.

**Quantum Physics**

**Quantum Field Theory**

**BMETE15MF46 – 3/2/0/v/6**

*Dr. Gábor Takács*


**Quantum Information Processing**

**BMETE11MF42 – 2/0/0/v/3**

*Dr. András Pályi*


**Quantum Optics**

**BMETE15MF49 – 2/1/0/v/4**

*Dr. Gábor Takács*

Many-Body Physics 1
BMETE15MF50 – 3/1/0/v/5
Dr. Gergely Zaránd
This course is the first and independent part of a two-semester many-body course. It gives an introduction to the basic machinery of field theoretical Green’s function methods applied for interacting solid state physics systems at $T = 0$ temperature, and demonstrates its power through applications for some simple cases. Although this is a basic course required for several advanced theoretical courses (The physics of one-dimensional systems, Many-body physics II, Localization theory, etc.), students taking this course must have a BSc level knowledge of quantum mechanics and statistical physics. The course focuses on the following topics: second quantized formalism, Green’s functions and their connection to measurable quantities, Heisenberg-, Schrödinger-, and interaction picture, perturbation theory, diagram technique (Wick theorem, Feynman diagrams), resummation techniques (self-energy, Dyson equation, vertex function, skeleton diagrams), equation of motion methods.

Many-Body Physics 2
BMETE15MF54 – 2/0/0/v/3
Dr. Gergely Zaránd
This course is the second part of a two-semester many-body course. It gives an introduction to the finite temperature Green’s function method applied for interacting solid state physics systems. This technology is one of the standard tools used in modern solid state physics. The course focuses on the following topics: Matsubara Green’s functions (analytical properties, spectral functions, etc.), imaginary time perturbation theory, diagram technique (Wick theorem, self-energy, vertex function, skeleton diagrams), applications (quantum transport, polarons, Peierls instability, Hartree-Fock method, RPA).

Quantum Monte Carlo Methods
BMETE15MF40 – 2/0/0/v/3
Dr. Csaba Tóke
The course provides an introduction to the stochastic modeling of interacting quantum-mechanical many-particle systems, which became popular due to the immense growth of computing power since the late 1970’s. We review the basic algorithms: the variational Monte Carlo method (VMC), the diffusion Monte Carlo method (DMC), the path-integral Monte Carlo method (PIMC), and possibly the Green’s function Monte Carlo method (GFMC), the Hirsch-Fye algorithm, and the continuous time quantum Monte Carlo method, as well as the range of problems that can be analyzed by these techniques, the major fields where Monte Carlo methods are indispensable, and have proven very successful (the interacting electron gas, liquid an superfluid Helium, the phase diagram of hydrogen, quantum chemistry, and nanostructures). After completing the course the students should be prepared to implement their own quantum Monte Carlo codes, thereby analyze interacting quantum-mechanical problems by stochastic methods.

Statistical Field Theory
BMETE15MF39 – 2/0/0/v/3
Dr. Gábor Takács

The Physics of One-Dimensional Systems
BMETE15MF05 – 2/0/0/v/3
Dr. Gergely Zaránd
This course gives a basic introduction to the physics and theoretical description of interacting one-dimensional electron and spin systems. One-dimensional systems display basic phenomena such as charge- and spin density wave formation, antiferromagnetism and exotic superconductivity, and are fundamental test-grounds for solid state physicists, since powerful field theoretical approaches can be used for them. Moreover, they are often realized in physical systems such as carbon nanotubes, quasi one-dimensional systems, or edge states. The course assumes the knowledge of basic Green’s function methods (Many body physics I), and is organized along the following topics: one-dimensional systems in nature (the Hubbard model, instabilities within the random phase approximation, spin and charge density waves, mapping to the Heisenberg model), basic properties of spin chains (Haldene’s conjecture, spin coherent states, spin liquids, the basics of Bethe Ansatz), the continuum limit (renormalization group and the Tomonaga-Luttinger model), bosonization (spin-charge separation, the Luttinger liquid phase), effects of disorder.

SOLID STATE PHYSICS

Modern Solid State Physics
BMETE11MF41 – 3/2/0/v/6
Dr. Attila Virosztek
This course describes the behavior of interacting many body systems (mainly electron systems) building on solid state physics and statistical physics knowledge gained while earning a BSc degree in Physics. The following topics are discussed: identical particles, second quantization, interacting electron systems in Bloch and Wannier representation, itinerant ferromagnetism, linear response theory, susceptibility of metals, spin density waves, Bose liquid.

Group Theory in Solid State Research
BMETE11MF12 – 2/0/0/v/3
Dr. György Kríza
Point groups, fundamental theorems on finite groups, representations, character tables. Optical spectroscopy: selection rules, direct product representations, factor group. Electronic transitions: crystal field theory, SO(3) and SU(2) groups, correlation diagrams, crystal double groups. Symmetry of

**Superconductivity**

BMETE11MF45 – 2/0/0/v/3

Dr. György Kríza


**Theory of Magnetism**

BMETE11MF44 – 2/1/0/v/4

Dr. Attila Virosztek

Magnetic phenomena are considered as electron correlation effects. The Hubbard model is used to interpret the Mott metal-insulator transition. A variational theory is given which allows the understanding of heavy fermion behavior. The antiferromagnetic: Heisenberg model is introduced as the effective hamiltonian of the large-U Hubbard model at half filling. Other kinetic exchange processes, including ring exchange with application to the magnetism of solid He3, are discussed. A detailed treatment of the two-site Coulomb processes allows the introduction of direct exchange. The survey of various mean field theories of magnetic order begins with the Stoner theory. Weak itinerant ferromagnets like ZrZn2 and MnSi are discussed in some detail.

**Theory of Magnetism 2**

BMETE11MF14 – 2/0/0/v/3

Dr. Attila Virosztek

The basic concepts and results from the first part of the course are assumed to be familiar. The variety of magnetic ordering phenomena is surveyed, the conditions of ordering, and the nature of the excited states over ordered ground states are discussed in various theoretical frameworks. The concept of the quantum critical point is used for rare earth systems with non-fermi-liquid behavior. Localized-spin order and spin wave theory is described both for ferromagnets and antiferromagnets. A detailed discussion of quantum fluctuations in the ground state is given, including recent results on the possibility of spin liquid ground states. A particular kind of magnetic cooperative behavior is shown to give rise to the integer and the fractional quantum Hall effect.

**Magnetic Resonance**

BMETE11MF43 – 2/1/0/v/4

Dr. Titusz Fehér

The course discusses one of the most important investigation methods in physics, chemistry and medical sciences. It is based on the electrodynamics and quantum mechanics studies required for the BSc degree. Topics include experimental methods of electron and nuclear magnetic resonance, Bloch equations, dipole-dipole interaction, motional narrowing, crystal fields and fine structure, hyperfine splitting, chemical shift, magnetic resonance in metals, superconductors and magnetically ordered materials.

**Theoretical Nanophysics**

BMETE15MF47 – 2/1/0/v/4

Dr. Gergely Zaránd

Mesoscopic and nanoscale systems represent one of the most intensely studied fields in modern solid state physics: by means of lithographic methods one can engineer semiconducting, metallic and superconducting devices, in which conduction electrons move coherently and quantum mechanics is at work, and can contact and manipulate molecules or nanoscale grains, and couple them to microresonators. The goal of this course is to survey theoretical tools that can be used to describe the physics of these nanoscale devices. The course assumes a solid knowledge of quantum mechanics, solid state physics and statistical physics, and focuses on the following topics: description of small grains (Coulomb interaction, coherence, single particle levels), basics of random matrix theory (level repulsion, universality classes), Coulomb blockade and spectroscopy (master equations, co-tunneling, Kondo effect), conductance and noise spectrum of point contacts, nanotubes and edge states, molecular transport, superconducting grains, Josephson-junctions and quantum bits, quantum spin manipulation. Solving problem sets in an integral part of this course. (Students are offered regular consultation.)

**Electronic Structure of Solid Matter**

BMETE15MF51 – 2/1/0/v/4

Dr. László Szunyogh

Building on the quantum mechanics and solid state physics studies within the Physics BSc program, this course aims to discuss modern theories and methods for the electronic structure of solid matter. The following topics will be outlined: Foundations of the static density functional theory. Variational and pseudopotential methods. Ab initio methods for correlated systems (LDA+U, self-interaction correction, DMFT). Point group symmetry in electronic states. Spin-orbit coupling and time-reversal symmetry. Surface states, the Bychkov-Rashba effect. Green's function technique within the tight-binding approximation. Alloy theory, the coherent potential approximation. Ab initio theory of metallic (itinerant) magnetism, the Stoner model. The method of disordered local moments.

**Foundations of Density Functional Theory**

BMETE15MF15 – 2/0/0/v/3

Dr. János Pípek

### Topological Insulators

**BMETE11MF34 – 2/0/0/v/3**  
Dr. András Pályi  
An important finding of the previous decade is that even the (non-interacting) band theory of electrons in solids can provide fundamental novelties. Topological insulators are crystalline band-insulator materials accomodating conducting – occasionally perfectly conducting – surface states. In this lecture series we use simple models to introduce the topological invariants that are important in band theory, we provide theoretical tools to calculate those, and show how topology protects the surface states from certain perturbations. We provide insight into the general theory of topological insulators, and review a few related experimental arrangements and results. Topics: One-dimensional crystals with chiral symmetry: the Su-Schrieffer-Heeger model, Adiabatic dynamics in quantum mechanics, Berry phase, Chern number. Adiabatic charge pumping in a one-dimensional crystal. Quantum Anomalous Hall effect: the Qi-Wu-Zhang model. Two-dimensional time-reversal-invariant topological insulators: the Bernevig-Hughes-Zhang model. Quantized conductance of two-dimensional topological insulators.

### Topological Insulators 2

**BMETE11MF35 – 2/0/0/v/3**  
Dr. András Pályi  
Based on the material covered in "Topological insulators", in this course we discuss how to store and process quantum information in topological superconductors. Regarding single-particle excitations, superconductors can be regarded as band insulators in the Bogoliubov-de Gennes formalism. Under certain conditions, a superconductor can be topologically nontrivial. Such one- and two-dimensional materials can support topologically protected zero-energy bound states, called Majorana fermions. We review the theoretical and experimental status of these bound states, and the basis of utilizing those for storing and processing quantum information. We also give an outlook on strongly correlated, topologically ordered models. Topics: Superconductivity and the Bogoliubov-de Gennes formalism. Topological superconductivity in one dimension: Kitaev wire, Majorana modes and bulk-boundary correspondence. Electronic transport in topological superconductors: tunneling spectroscopy and the Josephson effect. Experimental realization of topological superconductors. Topological superconductivity in two dimensions: p+ip superconductors, bound states in vortices. Majorana modes and topological quantum information processing. Topological order: Kitaev’s toric code and honeycomb models.

### Phase Transitions and Criticality

**BMETE15MF48 – 2/1/0/v/4**  
Dr. Gergely Zaránd  

### Complex Networks

**BMETE15MF38 – 2/0/0/v/3**  
Dr. János Kertész  

### The Physics of Disordered Systems

**BMETE15MF53 – 2/1/0/v/4**  
Dr. Gergely Zaránd  

### Random Matrix Theory and Its Physical Applications

**BMETE15MF10 – 2/0/0/v/3**  
Dr. Imre Varga  
Random matrix theory provides an insight of how one can achieve information relatively simply about systems having very complex behavior. The subject based on the knowledge acquired in quantum mechanics and statistical physics together with some knowledge of probability theory provides an overview of random matrix theory. The Dyson ensembles are defined with their numerous characteristics, e.g. the spacing distribution, the two-level correlation function and other quantities derived thereof. Then the thermo-
dynamic model of levels is obtained together with several models of transition problems using level dynamics. Among the physical applications the universality classes are identified in relation to classically integrable and chaotic systems. The problem of decoherence is studied as well. Then the universal conductance fluctuations in quasi-one-dimensional disordered conductors are investigated. Other models are investigated: the disorder driven Anderson transition and the random interaction model of quantum dot conductance in the Coulomb-blockade regime. We use random matrix models to investigate chirality in two-dimensional and Dirac systems and the normal-superconductor interface. The remaining time we cover problems that do not belong to strictly physical systems: EEG signal analysis, covariance in the stock share prize fluctuations, mass transport fluctuations, etc.

**Classical and Quantum Chaos**

**BMETE15AF45 – 2/0/0/v/3**

*Dr. Imre Varga*

Hamiltonian formalism, integrability in general, examples in physics for chaotic behavior in case of continuous and discrete dynamics; Continuous, non-autonomous differential equations; Anharmonic, dissipative oscillator; Mappings, Poincare-mapping; Periodically excited systems; Billiards. For some of these cases: application of techniques introduced for the analysis of chaos: Lyapunov exponent, invariant measures; Frobenius-Perron equation. Stability analysis; Bifurcations, attractors, strange attractors; Kolmogorov-entropy; KAM-theorem; Chaotic dynamics and its traces in quantum mechanics. Semi-classical quantization, WKB method; Gutzwiller-trace formula; Spectral statistics, Loschmidt-echo.

**NANOTECHNOLOGY AND MATERIALS SCIENCE**

**Fundamentals of Nanophysics**

**BMETE11MF37 – 3/0/0/v/4**

*Dr. András Hallbritter*

The building blocks of nowadays electronic devices have already reached a few tens on nanometers sizes, and further miniaturization requires the introduction of novel technologies. At such small length-scales the coherent behavior and the interaction of electrons, together with the atomic granularity of matter induce several striking phenomena, that are not observed at the macroscopic scale. The course gives an introduction to a broad set of nanoscale phenomena following the topics bellow: Characteristic length-scales in nanophysics. Development of semiconductor industry, heterostructures, two dimensional electron gas systems, nanoscale fabrication techniques. Diffusive and ballistic nanowires, quantum wires, Landauer description of mesoscopic transport, conductance quantization. Interference phenomena in nanocircuits, decoherence. Integer and fractional quantized Hall effect. Noise as the signal: shot noise in quantum point contacts, charge measurement, classical and quantum chaos, Hanbury Brown & Twiss experiments with electrons and photons. Quantum dots and applications, artificial atoms, spin qubits. Carbon nanostructures, graphene, carbon nanotubes, fullerene. Superconducting nanostructures, Andreev reflection, mesoscopic proximity effects. Spintronics, spin valve, spin torque, spin decoherence, spin injection, nonlocal measurements. Nanoelectromechanical systems.

**Material Science Laboratory**

**BMETE12MF50 – 0/0/3/f/4**

*Dr. Olga Homokíné Kračsik*

The goal of the course is an introduction - in the field of materials science - to material characterization measurement methods and technologies on theoretical level and in practice also. On each laboratories a measurement method, technical conditions of sample preparation and measurement, evaluation and informations obtained from measurements will be introduced. Practical measurement examples and technological informations obtained from the measurement will be demonstrated. Int he lab, as far as possible, the students perform the sub-tasks independently. In some cases the measurements will be connected to a technological lab by a ‘miniproject’, in this way students can get an overview from sample preparation to measurement evaluation in a specialization field of materials science. The chosen methods will be demonstrated by experts in Budapest, on the latest available equipments. Planned measurements: vibrational spectroscopies, infrared spectroscopy, Raman spectroscopy, Electron diffraction, X-ray diffraction, NMR, ESR, Measurements on Semiconductor structures.

**Selected Topics of the Modern Materials Science**

**BMETE12MF52 – 2/0/0/v/3**

*Dr. Ferenc Réti*


**Physics of Semiconductors 1**

**BMETE11MF26 – 2/0/0/v/3**

*Dr. Miklós Csontos*

This course describes the behavior of modern semiconductor physics, – mostly those properties (electrical and optical), which provides understanding of present day electronics –, building on solid state physics and statistical physics knowledge gained while earning a BSc degree in Physics. Emphasize is paid to those new phenomena, which are unique of semiconductor materials and/or structures and provides much help for our understanding of condensed materials. The following topics are discussed: crystal structure and bonding, electron states, effective mass approximation, localized states, statistics of semiconductors,
transport; phenomenological and microscopic, magnetic and high frequency transport, quantum hall Effect, thermal properties, inhomogeneous semiconductors, p-n junction, MOS structures, transport instabilities and Gunn effect, semiconductor lasers and light emitting diodes, principles of different applications: solar cell, optical communication, modern experimental techniques: deep level spectroscopy, lifetime measurements.

Chemistry in Nanotechnology

BMETE11MF38 – 2/0/0/v/3

Dr. István Lagzi


Optical Spectroscopy in Materials Science

BMETE11MF39 – 3/0/0/v/4

Dr. Sándor Bordács

Propagation of electromagnetic waves in isotropic medium, interfaces, complex response functions, Kubo’s formula, Kramers-Kronig relations; spectroscopy of atoms, X-ray emission and absorption spectroscopy; inter- and intraband excitations, excitons, plasmons, color centers; rotational and vibrational transitions, Fourier transform infrared and Raman spectroscopy; time-resolved spectroscopy, pump-probe experiments; near-field microscopy.

OPTICS AND PHOTONICS

Physics of Semiconductors 1

BMETE11MF26 – 2/0/0/v/3

Dr. Miklós Csontos

This course describes the behaviour of modern semiconductor physics, – mostly those properties (electrical and optical), which provides understanding of present day electronics, – building on solid state physics and statistical physics knowledge gained while earning a BSc degree in Physics. Emphasize is paid to those new phenomena, which are unique of semiconductor materials and/or structures and provides much help for our understanding of condensed materials. The following topics are discussed: crystal structure and bonding, electron states, effective mass approximation, localized states, statistics of semiconductors, transport: phenomenological and microscopic, magnetic and high frequency transport, quantum hall Effect, thermal properties, inhomogeneous semiconductors, p-n junction, MOS structures, transport instabilities and Gunn effect, semiconductor lasers and light emitting diodes, principles of different applications: solar cell, optical communication, modern experimental techniques: deep level spectroscopy, lifetime measurements.

Light Sources

BMETE12MF14 – 2/0/0/v/3

Dr. László Kocsányi

The goal of the course is to introduce physicist-, electrical engineer- and chemical engineer students to the science and technology of light sources. The thematic includes the overview of the usual photometric parameters, the survey of the development of lamps from incandescent light sources, through discharge lamps to LEDs, the basic physical processes, and the comparison of the advantages, disadvantages and possible fields of application of different lamp types.

Physical Optics

BMETE12MF37 – 4/0/0/v/5

Dr. Pál Koppa

The objective of the course is the introduction and application of light propagation models for the description of different optical phenomena. Based on the classical electromagnetic wave theory, we discuss the propagation in homogeneous isotropic and anisotropic media, thin films, dielectric waveguides, geometrical optical description and Fresnel-Kirchhoff diffraction theory. The acquired knowledge will be applied for problem solving in the areas of e.g. soliton propagation, slow light or photonic crystals.
Spectroscopy and Structure of Matter

BMETE12MF25 – 2/0/0/v/3

Dr. Péter Richter
This course organizes the knowledge obtained during the BSc training (electrodynamics of media, quantum mechanics, group theory, statistical physics, optics, optical measurement techniques) regarding the use of spectroscopy in materials characterization and structure elucidation. The methods covered are mainly optical techniques (infrared and visible/UV absorption and reflectance spectroscopy, Raman scattering, ellipsometry, optical rotation dispersion, circular dichroism) but other topics, as excitations of inner shells (X-ray and photoelectron spectroscopy, Mössbauer spectroscopy) will also be mentioned. The purpose of the course is to prepare the students to decide which spectroscopic methods to use for a given specific problem, and to be able to basically interpret the results.

Laser Physics

BMETE12MF17 – 2/0/0/v/3

Dr. Pál Maák
Fenomenological, semiclassical (interaction of quantized material with classical electromagnetic field) and quantum theory (interaction of quantized material and field) of continuous wave and pulsed laser oscillation. Properties of laser light. Laser types and laser applications. Problem solving on practices helps to develop a better understanding of the theory.

Optical Metrology

BMETE11MF21 – 2/0/0/v/3

Dr. János Korns
The goal is to present an overview of the methods of optical metrology and present the most recent techniques and results. Topics: Elements of the optical measuring systems. Light sources, detectors, recording materials. Measurement of optical properties of the optical elements. Measurement of angle, length, and flatness by classical methods and using coherent optics. Heterodyne and phase stepping interferometry. Holography and speckle metrology. Digital holography. Application of optical signal processing in speckle metrology. Photo elasticity. Optical fiber sensors. Color measurement, optical metrology based on detection in different colors.

Physical Foundations of Optical Communications

BMETE11MF20 – 2/0/0/v/3

Dr. Zsolt Papp
This course gives an introduction to physics of optical communication building on knowledge of optics gained on a BSc course program in Physics. The following topics will be treated: optics (ray propagation in lenslike media, dispersion, etc.), laser physics (fiber-laser, optical fiber-amplifiers, DFB laser, etc.), nonlinear optics (nonlinear effects, phase-modulation, soliton, etc.), optical fibers – wave guides (optical fibers, modes, dispersion, photonic crystals, couplers, etc.).
an LB LOCA accident in PWR reactors. Severe Accidents –
typical phenomena during SA. International Nuclear Event
Scale (INES) – classification of events. Exercise: group work
for classification. Lessons learned from incidents, accidents.
The Fukushima accident. National and international regula-
tion of nuclear safety. Standards, limits.

**Nuclear Techniques Laboratory**

**BMETE80MD03 – 0/0/4/f/5**

*Dr. Rita Dóczi*

Critical experiment. Measurement of void coefficient. Neutron
activation analysis. Determination of the values and
spatial distribution of thermal neutron flux. Measurement of
delayed neutron parameters. Study of shielding materials.
Measurement of neutron and gamma dose rate. Analysis of
xenon and samarium poisoning on simulator. Measurement
of reactivity coefficients on simulator. Analyses with the
APROS system code. Thermal hydraulics measurements on
the TRATEL device. Particle Image Velocimetry.

**MEDICAL PHYSICS**

**Nuclear Medicine**

**BMETE80MF97 – 2/0/1/v/3**

*Dr. Szabolcs Czifrus*

**Medical Imaging**

**BMETE80MF91 – 3/1/0/v/4**

*Dr. Dávid Légrády*

The lecture focuses on the mathematics of medical imaging
with special attention to tomography. We discuss ba-
sic image property descriptors (contrast, noise, resolution,
Modulation Transfer Function); basic image processing
(smoothing, sharpening, contrast enhancement) and some
more advanced techniques (image recognition with mor-
phology); practical recap of Fourier transform; the 2D
Radon transform and some inversion options (direct Fou-
rier reconstruction, Filtered Backprojection, Inversion with
Riesz-potentials); the 3D Radon and X-ray transforms and
their inversion. Direct algebraic image reconstruction (ART,
pseudoinverse) and stochastic methods like ML-EM will also
be treated for both Emission and Transmission tomography.

**Magnetic Resonance and Clinical
Applications**

**BMETE80MF90 – 2/0/0/v/2**

*Dr. Dávid Légrády*

The lecture focusses on the principles of Magnetic Reso-
nance Imaging. Discussed topics are the mathematics
of spin physics, spin physics, classical approach and the
Bloch-equations, NMR spectroscopy. Imaging principles,
basic pulse sequences (Spin-Echo, Free Induction Decay),
and principles of 3D imaging, 3D imaging artefacts. Hard-
ware elements of MRI scanners, practical, clinical applica-
tions, safety measures. The oral lectures are complemented
by visits to actual MRI scanners.

**Magnetic Resonance and Clinical
Applications 2**

**BMETE80MF75 – 2/0/0/v/3**

*Dr. Dávid Légrády*

Based on the Magnetic Resonance Imaging lecture ad-
vanced mathematics and physics applicable at MRI imag-
ing is presented. Advanced methods are shown for higher
level artefacts and their corrections and advanced applica-
tions. Main topics are chemical shift and corrections (fat,
saturation, SPSP techniques, etc.). Fast Echo Planar Imaging
and artefacts. Steady-state sequences, details of coherent
and incoherent equilibrium. RF and gradient spoiling. Effect
of inhomogeneous RF field, slice profile. Signal to Noise
ratio in terms of imaging parameters, noise statistics in real
and k-space. Parallel imaging: SMASH, GRAPPA, SENSE.
Description of MSc Subjects in Mathematics

**Advanced Linear Algebra**  
**BMETE91MM05 – 2/0/0/v/3**  
Dr. Erzsébet Horváth  

**Algebraic and Arithmetical Algorithms**  
**BMETE91MM08 – 3/1/0/f/5**  
Dr. Attila Nagy  

**Algebraic Number Theory**  
**BMETE91MM07 – 2/0/0/v/3**  
Dr. Ferenc Wettl  
Motivation: Gaussian integers and Lagrange’s theorem; real quadratic fields and the Pell equation. Algebraic numbers, algebraic integers, number fields, trace and norm. Lattices, orders, integral closure, fractional ideals. Dedekind rings, their basic properties, factorization of ideals, factorization in extensions. Introduction to the theory of valuations, valuations in number fields. The log map of Dirichlet, the unit theorem, Pell equations. Minkowski’s theorem for lattices. Norm of ideals, finiteness of the class group. Integers in cyclotomic fields, Fermat’s last theorem for regular prime exponents. The Hasse principle for quadratic forms. A glimpse at class field theory. (3 credits)

**Algorithms and their Complexity**  
**BMEVISZM031 – 3/1/0/f/5**  
Dr. Katalin Friedl  

**Analysis of Economic Time Series**  
**BMGET30M400 – 2/0/0/v/2**  
Dr. Dietmar Meyer  
The course starts with a short introduction, which is followed by the generalization of the already known growth and conjuncture models. We discuss the issues of financing growth, the role of human capital, the dynamics of the budget deficit, endogenous population growth, healthcare economics and renewable resources. It is followed by the problem of the time consistency (both in finance and in budget policy), which – through different expectations – lead to the dynamic game theoretical approaches. This allows us to give the microeconomic background of the discussed macroeconomic events. The course concludes with the discussion of the models of economic evolution. (2 credits)

**Analytic Number Theory**  
**BMETE95MM13 – 2/0/0/f/2**  
Dr. Csaba Sándor  
The aim of the course is to present some of the most important results and methods in this area. Topics included are: Partitions, additive problems, representation functions. The method of generating functions. Average of additive representation functions: Erdős–Fuchs theorem. The density of sequences without 3-term arithmetic progressions. The Hardy–Ramanujan partition theorem. The Waring problem. Dirichlet series. L-series and their zeroes. Proof of prime number theorem. (2 credits)

**Biomathematics**  
**BMETE93MM11 – 2/0/0/f/2**  
Dr. Krisztina Kiss  

**Combinatorial and Discrete Geometry**  
**BMETE94MM02 – 3/1/0/f/5**  
Dr. Zsolt Lángi  

**Combinatorial Optimization**  
**BMEVISZM029 – 3/1/0/v/5**  
Dr. David Szeszler  
Basic concepts of matroid theory (independence, bases, circuits, rank). Dual, minors, direct sum, graphic and cographic matroids. Vector matroids, representability, binary and regular matroids, the theorems of Tutte and Seymour. Sum of matroids, the matroid partition algorithm, complexity of the matroid intersection problem. Polymatroid rank function, Lovász’ theorem on polymatroid matching. Approximation algorithms. Scheduling problems. Applications in engineering: constructing reliable telecommunication networks, disjoint trees, connectivity augmentation, detailed routing of VLSI circuits, solvability of active linear networks, rigidity of bar-and-joint frameworks. (5 credits)
Commutative Algebra and Algebraic Geometry

BMETE91MM01 – 3/1/0/f/5

Dr. Alex Küronya

Closed algebraic sets and their coordinate rings, morphisms, irreducibility and dimension, Hilbert Nullstellensatz, the correspondence between radical ideals and subvarieties of affine space. Monomial orders, Gröbner bases, Buchberger algorithms, computations in polynomial rings. From regular functions to rational maps, local rings, fundamentals of sheaf theory, ringed spaces. Projective space and its subvarieties, homogeneous coordinate ring, morphisms, the image of a projective variety is closed. Geometric constructions: Segre and Veronese embeddings, Grassmann varieties, projection from a point, blow-up. Dimension of affine and projective varieties, hypersurfaces. Smooth varieties, Zariski tangent space, the Jacobian condition. Hilbert function and Hilbert polynomial, examples, computer experiments. Basic notions of rings and modules, chain conditions, free modules, Finitely generated modules, Cayley-Hamilton theorem, Nakayama lemma. Localization and tensor product. Free resolutions of modules, Gröbner theory of modules, computations, Hilbert syzygy theorem. (5 credits)

Control Systems

BMETE93MM07 – 2/0/0/v/3

Dr. Éva Gyurkovics


Differential Geometry and Topology

BMETE94MM00 – 3/1/0/v/5

Dr. Szilárd Szabó

Smooth manifolds, differential forms, exterior derivation, Lie-derivation. Stokes’ theorem, de Rham cohomology, Mayer–Vietoris exact sequence, Poincaré duality, Riemannian manifolds, Levi–Civita connection, curvature tensor, spaces of constant curvature. Geodesics, exponential map, geodesic completeness, the Hopf–Rinow theorem, Jacobi fields, the Cartan–Hadamard theorem, Bonnet’s theorem. (5 credits)

Dynamic Programming in Financial Mathematics

BMETE93MM14 – 2/0/0/v/3

Dr. József Fritz


Dynamical Systems

BMETE93MM02 – 3/1/0/v/5

Dr. Károly Simon


Econometrics

BMETE93MM10 – 0/0/2/f/2

Dr. Zsazett Orlovits


Ergodic Theory and Dynamical Systems

BMETE95AM22 – 2/0/0/f/2

Dr. Domokos Szász


Extreme Value Theory

BMETE95MM16 – 2/0/0/v/3

Dr. Béla Barabás

Financial Processes

**BMETE95MM14 – 2/0/0/f/3**

*Dr. József Fritz*


Fourier Analysis and Function Series

**BMETE92MM00 – 3/1/0/v/5**

*Dr. Miklós Horváth*


Fractals and Geometric Measure Theory

**BMETE95MM06 – 2/0/0/f/3**

*Dr. Károly Simon*


Game Theory

**BMETE93MM09 – 2/0/0/f/3**

*Dr. Tibor Illes*

Introduction into Game theory, especially into its non-cooperative variant. Game theory models such economic, political, military etc. situations where more than one actor optimizes his utility function, whose value also depends on the others’ decisions. By now game theory has become the fundament of economics, which helps modelling monoply, the dynamics of auctions and other problems. The structure of the lectures is as follows: Non-cooperative game theory (Nash-equilibrium, Bayesian equilibrium). Cooperative game theory: Shapley value. Introduction into economet-
Group Theory

Dr. Erzsébet Horváth


Homological Algebra

Dr. Alex Küronya

Basic notions: chain complex, exactness, homology modules, homotopy, long exact sequences, functors, 3x3 lemma, 5-lemma, snake lemma, applications. Multilinear algebra over general rings, hom and tensor product, limits, p-adic numbers, profinite groups, adjoint functors. Derived functors, cohomological delta functors, projective and injective modules, resolutions, Tor and Ext: calculation of Tor for Abelian groups, flatness, Tor and Ext for some important rings, Künneth formulas, universal coefficient theorem, homological dimension, rings with small dimension. Cohomology of groups. Shapiro lemma, Hilbert’s Theorem 90 for finite Galois extensions, the first cohomology group, blow up, restriction, transfer. Spectral sequences: definiton, boundedness, the Lyndon–Hochschild–Serre spectral sequence, application to calculating group cohomology. (2 credits)

Individual Projects 1, 2

Dr. Márta Lángné Lázi

Within the framework of the subject the student is working on an application oriented research subject based on stochastic mathematics lead by an external supervisor. At the end of each semester the student writes a report about his results which will be also presented by him to the other students in a lecture. The activities to be exercised: literature research, modelling, computer aided problem solving, mathematical problem solving. (4 credits)

Insurance Mathematics 2

Dr. Béla Barabás


Introduction to Economic Dynamics

Dr. András Simonovits

The traditionally static economic theory has recently paid more and more attention to modelling dynamic economics. In comparison with physical and chemical systems, here the role of discrete time approach is much more important. The dynamic optimization is not only a technique but for many economists, it is the only valid approach. A further distinguishing feature that the present is determined not only by the past, by via expectations, by the future as well. In addition of the exposition of the necessary mathematical methods, the course stresses the most important economic models: optimal growth and overlapping generations. (5 credits)

Inverse Scattering Problems

Dr. Miklós Horváth

The seeing process, radar, ultrasound-based medical investigations, geological prospecting of the Earth, investigation of interactions between elementary particles are just a few examples of inverse scattering problems. The course aims to present the mathematical background of such problems, on an introductory level. The main topics include: Time dependent description: wave operator, scattering operator, scattering matrix. Time independent description: scattering amplitude, Lippmann-Schwinger equation, Dirichlet-to-Neumann map, Sylvester-Uhlmann theorem. Acoustic and electromagnetic scattering. One- and three-dimensional quantum scattering problems. The many-body problem. (3 credits)

Limit- and Large Deviation Theorems of Probability Theory

Dr. Bálint Tóth

Linear Programming

**BMETE93MM01 – 3/1/0/v/5**

*Dr. Tibor Illes*


Markov Processes and Martingales

**BMETE95MM07 – 3/1/0/v/5**

*Dr. Márton Balázs*


Mathematical Chemistry

**BMETE92MM09 – 2/0/2/v/5**

*Dr. János Tóth*


Mathematical Modelling Seminar 1, 2

**BMETE95MM01, 02 – 2/0/0/f/1**

*Dr. Domokos Szász*

The aim of the seminar to present case studies on results, methods and problems from applied mathematics for promoting, the spreading of knowledge and culture of applied mathematics; the development of the connections and cooperation of students and professors of the Mathematical Institute, on the one hand, and of personal, researchers of other departments of the university or of other firms, interested in the applications of mathematics. The speakers talk about problems arising in their work. They are either applied mathematicians or non-mathematicians, during whose work the mathematical problems arise. An additional aim of this course to make it possible for interested students to get involved in the works presented for also promoting their long-range carrier by building contacts that can lead for finding appropriate jobs after finishing the university. (1 credit)

Mathematical Methods of Classical Mechanics

**BMETE93MM12 – 2/0/0/f/2**

*Dr. Gábor Etesi*


Matrix Analysis

**BMETE92MM03 – 2/0/0/v/3**

*Dr. Dénes Petz*

Vector spaces and linear operators, Hilbert spaces, orthonormal basis, the matrix of a linear operator, matrix norms, self-adjoint and unitary matrices, localization of eigenvalues and singular values, positive definite matrices, tensor product and Hadamard product, Schur theorem and ap-
applications, functional calculus, derivation, the exponential function, Lie-frolicher formula, matrix monotone functions, means of positive matrices, block-matrices, applications to differential equations, matrices with positive entries. (3 credits)

**Multivariate Statistics**

**BMETE95MM15 – 3/0/1/v/5**

*Dr. Marianna Bolla*


**Multivariate Statistics with Applications in Economy**

**BMETE95MM18 – 2/0/0/l/2**

*Dr. Marianna Bolla*


**Non-Euclidean Geometry**

**BMETE94MM03 – 3/1/0/l/5**

*Dr. Ákos G. Horváth*


**Nonlinear Hyperbolic Equations**

**BMETE93MM13 – 2/0/0/v/3**

*Dr. Katalin Nagy*


**Nonlinear Programming**

**BMETE95MM04 – 3/1/0/v/5**

*Dr. Tibor Illés*


**Nonparametric Statistics**

**BMETE95MM20 – 2/0/0/v/3**

*Dr. László Győrfi*


**Numerical Methods 2 – Partial Differential Equations**

**BMETE92MM07 – 2/0/2/v/5**

*Dr. Róbert Horváth*

Operations Research Softwares

**BMETE93MM06 – 0/0/2/f/2**

Dr. Boglárka Gazdag-Tóth

The aim of this course is twofold. On the one hand it aims to advance the student’s routine in programming by coding the basic algorithms of operations research. On the other hand its goal is to give perfection in the use of operations research software. The standard description of linear programming problems, the MPS data structure, and the most important algebraic modelling languages (GAMS, AMPL, AIMMS). Introduction and usage of the most important software packages in linear, integer, non-linear, and stochastic programming (CPLEX, MINOS, SNOPT, LOQO, LGO).

(2 credits)

Partial Differential Equations 2

**BMETE93MM03 – 3/1/0/f/5**

Dr. Márton Kiss


Potential Theory

**BMETE92MM04 – 2/0/0/f/3**

Dr. Ágota G. Horváth


Projective Geometry

**BMETE94MM01 – 2/2/0/f/5**

Dr. Ákos G. Horváth

Perspectivity in the practice, harmonic division, cross-ratios, the projective scale. The addition and multiplication of points on the base of the Desargues’s theorem. The field defined by the above operations. Structures based on incidences. Projective and affine planes. The Galois-type geometries. The n-dimensional spherical space, projective space and affine space. The classifications of collineations and polarities by the normal form of Jordan. The projective geometrical base of the visualization by computer. The central projection of figures of dimension 3 and 4 and its visualization on the monitor. (5 credits)

Representations of Groups and Algebras

**BMETE91MM04 – 3/1/0/f/5**

Dr. Erzsébet Lukács

Group algebra, Maschke’s theorem, Shur’s lemma, Wedderburn-Artin theorem. Characters of finite groups, orthogonality relations, induction, Frobenius reciprocity, Mackey’s theorem.


Representation Theory

**BMETE91MM02 – 3/1/0/f/5**

Dr. Alex Küronya


Statistical Program Packages 2

**BMETE95MM09 – 0/0/2/f/2**

Dr. Csaba Sándor

The goal of the course is to provide an overview of contemporary computer-based methods of statistics with a review of the necessary theoretical background. 1. How to use the SPSS (Statistical Package for Social Sciences) in program mode. Writing user’s macros. Interpretation of the output data and setting the parameter values accordingly. Definition and English nomenclature of the displayed statistics. 2. Introduction to the S+ and R Program Packages and surveying the novel algorithmic models not available in the SPSS (bootstrap, jackknife, ACE). 3. Practical application. Detailed analysis of a concrete data set in S+. (2 credits)

Statistics and Information Theory

**BMETE95MM05 – 3/1/0/f/5**

Dr. Marianna Bolla

Stochastic Analysis and Applications
BMETE95MM04 – 3/1/0/v/5
Dr. Károly Simon

Stochastic Differential Equations
BMETE95MM08 – 3/1/0/v/5
Dr. Bálint Tóth

Stochastic Models
BMETE95MM11 – 2/0/0/f/2
Dr. Márton Balázs

Stochastic Programming
BMETE93MM05 – 3/1/0/v/5
Dr. Tamás Szántai

Theoretical Computer Science
BMETE91MM00 – 3/1/0/f/5
Dr. Miklós Ferenczi
### Theory of Operators

**BMETE92MM05 – 3/1/0/v/5**

Dr. Béla Nagy


### Wavelet Analysis

**BMETE92MM06 – 2/0/0/f/2**

Dr. Ky Nguyen Xuan

A wavelet is a kind of mathematical function used to divide a given function into different frequency components and study each component with a resolution that matches its scale. A wavelet transform is the representation of a function by wavelets. The wavelets are scaled and translated copies (known as “daughter wavelets”) of a finite-length or fast-decaying oscillating waveform (known as the “mother wavelet”). Wavelet transforms have advantages over traditional Fourier transforms for representing functions that have discontinuities and sharp peaks, and for accurately deconstructing and reconstructing finite, non-periodic and/or non-stationary signals. In this course the theoretical background of all that and some applications will be presented as well. (2 credits)
Description of MSc Subjects in Computational and Cognitive Neuroscience

Brain in Trouble
BMETE47MC34 – 2/0/0/f/2
Dr. Mátyás Zimmer

Cognition and Emotion
BMETE47MC26 – 2/0/0/f/3
Dr. Gyula Demeter
The primary objective of the course is to present an overview of current research on basic emotional and cognitive processes and underlying brain function. We strive to illustrate the complex relationships between cognition and emotion by presenting specific examples and clinical cases, and by highlighting the underlying brain circuits. We focus on the major clinical disorders with dysfunctional brain networks. We try to answer questions, such as: Thought or feeling – what is first or sooner? What are the neural and evolutionary determinants of anxiety? How did our emotions and cognitive abilities evolve? – Introduction and examples. The psychology of emotions. Brain and emotion. Brain and cognition. Interactions of cognition and emotion. The development of cognition and emotion. Sleep and emotional information processing. Cognition and emotion after brain damage. Cognition and emotion in psychiatric disorders. (3 credits)

Cognitive Neuropsychiatry
BMETE47MC30 – 2/0/0/f/3
Dr. Szabolcs Kéri

Cognitive Psychology Laboratory
BMETE47MC20 – 0/0/8/v/9
Dr. Ferenc Kemény
The aim of the course is to keep students up-to-date on the most popular paradigms of human psychological research. To introduce the major methodologies and related softwares. The course covers three major issues: Psycholinguistics, Memory and Sleep research. Students learn computer programming (E-prime), with which they will be able to plan and run experiments. Neuroscience methods like EEG and eye-tracking will also be demonstrated. Psycholinguistics: students design and conduct a traditional psycholinguistic experiment, and disseminate results in the format of a course paper. Memory: students plan and conduct an experiment on memory using either behavioural or eye-tracking methodology. Sleep research: students learn the basics of the discipline, with special focus on the overlap of sleep research and cognitive neuroscience, its research streams and most important methodologies. Along with the major research paradigms (e.g. sleep deprivation, biorhythms, the neurobiological background of sleep disorders, sleep and memory consolidation, sleep-related information processing) students learn how to register and analyse sleep-related EEG. (9 credits)

Evolutionary Psychology
BMETE47MC07 – 2/0/0/f/3
Dr. Péter Simor
Evolutionary sciences and their hierarchy. The origin and fate of the Darwinian heritage in psychology. The notion of adaptation. Modular and single factor

Informatics

**BMETE92MC19 – 0/2/0/f/3**

*Dr. János Tóth*

The aim is to provide and extremely powerful tool to solve calculation, simulations, drawing, presentation, etc. problems connected with the studies of the student, which will also come useful later in research. The tool Mathematica, Version7, at the time of writing this syllabus, is also useful to show the latest developments in different fields of applied computer science, such as programming paradigms (with emphasis on functional programming). Parts of mathematics will also be presented or repeated in this course. – Topics: Mathematical program packages. An intelligent calculator; application in elementary mathematics. Kernel, frontend, packages, demonstrations. Numbers, solving equations. Plotting, graphics. Animation, manipulation, sound. The language of Mathematica. Lists and generalized lists. Functional programming. Rule based programming. Rewrite rules. Pattern matching. Procedural programming. Applications in mathematics: discrete, continuous, stochastic. Applications in linguistics. Elements of image processing. (3 credits)

**Introduction to Cognitive Science**

**BMETE47MC01 – 2/0/0/f/3**

*Dr. Gyula Demeter*


**Introduction to Experimental Psychology**

**BMETE47MC25 – 2/0/0/v/3**

*Dr. Gyula Demeter*

Introduction. Understanding psychology as a science. Experimental psychology and the scientific method. Research techniques: observation and correlation, experiments. Ethics in psychological research. Attention and reaction time. 1st Written examination paper. Conditioning and learning. Memory and forgetting. Individual differences and development. 2nd Written examination paper. Presentation of research plans. Presentation of research plans. (3 credits)

**Mathematics**

**BMETE92MC15 – 2/2/0/v/5**

*Dr. János Tóth*

The aim of the course is to give a nontechnical introduction into higher mathematics via lectures and via reading texts containing the use of mathematics in the different parts of cognitive science. Instead of calculation methods logical and philosophical connections will be emphasized. Technical and geometrical aspects will not receive emphasis, however, we try to analyse the meaning of notions within and, if possible, outside mathematics. Instead of proofs examples will be shown together with applications and with historical remarks. A shortened introduction to the classical material of calculus will be followed by introductions to areas which cannot be absolutely neglected by someone interested in cognitive science: dynamical systems, graphs and networks, algorithms and the use of computers in mathematics. – Topics: Fundamental notions of set theory and logic. A review of the notion of numbers. Relations and functions. The connection between operations and relations and between functions. Operations on functions. Series and infinite sums. Convergence, limit. Limit and continuity of real variable real valued functions. Differentiability of real variable real valued functions. Tangent. Rules of derivation. Applications of calculus: analysis of functions. Monotonicity, maxima and minima. Integration: antiderivative, definite integral. The fundamental theorem of calculus. Solving simple differential equations. On discrete dynamical systems. Simple models with chaotic behavior. On graphs and networks. Their rules of modelling. Algorithms. Applying mathematical program packages. (5 credits)

**Memory and the Psychology of Learning**

**BMETE47MC29 – 0/3/0/f/3**

*Dr. Mihály Racsmány*

The topics covered in the course are the currently topical areas of memory research. The most controversial results and new theories of the various topics are discussed based on one or two studies. – Sleep and memory. Consolidation and reconsolidation.
Amnesia. Prospective memory. Autobiographical memory. Memory decay. Consultation with students on research proposal. Recall. Inhibition and interference. Learning and transfer. Working memory. Consultation with students on second research proposal. (3 credits)

**Neurobiology 1 – Foundations and Neurobiology of Perception**

**BMETE47MC22 – 2/0/2/v/5**  
*Dr. Gyula Kovács*


**Neurobiology 2 – Sensory and Motor Processes**

**BMETE47MC23 – 2/0/0/v/3**  
*Dr. Gyula Kovács*

Multisensory integration. The human eye – anatomy, eye-movements, the retina. Subcortical mechanisms, thalamic nuclei and the superior colliculus. The V1. Visual cortical processes – after the V1. Dorsal and ventral visual pathways. Hearing. The motor system: from the muscle fibre to the spinal chord, brainstem, cortex, the basal ganglia and the cerebellum. (3 credits)

**Neurobiology 3 – Higher Cognitive Functions**

**BMETE47MC24 – 2/0/0/v/3**  
*Dr. Szabolcs Kéri*


**Neuropsychology**

**BMETE47MC06 – 2/0/2/v/5**  
*Dr. Gyula Demeter*

In this course students will study the neural foundations of higher cognitive functions such as concept formation, language, planning of action, problem solving, emotions and consciousness, with a focus on recent findings and methodological development. Not only do recent findings and methodological achievements shape scientific theory, they also tend to affect therapy as well. We review these new findings while looking for links between normal and pathological functioning. (5 credits)

**Psycholinguistics**

**BMETE47MC36 – 2/0/0/v/3**  
*Dr. Agnes Lukács*

The course is based on the relationship between problems in linguistics and psychology and the history of the overlap between the two fields of research. In analysing the processes of language comprehension, beside presenting experimental methods in psycholinguistics, the main organizing principle is the contradiction of decompositional and interactive theories in explaining linguistic behavior, together with the problem of the psychological reality of linguistic levels. For speech production, the goal is to present stage models of planning and realization, as well as to demonstrate how production is embedded in conversation. The course also relates models of lexical organization to analyses of conceptual organization. The part on child language mainly focuses on constructivist and innatist explanations of language development, and connects them to our current biological knowledge. (3 credits)

**Reading Seminar in Psycholinguistics 1, 2, 3**

**BMETE47MC31, 32, 33 – 2/0/0/v/3**  
*Dr. Anna Babarczy*

The course discusses current issues in psycholinguistics and experimental linguistics through the analysis of current theoretical and empirical papers in the Hungarian and international literature. Each semester, the most topical issue will be chosen. Topics to choose from include: Theoretical debates in...

Social Cognition

BMETE47MC28 – 2/0/0/v/3

Dr. Szabolcs Kéri


Statistics and Methodology

BMETE92MC20 – 2/0/2/v/5

Dr. Márta Lángné Lázi

All the major areas of statistics (such as estimation, hypothesis testing, regression) will be treated with special reference to the assumptions usually assumed in introductory courses (such as normality, linearity, stationarity and scalar valuedness), which, however, are never fulfilled in real applications. How to test these assumptions and what to do if they are violated - these questions will act as guides in the course. – Topics: Random variables. Distributions. Generating random numbers. Sampling. Methods of estimation. Confidence intervals. Testing hypotheses. Independence, normality. Regression and interpolation. Getting and importing data. Cluster analysis. Experimental designs. Applications. Writing a report. Depending on the circumstances the calculations will either be done using Mathematica, or EXCEL, or SPSS. (5 credits)
General Information

The Faculty of Economic and Social Sciences (GTK) of the Budapest University of Technology and Economics (BME) is one of the prime institutions of higher education in Hungary specialised in the fields of business, economics and social sciences.

As the youngest faculty of BME, it provides a dynamic and accommodating environment to all of its students and academic staff in the middle of Budapest, the historic capital of Hungary.

Programs offered by the Faculty provide solid theoretical foundations along with up-to-date practical skills at the bachelor, master and doctorate levels. The Faculty offers the largest MBA program in the country, as well as a high-ranking Ph.D. program in management science. Apart from its full programs, the Faculty is very active in providing courses to students of the engineering and natural science faculties of the University.

From 2019 September, the Faculty of Economic and Social Sciences launches three full time master programmes and a doctoral programme in English for both Hungarian and international students. Our programmes focus on innovation, both technical and social in nature, to equip our students with the most relevant and up-to-date knowledge and skills to tackle the fast changing business and social environment of the coming decades. Being in a STEM (Science Technology Engineering Mathematics) environment we build on our unique capabilities for familiarizing our students with data analytics, the new models of data economy and technological innovations in finance.

GTK plays an extensive role in the scientific scene, both domestic and international, by conducting research projects within the field of expertise of the 11 departments and centres operating at the Faculty. Research and high quality publication has a high priority in order to facilitate up-to-date teaching and practical training activities. The Faculty publishes ‘Periodica Polytechnica – Social and Management Sciences’, a peer-reviewed international scientific journal founded in 1993, publishing both research and application oriented papers in the area of management and social sciences.

Adult education and training, as well as specialised life-long training programs tailored to the requirements of various enterprises, companies and other clients also play a significant role in the life of the Faculty.

The Faculty hosts the Centre of Modern Languages, which provides language courses, exams and a translator and interpreter training program to students and staff of the University, and is also active in research activities.

The Faculty also offers a wide range of curricular and extra-curricular forms of physical education within the framework of the Centre of Physical Education.

The following pages introduce the three master and one doctoral programme of the Faculty for the academic year 2019/20.
Departments

Department of Business Law
Department of Economics
Department of Environmental Economics
Department of Ergonomics and Psychology
Department of Finance
Department of Management and Business Economics
Department of Philosophy and History of Science
Department of Sociology and Communication
Department of Technical Education
Centre of Modern Languages
Centre of Physical Education

Budapest University of Technology and Economics
Faculty of Economic and Social Sciences
Faculty Office: Building “Q” wing A, 203.
Address:
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E-mail: gtk-dekani@gtdh.bme.hu
Phone: (+36-1) 463-2152
International Study Office: Ms. Noémi Girst
E-mail: iso@gtdh.bme.hu

Dean of the Faculty: Prof. Dr. Tamás Koltai
Vice-Deans of the Faculty:
Dr. András Bethlendi (finance)
Dr. Anikó Grad-Gyenge (innovation)
Dr. Emma Lógó (education)
Prof. Dr. Gyula Zilahy (scientific and international affairs)
Description of master programmes

Master in Finance

Length of study: 4 semesters
Programme objectives: The goal of the program is to equip our students with a global competitive edge in finance, in particular financial analysis and risk management. Our graduates will be capable to solve complex financial tasks independently and to manage and analyse financial processes present in the economy both at macro and micro levels. The main focus of our program is to provide high level of professional standards in investment analysis, portfolio management, corporate and bank treasury and risk management.

To this end, we designed our course structure and curricula to meet the requirements of the international Chartered Financial Analyst (CFA) Program and Financial Risk Manager (FRM) accreditation. As a consequence, our students, upon graduation, will also have gained the knowledge to successfully pass CFA/FRM exams. This feature of our programme is unique in the Hungarian higher education market, and is also rare in an international setting.

General conditions of admission into the master programme:

- BSc in Finance and Accounting or Business Administration and Management (ISDEC level 6 or higher)
- Any other BA/BSC with the proof of minimum 60 ECTS equivalent required in the following disciplines:
  - 15 ECTS from Quantitative foundations (mathematics, statistics, informatics)
  - 10 ECTS of Economics (micro and macroeconomics, international economics, environmental economics, economics theory, economics statistics, economics theory, economic modelling, economic policy, sectoral and functional economics, international economy, European economy, public policy);
  - 10 ECTS of Business Basics (corporate economics, accounting, controlling human resources, business law, marketing, management and organization, value creation processes, decision theory and methodology, business ethics, strategic planning, business communication);
  - 10 ECTS from the basics of Social Sciences (European Union, general and business law, economic history, sociology, psychology, philosophy);
  - 15 ECTS of Financial Knowledge (finance, money and capital market, banking, financial policy, taxation, corporate finance, corporate valuation).
- Applicants can be admitted with 30 ECTS from the above listed disciplines on the condition that they collect the remaining 30 ECTS during the first year of their studies
- Minimum GPA of accepted credits is on the middle of the scale
- B2 level command of English: a TOEFL iBT score of 88 or above, IELTS overall band 6.5 or above.
Master in Management and Leadership

Length of study: 4 semesters

Programme objectives: The key objective of the program is to develop future business leaders by putting strategy and leadership into the center of the curriculum for enabling our students to make decisions in non-standard situations in an autonomous way. Graduates will be able to demonstrate relevant knowledge of, and critical engagement with, the key issues in strategy and leadership alongside more broadly the types and networks of organizations, the external environment in which they operate and how they are managed.

The program aims to equip students with knowledge, skills, and competencies required for a successful carrier in the age of digital transformation, cultural and global change. The basic essentials of the program cover knowledge areas in quantitative decision making, operations management, organizing services, financial management, marketing, law, human resources and international strategy. In these fields students develop competencies of effective communication, working in teams, adopting international benchmarks, appreciating cultural differences and acting upon ethical principles of social and environmental sustainability.

The programme’s unique features include a focus on digital transformation and its consequences and the integration of such contemporary skills as understanding cultural diversity and the importance of balancing economic interests with the interest of society (corporate social responsibility).

General conditions of admission into the master programme:

- BA/BSc in Finance and accounting or Business Administration or Management (ISDEC level 6 or higher)
- Any other BA/BSc with the proof of minimum 60 ECTS equivalent in the following disciplines:
  - 15 ECTS in Quantitative Studies (mathematics, statistics, computer science/programming);
  - 10 ECTS in Economics (micro and macroeconomics, international economics, environmental economics, economics theory, economics statistics, economic modelling, economic policy, regional economics, European economy, public policy);
  - 15 ECTS in Business and Management (business economics, accounting, controlling, human resources, business law, marketing, management and organization, production management, decision theory and methodology, business ethics, strategic planning, business communication);
  - 10 ECTS in Social Sciences (International or European studies, general and business law, sociology, psychology, philosophy);
  - 10 ECTS credits of financial knowledge (finance, money and capital market, banking, financial policy, taxation, corporate finance, corporate valuation)
- Applicants can be admitted with 30 ECTS from the above listed disciplines on the condition that they collect the remaining 30 ECTS during the first year of their studies
- B2 level command of English: a TOEFL iBT score of 88 and above, IELTS overall band 6.5 or above.
Master in Regional and Environmental Economic Studies

Length of study: 4 semesters

Programme objectives: The programme aims to train experts of environmental and regional economics, capable of analysing regional and sustainability-related problems, and propose novel solutions by putting their theoretical knowledge and acquired expertise to practice. Regional economics and business aspects of sustainability are important parts of the programme as well. Courses are highly workshop-oriented, where students may work together to focus local and regional aspects of actual global sustainability challenges.

Our graduates will be capable of creatively and innovatively contribute to the solution of sustainability challenges and to regional policy-making, strategic planning and project programming, both in governments and in private enterprises.

General conditions of admission into the master programme:

- BSc/BA in economics, management or engineering/natural sciences (ISDEC level 6 or higher)
- In case of BA/BSc in engineering/natural sciences it is necessary to prove a minimum of 60 ECTS equivalent in the following disciplines:
  - 20 ECTS in Quantitative Studies (mathematics, statistics, computer science/programming, etc.);
  - 20 ECTS in Economics and Management Studies (micro and macroeconomics, international economics, environmental economics, economics theory, economics statistics, economic modelling, economic policy, regional economics, European economy, public policy, business economics, accounting, controlling, human resources, business law, marketing, management and organization, production management, decision theory and methodology, etc.);
  - 20 ECTS in Natural or Social Sciences (International or European studies, general and business law, sociology, psychology, philosophy, biology, physics, chemistry, geography, earth sciences, etc.).
- Applicants can be admitted with 40 ECTS from the above listed disciplines on the condition that they collect the remaining 20 ECTS during the first year of their studies
- ECTS-proof is compulsory for all applicants regardless of their preliminary studies and the discipline of BA/BSc diploma
- B2 level command of English: a TOEFL iBT score of 88 and above, IELTS overall band 6.5 or above.

Ph.D. Programme in Business and Management

Length of study: 8 semesters

Programme objectives: The aim of the Doctoral School of Business and Management is to provide PhD studies for students specializing in engineering management, management sciences and business economics. In their studies they concentrate on recognizing, formulating, modelling the economic, technical and social aspects of different production, service and public activities.

PhD students will be able to acquire the basic knowledge and skills needed for research beyond general economics knowledge. The programme will allow students to master analytical and methodological skills required to conduct research in their area of specialization, design and carry out original research and demonstrate the ability to communicate research findings in a clear and effective manner.

Admission requirements:

The Business and Management PhD program accepts students with a master degree from all domains of business and management master programs, such as marketing, management and leadership, finance, accounting, regional and environmental economics, international economy and business and master of business administration (MBA).

Applications with a master’s degree from other disciplines may also be acceptable on the basis of an assessment of the doctoral school management.
# Curriculum of MA in Regional and Environmental Economics

<table>
<thead>
<tr>
<th>Subject</th>
<th>Contact hours / Exam type / Credit</th>
<th>Preliminary requirements</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Name</strong></td>
<td><strong>1</strong></td>
<td><strong>2</strong></td>
</tr>
<tr>
<td>Economics</td>
<td>2/h/3</td>
<td></td>
</tr>
<tr>
<td>Quantitative Methods</td>
<td>4/h/5</td>
<td></td>
</tr>
<tr>
<td>Environmental Economics*</td>
<td>3/e/5</td>
<td></td>
</tr>
<tr>
<td>Regional Economics*</td>
<td>4/e/5</td>
<td></td>
</tr>
<tr>
<td>Geoinformatics</td>
<td>3/h/4</td>
<td></td>
</tr>
<tr>
<td>Economic and Social Geography</td>
<td>2/h/3</td>
<td></td>
</tr>
<tr>
<td>Elective Course Unit 1</td>
<td>2/h/3</td>
<td></td>
</tr>
<tr>
<td>Methods of Regional and Environmental Analysis</td>
<td>2/h/3</td>
<td></td>
</tr>
<tr>
<td>Data Analytics</td>
<td>2/e/3</td>
<td></td>
</tr>
<tr>
<td>Sustainable Environmental and Natural Res. Econ.*</td>
<td>4/e/5</td>
<td></td>
</tr>
<tr>
<td>Environmental and Regional Policy of the EU</td>
<td>4/h/5</td>
<td></td>
</tr>
<tr>
<td>Environmental and Urban Sociology</td>
<td>4/h/5</td>
<td></td>
</tr>
<tr>
<td>Municipal Management and Local Governance</td>
<td>4/e/5</td>
<td></td>
</tr>
<tr>
<td>Elective Course Unit 2</td>
<td>2/h/3</td>
<td></td>
</tr>
<tr>
<td>Regional Economic Development*</td>
<td>4/e/5</td>
<td></td>
</tr>
<tr>
<td>Project Management</td>
<td>4/e/5</td>
<td></td>
</tr>
<tr>
<td>Environmental Management Systems*</td>
<td>4/e/5</td>
<td></td>
</tr>
<tr>
<td>Regional and Municipal Marketing</td>
<td>4/h/5</td>
<td></td>
</tr>
<tr>
<td>Diploma Project 1 (Compulsory Elective)</td>
<td>11/h/12</td>
<td></td>
</tr>
<tr>
<td>Local Development and Social Policy</td>
<td>2/h/3</td>
<td></td>
</tr>
<tr>
<td>Urban Development and Urbanism</td>
<td>4/e/5</td>
<td></td>
</tr>
<tr>
<td>Sectoral Sustainability Studies</td>
<td>4/h/5</td>
<td></td>
</tr>
<tr>
<td>Competitiveness Evaluations</td>
<td>4/e/5</td>
<td></td>
</tr>
<tr>
<td>Diploma Project 2 (Compulsory Elective)</td>
<td>12/h/13</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>21/2e/28</td>
<td>22/3e/29</td>
</tr>
<tr>
<td>Elective units</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Language courses (refer to separate documentation)</td>
<td>4/h/0</td>
<td>4/h/0</td>
</tr>
<tr>
<td>Physical Education and Sports (refer to separate documentation)</td>
<td>2/h/0</td>
<td>2/h/0</td>
</tr>
</tbody>
</table>

For curriculum updates please visit our website [http://www.gtk.bme.hu/en/](http://www.gtk.bme.hu/en/)

**Course Unit Type**

- Compulsory (Core) Unit
- Compulsory Elective Unit (students may choose course units from a pre-selected list)
- Elective Unit (students may choose course units from the entire university portfolio)

**Criterion Requirement**

*Final Examination Course Units*
final examination course unit (a course unit whose topics constitute some of the topic questions on the final examination)

**Weekly Hours**
Weekly Hours = Lectures + Practicals/Seminars + Laboratory work

**Assessment Type**
e: examination  t: term grade s: signature (proof of completion only, no evaluation of performance required)

**Example of Notation**
E.g.: Quantitative Methods 4/h/5
Meaning: Compulsory (Core) Unit, 4 contact hours a week, performance assessed by means of examination, totalling 5 ECTS credits.
# Curriculum in MA of Finance

<table>
<thead>
<tr>
<th>Subject</th>
<th>Contact hours / Exam type / Credit</th>
<th>Preliminary requirements</th>
</tr>
</thead>
<tbody>
<tr>
<td>Name</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Economics</td>
<td>2/e/3</td>
<td></td>
</tr>
<tr>
<td>Quantitative Methods</td>
<td>4/t/5</td>
<td></td>
</tr>
<tr>
<td>Principles of Accounting</td>
<td>4/t/5</td>
<td></td>
</tr>
<tr>
<td>Investments*</td>
<td>2/t/3</td>
<td></td>
</tr>
<tr>
<td>Introduction to Financial Mathematics</td>
<td>4/t/5</td>
<td></td>
</tr>
<tr>
<td>Foundations of Risk Management*</td>
<td>4/e/5</td>
<td></td>
</tr>
<tr>
<td>Business Law</td>
<td>2/e/3</td>
<td></td>
</tr>
<tr>
<td>Intensive Seminar</td>
<td>2/t/4</td>
<td></td>
</tr>
<tr>
<td>Data Analytics</td>
<td>2/t/3</td>
<td></td>
</tr>
<tr>
<td>Management controlling</td>
<td>4/e/5</td>
<td></td>
</tr>
<tr>
<td>Economic History</td>
<td>2/e/3</td>
<td></td>
</tr>
<tr>
<td>Corporate Finance*</td>
<td>4/t/5</td>
<td></td>
</tr>
<tr>
<td>Macro Finance*</td>
<td>2/e/3</td>
<td></td>
</tr>
<tr>
<td>Pricing and Price Forecasting</td>
<td>4/t/5</td>
<td></td>
</tr>
<tr>
<td>Innovation and Green Finance</td>
<td>2/e/3</td>
<td></td>
</tr>
<tr>
<td>Valuation of Enterprises*</td>
<td>4/t/5</td>
<td>Corporate Finance</td>
</tr>
<tr>
<td>Environmental Management Systems</td>
<td>4/e/5</td>
<td></td>
</tr>
<tr>
<td>Organisational Behavior</td>
<td>4/e/5</td>
<td></td>
</tr>
<tr>
<td>Fixed income and Management of Market Risk*</td>
<td>4/t/5</td>
<td>Foundations of Risk Management</td>
</tr>
<tr>
<td>Credit and Operational Risk Management*</td>
<td>4/t/5</td>
<td>Foundations of Risk Management</td>
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<tr>
<td>Management Information Systems</td>
<td>2/t/3</td>
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</tr>
<tr>
<td>Elective Course Unit 1. (Compulsory Elective)</td>
<td>2/t/3</td>
<td></td>
</tr>
<tr>
<td>Analysis of production and operation decisions</td>
<td>4/t/5</td>
<td></td>
</tr>
<tr>
<td>Elective Course Unit 2. (Compulsory Elective)</td>
<td>2/t/3</td>
<td></td>
</tr>
<tr>
<td>Thesis</td>
<td>12/t/15</td>
<td></td>
</tr>
</tbody>
</table>

**Compulsory Electives**
- Specialisation in risk management (2 courses should be selected from the list)
- Investment management risk measurement 2/e/3
- Banking 2/e/3
- Insurance 2/e/3
- Specialisation in financial analysis (2 courses should be selected from the list)
- Portfolio Management and Alternative Investments 2/e/3
- International Finance 2/e/3
- Derivatives and Real Options 2/e/3

**Total** 24/33 20/27 22/31 22/29

**Electives (refer to separate documentation)**

| Language courses | 4/t/0 4/t/0 |
| Physical Education and Sports | 2/t/0 2/t/0 |

For curriculum updates please visit our website [http://www.gtk.bme.hu/en/](http://www.gtk.bme.hu/en/)

**Course Unit Type**
- Compulsory (Core) Unit
- Compulsory Elective Unit (students may choose course units from a pre-selected list)
- Elective Unit (students may choose course units from the entire university portfolio)

**Criterion Requirement**

*Final Examination Course Units*

final examination course unit (a course unit whose topics constitute some of the topic questions on the final examination)

**Weekly Hours**

Weekly Hours = Lectures + Practicals/Seminars + Laboratory work

**Assessment Type**

e: examination  t: term grade  s: signature (proof of completion only, no evaluation of performance required)

**Example of Notation**

E.g.: Quantitative Methods 4/e/5

Meaning: Compulsory (Core) Unit, 4 contact hours a week, performance assessed by means of examination, totalling 5 ECTS credits.
## Curriculum in MA of Management and Leadership

<table>
<thead>
<tr>
<th>Subject</th>
<th>Contact hours / Exam type / Credit</th>
<th>Preliminary requirements</th>
</tr>
</thead>
<tbody>
<tr>
<td>Name</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Economics</td>
<td>2/e/3</td>
<td></td>
</tr>
<tr>
<td>Quantitative Methods*</td>
<td>4/e/5</td>
<td></td>
</tr>
<tr>
<td>Marketing*</td>
<td>4/e/5</td>
<td></td>
</tr>
<tr>
<td>Business Law</td>
<td>2/t/3</td>
<td></td>
</tr>
<tr>
<td>Production and Operations Management*</td>
<td>4/e/5</td>
<td></td>
</tr>
<tr>
<td>Accounting*</td>
<td>4/e/5</td>
<td></td>
</tr>
<tr>
<td>Organisational Behaviour*</td>
<td>4/e/5</td>
<td></td>
</tr>
<tr>
<td>Data Analytics*</td>
<td>2/e/3</td>
<td></td>
</tr>
<tr>
<td>Corporate Finance 1.*</td>
<td>4/e/5</td>
<td>Accounting</td>
</tr>
<tr>
<td>Production Organisation*</td>
<td>4/e/5</td>
<td>Production and Operations Management</td>
</tr>
<tr>
<td>Quality Management*</td>
<td>4/e/5</td>
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<tr>
<td>Management Elective Block 1, (Compulsory Elective)</td>
<td>2/t/3</td>
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</tr>
<tr>
<td>Finance Elective Block 1.</td>
<td>2/t/3</td>
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<tr>
<td>Elective Course Unit 1.</td>
<td>2/t/3</td>
<td></td>
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<tr>
<td>Investments</td>
<td>2/t/3</td>
<td>Production Organisation</td>
</tr>
<tr>
<td>Environmental Management Systems*</td>
<td>4/e/5</td>
<td></td>
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<tr>
<td>Management Information Systems (MIS)*</td>
<td>2/e/3</td>
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<tr>
<td>Project Management*</td>
<td>4/e/5</td>
<td></td>
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<tr>
<td>Intensive Seminar</td>
<td>2/t/4</td>
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<tr>
<td>Management Elective Block 2,</td>
<td>2/t/3</td>
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<tr>
<td>Finance Elective Block 2.</td>
<td>2/t/3</td>
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<tr>
<td>Business Law Elective Block</td>
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<td></td>
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<tr>
<td>Elective Course Unit 2.</td>
<td>2/t/3</td>
<td></td>
</tr>
<tr>
<td>Logistics and supply chain management</td>
<td>4/t/5</td>
<td>Production and Operations Management</td>
</tr>
<tr>
<td>Analysis of production and operation decisions</td>
<td>4/e/5</td>
<td></td>
</tr>
<tr>
<td>Technology Management</td>
<td>4/e/5</td>
<td></td>
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<tr>
<td>Thesis</td>
<td>12/t/15</td>
<td>A total of 80 ECTS credits shall have been obtained before taking this course unit.</td>
</tr>
<tr>
<td>Total</td>
<td>24/t/31</td>
<td>22/t/27</td>
</tr>
</tbody>
</table>

Electives (refer to separate documentation)
Language courses | 4/t/0 | 4/t/0 |
Physical Education and Sports | 2/t/0 | 2/t/0 |

For curriculum updates please visit our website http://www.gtk.bme.hu/en/

### Course Unit Type

- **Compulsory (Core) Unit**
- **Compulsory Elective Unit** (students may choose course units from a pre-selected list)
- **Elective Unit** (students may choose course units from the entire university portfolio)

### Criterion Requirement

- **Final Examination Course Units**
  - final examination course unit (a course unit whose topics constitute some of the topic questions on the final examination)

### Weekly Hours

- **Weekly Hours = Lectures + Practicals/Seminars + Laboratory work**

### Assessment Type

- **e**: examination
- **t**: term grade
- **s**: signature (proof of completion only, no evaluation of performance required)

### Example of Notation

**E.g.:** Quantitative Methods 4/e/5

**Meaning:** Compulsory (Core) Unit, 4 contact hours a week, performance assessed by means of examination, totalling 5 ECTS credits.
Faculty of Transportation Engineering and Vehicle Engineering
The Faculty of Transportation Engineering and Vehicle Engineering is an accredited source of engineering studies since 1951, transferring knowledge in the fields of transportation processes, modeling and optimization, vehicle operation, automation, planning and control, manufacturing and services. The Faculty’s mission defines the undertaking of high level professional training and high quality scientific activity, research and development, offering expertise and consultation to transport operators, vehicle industry companies and logistics providers.

**BSc programmes in Hungarian:**
- **Transportation Engineering BSc** – we focus on transportation and shipping related processes and their control.
- **Vehicle Engineering BSc** – students will acquire knowledge on the transportation vehicles, machinery, material handling and building machinery.
- **Logistics Engineering BSc** – the programme offers complex insight and knowledge in corporate logistics systems and supply chains and also helps with building up an analytical point of view.

**MSc programmes in Hungarian:**
- **Vehicle Engineering MSc**
- **Transportation Engineering MSc**
- **Logistics Engineering MSc**

**MSc programmes in English:**
- **Vehicle Engineering MSc**
- **Transportation Engineering MSc**
- **Logistics Engineering MSc**
- **Autonomous Vehicle Control Engineer MSc**

**PhD studies:**
The highest level of the faculty’s education is represented by the Kandó Kálmán Doctoral School, where the PhD students are being prepared for scientific research and a possible career as a professor and researcher. The 4 year program lets the students take part in professional subjects and courses, teaching activities and individual scientific research tasks. Research activity is being lead by a professional supervisor, and the PhD students will show their results through their publications and later in their dissertation.

**Departments:**
- Department of Material Handling and Logistics Systems
- Department of Automotive Technologies
- Department of Vehicle Elements and Vehicle Structure Analysis
- Department of Control for Transportation and Vehicle Systems
- Department of Transport Technology and Economics
- Department of Aeronautics, Naval Architecture and Railway Vehicles

---

**Budapest University of Technology and Economics**
**Faculty of Transportation Engineering and Vehicle Engineering**
Faculty Office: Building K I. 27
Address: H-1111 Budapest, Műegyetem rkp. 3.
E-mail: kjk@mail.bme.hu
Phone: +36- 1-463-3551

Dean of the Faculty: Dr. István Varga
Vice-dean of the Faculty: Dr. Ádám Török
Program co-ordinator: Ms. Barbara Mag
Description of BSc training

BSc in Vehicle Engineering

Length of study: 7 semesters

Program objectives: The aim of the bachelor education programme is to train vehicle engineers, who will be able to maintain and operate road, railway, water, air, construction and material handling vehicles with appropriate knowledge in the fields of transportation and logistics. They will be able to fulfill roles of vehicle engineering tasks, like improvement, manufacturing and operation. The listed tasks are accomplished by taking into account safety, environment and energy management aspects. The gained knowledge provides the basics to continue their education in the MSc programmes of the Faculty.

Specializations: Automotive vehicle, Aerospace vehicle, Naval vehicle, Railway vehicle, Construction equipment, Automated material handling equipment and robotics, Vehicle manufacturing, Vehicle mechatronics, Vehicle structure

Competencies and skills: Possessing the basic certificate, the vehicle engineers - taking into consideration also the prospective specialisations - become able:

- to determine the necessary equipment for the realisation of transportation and logistic processes,
- to organize, arrange, control the safe, the powerful and environmental-protective operation of vehicles, vehicle systems, mobile machines, materials-handling machines and machine systems,
- to perform the basic engineering tasks related to the designing, manufacturing, repair, as well as organisation of vehicles and mobile-machinery,
- to provide and organize the official work related to installation and operation of vehicles and mobile-machinery.

BSc in Transportation Engineering

Length of study: 7 semesters

Program objectives: The aim of the bachelor engineering programme is to train transportation engineers, who will be able to organize and operate processes of passenger and goods transportation. They will learn how to choose proper measures for these tasks, how to operate and maintain such transportation systems, including elements of infrastructure, control and IT systems. The gained knowledge is sufficient to continue their education in the MSc programmes of the Faculty.

Specializations: Road transportation, Railway transportation, Air transportation, Waterborne transportation

Competencies and skills: The transportation engineers received a basic certificate (BSc) - taking into consideration also the specialisations - become able:

- to recognise the demands for transportation and transportation-logistics, to determine the relationships to be applied,
- to exert active detailed cognition of transportation-and transportation logistics processes, to manage the processes mentioned together with their technical realisation,
- to design processes in accordance with the function of transportation and transportation-logistics systems, to select the technical components and to manage the operation of the system,
- to keep in operation vehicles and mobile machines serving the transportation process, to make the control systems operated, to take into consideration the environmental factors,
- to perform designing, organising and keeping in operation duties,
- to carry out public service and marketing activities.
BSc in Logistics Engineering
Length of study: 7 semesters

Program objectives: The aim of the study is to train logistics engineers, who will be able to maintain and operate corporate logistics and good transportation systems. They will know modern supply chains and networks, their management and organizational basics, and transport control processes and workflows. Related logistics control and IT systems basics are also acquired. The gained knowledge is sufficient to continue their education in the MSc programmes of the Faculty.

Specializations: From the 5th semester every student will participate in one logistics engineer specialization, which covers all specific areas of logistics, and prepares the further MSc integration and specializations, and/or the specific logistics operating engineer work.

Competences and skills: Possessing the basic certificate, the logistics engineers - taking into consideration also the prospective specialisations - become able:
- to define the equipment necessary to realize logistics systems and processes,
- to organize, arrange, control logistics systems in a safe and environmentally-friendly way,
- to perform the basic engineering tasks related to the design, manufacture and repair, as well as the organization of material handling machines,
- to provide and organize the official work related to the installation and operation of logistics machinery.

Actually, due to changes in basic training (BSc) our Faculty can ensure training in English with tuition fee for the time being only part-time (attending term at other faculties, training exchange students). The list of optional subjects in the given term is on website: http://transportation.bme.hu/for-students/courses/

Description of MSc training
MSc in Autonomous Vehicle Control Engineer
Length of study: 4 semesters

Program objectives: The Autonomous Vehicle Control Engineer Master programme focuses on transferring high level knowledge regarding vehicle technology, engineering, computer science and economics. The application of new technologies and methodologies will ensure that engineers are able to plan, develop, operate and conduct practical and research oriented tasks in the field of autonomous vehicles.

The aim of the programme is to educate the next generation of engineers, who are capable of developing new technologies and handling problems of autonomous vehicles transport systems taking into account environmental and energy management requirements. Furthermore they will be prepared to continuously deepen their knowledge, thus providing up-to-date solutions for new challenges.

Competences and skills: The students will be prepared to take part in designing, developing and manufacturing autonomous vehicles, simulate networks, test and validate processes and work in a complex environment with various sensor data. The students will also be able to facilitate the creation of safe and energy-saving operation of autonomous transportation systems considering environmental and sustainable parameters.

The cooperation with our industrial partners guarantees that students will be able to participate in the latest research and development projects. The integration of the requirements of the industrial partners and project results to the curriculum leads to a unique education programme, that helps to achieve a specific knowledge transfer between the university and the vehicle industry.
MSc in Vehicle Engineering

Length of study: 4 semesters

Program objectives: The master education programme is a continuation of the bachelor vehicle engineering studies. Our aim is to provide the required knowledge to graduates, required to manage development, design, dimensioning, manufacturing and analyzing internal processes of different vehicles. The students will also be prepared to management tasks and to creatively participate in Research & Development related tasks. These studies prepare students for our PhD programmes.

Specializations: Automotive vehicle engineer, aerospace vehicle engineer, naval vehicle engineer, railway vehicle engineer, Mobile machinery and construction equipment engineer, automated material handling system, Vehicle manufacturing and repairing engineer, Vehicle system engineer, Road and traffic safety engineer, Vehicle automation engineer, Vehicle structure engineer.

Competencies and skills: Possessing the MSc degree, vehicle engineers are able:
- to integrate a system oriented and process analysing way of thinking directed on vehicles and mobile-machinery, having a role in transportation processes,
- connected with the specialization selected, to carry out assessments, to develop, design, organise and control complex systems of vehicle technology.

Accepted to the input without any conditions:
- Transportation engineering

Accepted to the input under given conditions:
- mechanical engineering;
- mechatronics engineering;
- military staff, and safety technology engineering;
- agricultural and food industrial engineering;
- engineering informatics.

MSc in Transportation Engineering

Length of study: 4 semesters

Program objectives: The master education programme is a continuation of the bachelor studies. Our aim is to train graduates, who will be able to analyze, plan, organize and control transport related processes in an integrated way considering economic, safety, environmental and human resource aspects. Graduates will be able to deal with tasks of transport administration and transport authorities, choice and operation of vehicles and facilities of passenger and good transportation systems and related infrastructural, control and IT system elements. The students will also be prepared to higher management tasks, to creatively participate in Research & development tasks. These studies prepare students for our PhD programme.

Specializations: Transportation systems, Transportation automatization, Transportation engineer manager, Freight forwarding management, Air Traffic Management.

Competencies and skills: Possessing the MSc degree, transportation engineers are able:
- to recognise connections between systems and processes of transportation, to evaluate and to handle them in the framework of system theory, as well as to apply the related principles and methods,
- connected with the specialization selected, to carry out state assessments, to develop, design, organise and control complex transportation systems.

Accepted to the input without any conditions:
- Transportation engineering

Accepted to the input under given conditions:
- mechanical engineering;
- mechatronics engineering;
- military staff and safety technology engineering;
- civil engineering;
- engineering informatics;
- light industry engineering.
MSc in Logistics Engineering

Length of study: 4 semesters

Program objectives: The MSc study is a continuation of the BSc studies. Our aim is to train graduates, who will be able to plan, organize and control corporate logistics systems, good transport systems and supply and distribution networks. Furthermore they will be able to join to developing logistics systems related machines and tools. The students will also be able to deal with complex logistics system modeling and optimization, they understand operation and planning principles of corporate logistics systems, distribution networks and supply chains. The students will also be prepared to manage leading tasks, to creatively participate in R&D related problem, and continue their studies later on our PhD programme.

Specializations: Corporate logistics and operations planning, Technical logistics, Freight forwarding management.

Competencies and skills: Possessing the MSc degree, logistic engineers are able to interconnect the component-processes of logistic systems and the component-units performing the physical realisation of the former relationships.

Accepted to the input without any conditions:
- Transportation engineering

Accepted to the input under given conditions:
- mechanical engineering;
- mechatronics engineering;
- military staff, and safety technology engineering;
- agricultural and food industrial engineering;
- engineering informatics;
- light industry engineering.

Admittance to master courses (MSc) ensured by the announced training, partly in English language, is possible in case of meeting the input conditions, passing entrance examination and in case of at least 5 students’ participation.

PhD studies

The highest level of the faculty’s education is represented by the Kándó Kálmán Doctoral School, where the PhD students are being prepared for scientific research and a possible career as a professor and researcher. The programme’s tasks deal with transportation, vehicle industry and logistics related questions, which actual topics are frequently updated.

The 4 year program lets the students take part in professional subjects and courses, teaching activities and individual scientific research tasks. The programme will deepen the students’ knowledge in 3 main fields: high level natural science, foundation of profession and specialist subjects in vehicles and mobile machines, transportation and logistics sciences. Furthermore they will gather knowledge through specific optional subjects.

The high quality of the education is guaranteed by the well recognized core members of the programme. Research activity is being lead by a professional supervisor, and the PhD students will show their results through their publications and later in their dissertation.
## Curriculum of MSc in Autonomous Vehicle Control Engineering

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## Curriculum of MSc in Vehicle Engineering

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Curriculum of MSc in Vehicle Engineering (Contd.)
## Curriculum of MSc in Transportation Engineering

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Description of M.Sc. Subjects

Master Section in Autonomous Vehicle Control Engineering

Control theory and system dynamics

BMEKOKAM701

Dr. József Bakor

The course aims the study of the analytical and control design methods of electromechanical systems. First, the modeling paradigms and state space representations are outlined. After this, system analysis is presented, such as controllability, observability and stability. Through the control design problem, the course examines the different qualitative properties, and the consideration techniques of system uncertainties and disturbances. From the classical methods, the pole allocation and the quadratic linear control is presented. The course focuses on the interpretation of the observer design and the separation principle.

Automotive environment sensors

BMEKOKAM708

Dr. Tamás Bécsi

The course aims the studying of the technologies developed for the tasks of environment sensing of an automated vehicle, the currently available technologies and the corresponding signal processing techniques. First, the course introduces the inner sensors of the vehicles, such as position, velocity, translation or rotation, basics of their physical operation and their limitations. After this, the main principles of environment sensing, such as ultrasonic, radar, lidar and machine vision systems are introduced through application examples. To strengthen the robustness of the collected data, several typical sensor fusion techniques are also studied.

Automotive vehicle systems

BMEKOGGM712

Dr. Bálint Szabó

The target of the subject is to present the vehicle systems and structures. Within the framework of the subject the vehicle engines, transmissions, suspension systems, brake systems and frame structures are taught. In the Autonomous Vehicle Control Engineering MSc tematics, the target of the subject is to taught up the students, who do not have vehicle engineer BSc. By the end of the subject the students are able to recognise the important parts and systems of road vehicles, they know their function and operation.

Vehicle testing and validation

BMEKOGGM406

Dr. Bálint Szabó

Introduction into the modern instrumental vehicle measurements. Acquirement of the usage of instruments, testing methods, and application of vehicle testing processes. In the Autonomous Vehicle Control Engineering MSc tematics, the target of the subject is to present the students the testing procedures and possibilities of vehicle and software testing. By the subject the students are able to coordinate tests in simulation, laboratory and open road environment. Introduction of the basic measurement methods and instruments. Demonstration of different vehicle testing instruments. The subject goes through on the testing methods and tools different vehicle subsystem. Engine and driveline testing on modern engine test rigs demonstrates the dynamics, efficiency and emission of the powertrain. Brake system testing will be performed on both test benches and on a test track using a real vehicle according to the ECE directives.

Suspension testing introduces both the passanger car suspension measurement methods, and the air spring system testing for heavy duty vehicles. Steering system testing is demonstrated as well. This course also shows different levels of testing: like laboratory tests on a subsystem of a vehicle, laboratory tests in simulation environment (HIL), laboratory tests on a real vehicle, and testing on test track. In addition the testing as a part of the V-model based development is also explained during this course.

High Performance Microcontrollers and Interfaces

BMEVIAUMA07

Dr. Gábor Tevesz

Insight is given of the computer system architectures, high performance microcontroller architectures and their building blocks. Convolional architectures are analyzed then special architectures (ARM, DSP, network and graphic processors, GPGPU) are dealt with and compared with the SoC devices with soft and hard processors. Methods increasing the performance, security and reliability, decreasing power consumption are treated. Mechanical, electrical and logical aspects of bus systems connecting parts of control systems are treated in detail. Diagnostic methods of WEB, mobile, etc. based control systems are also introduced.

Numerical methods

BMEKOVRM121

Dr. József Rohács


Programming in C and Matlab

BMEKOKAM603

Dr. Tamás Bécso

The subject aims the learning of the C and Matlab programming languages and environments. These tools aim the students in the implementation tasks required by other courses.

The goal on one hand is the introduction of the syntax of the two languages: Types, variables, data structures. Flow control, if-then, loops, functions, complex types and data structures. On the other hand, through the learning of syntax, the design and application of basic algorithm design paradigms is also studied.

Computer Vision Systems

BMEVIIIMA07

Dr. László Vajta

Along with the development of computer technologies, automatic evaluation of visual content became a daily practice on areas of quality control, process control, navigation, security systems, medical diagnostics, and many more.
The aim of the course is to provide an introduction of the principles and applications of advanced computer image processing and visualisation, covering virtual technologies which are playing a key role in the management of supervised autonomous industrial processes.

Automated driving systems

**BMEKOGGM707**

*Dr. Zsolt Szalay*

The goal is to present driver assistant systems and automated driving functions. The levels of automation according to SAE. Brief overview about vehicle dynamics. Driver assistance system overview on the stabilization level. Typical DAS systems, like AEBS, LDW, LKA available at present vehicles. Outlook on future advanced driver assistance systems at higher automation levels.

Topics included: SAE automation levels, Basic vehilce dynamic model, lateral and longitudinal, ABS, ASR, ESP, Automated emergency braking, Lane departure warning, Lane keep assist, Lane change assist, Turning assist, Tempomat, adaptive cruise control, Park assist, Traffic jam assist, Highway Assist Pilot, Platooning.

### Autonomous Robots and Vehicles

**BMEVIIIMA12**

*Dr. Bálint Kiss*

The course presents the theoretical and practical fundamentals of the modeling, control and realization of robotic and autonomous systems. The construction and programing of robotic devices are studied together with the principles of mechanical modeling and navigation of mobile platforms. Advanced methods for path planning and control are explained in details including the real-time aspects of their realization. Special emphasis is put on the principles of cooperation of legged and wheeled autonomous robots and UAVs.

### Embedded Operating Systems and Client Applications

**BMEVIAUAC07**

*Dr. Gábor Tevesz*

Basic concepts of embedded operating systems. The objective of the course is to present platforms, techniques and tools which are required to create and run both application and system level software for embedded systems. After creating the hardware unit and embedded programs for it, the next natural step is the implementation of a desktop or web application that enables monitoring and parameterizing the hardware unit from a standard PC. Mobile applications are becoming more widely used as well. The course presents the programming of desktop and web based client applications, focusing on user interfaces, graphics drawing tools, multitthreaded and network programming. Most modern development platforms follow object-oriented concepts. Consequently, the course provides introduction to object-oriented design, basic UML and a few architectural and design patterns.

Students will be able to develop desktop and thin client applications to access hardware units from PCs, and to create user friendly user interfaces for different client types. Network programming also gets an important role. The topics covered are illustrated by case studies and demo applications.

### Vehicle operation

**BMEKOGGM174**

*Dr. Tamás Sziráni*


### Localization and mapping

**BMEEOFMM01**

*Dr. Árpád Barsi*

Goal of the subject is to present the basics of positioning and localization, the map making procedure, the requirements against the maps, as well as the use of maps. During the semester the surveying methods, the basics of geoinformatics (GIS) and the modern map making is demonstrated. The students get knowledge about positioning and its accuracy measures by own conducted measurements. The latest map standards, the newest research results and the future trends are also presented.

### Vehicle dynamics

**BMEKOGGM705**

*Dr. Zsolt Szalay*

Analysis of dynamical models apt for examining the main motion of vehicles and vehicle-strings, as well as traffic flows. The non-linear dynamic model of the force transfer in rolling contact with regard to stochasticity coming from tribological properties. Motion equations of lumped parameter models capable for vibrations describing vehicle system. The forces and motion excitation, as well as parametric excitations. The stochastic ordinary differential equation system of the discrete dynamical system. Construction of motion equation systems of distributed parameter vehicle systems. The stochastic partial differential equation system of the distributed parameter dynamical system. The vehicle dynamical systems as a controlled or regulated section. Formulation of some typical vehicle dynamical task for control, with operation-technical explanation of the control signals. The vehicle control problem formulated by model based methods. Methods apt for designing vehicle control. Failure detecting in the vehicle control system. Design of vehicle control of reconfigurating and fault-toleranting character. Design of integrated control and inspection control. Case studies concerning controlled vehicle dynamical systems.

### Vehicle mechanics fundamentals

**BMEKOGGM713**

*Dr. Bálint Szabó*

Introduction into the basics of vehicle dynamics. Description of motion equation of vehicles. Longitudinal, lateral and vertical dynamics of road vehicles. In the Autonomous Vehicle Control Engineers MSc tematics, the target of the subject is to caught up the students, who do not have ve-
The students solve adaptive identification and equalization tasks. In this way, after successfully completing the course the students are capable of solving various signal processing tasks arising in different applications.

**Automotive network and communication systems**

BMEKOGGM709

Dr. Zsolt Szalay

The goal is to present the communication systems of vehicles with advanced driver assistance systems. ECU level communications, communication types between ECU-s like CAN, LIN, MOST, FlexRay, Ethernet. Communication between vehicles, V2x. ADAS related localization and mapping systems and their communication protocols. Cyber security aspects. Electromagnetic compatibility. Diagnosis and testing and validation of communication systems.

**Automated vehicle design project**

BMEKOKAM710

Dr. Péter Gáspar

The aim of the course is to apply the knowledge gained by the previous courses through the elaboration of an individual or group project. The students choose from an well described problem group of the automated vehicles, and after studying the problem, they design a solution for it. The elaboration of the task goes through the stages of specification, state of the art study, algorithm design, implementation, documentation and end-semester presentation. The classes of the projects aim the elaboration of the project, the supervision of the progress, and consultation.

**Safety and reliability in vehicle industry**

BMEKOKAM703

The aim of the course is to provide the students with theoretical and practical knowledge about the approach and methods for designing reliable, safe and secure vehicle systems. The task is to review the safety and reliability analysis methods used in the vehicle industry and to describe the safety standards for the automotive industry. The curriculum includes the introduction of the concepts of risk and risk analysis, basic concepts of safety and reliability, as well as an overview of reliability modeling techniques used in the vehicle industry, as well as a set of best practices for reliability and safety analysis. During the processing of the subject we pay attention to ISO 26262 for vehicle safety.

**MSc Diploma Thesis I.**

BMEKOKAM553/BMEKOGGM553

Dr. Péter Gáspar / Dr. Zsolt Szalay

**Traffic modelling, simulation and control**

BMEKOKAM704

Dr. István Varga

This subject gives an introduction to road traffic automation and control. Students become familiar with the basic notions and theories, and get acquainted with the hardware architectures of road traffic control systems. Traffic detection technologies, signal automation, road traffic controllers, as well as traffic control centers and monitoring systems are introduced. An introduction to the traffic control theories is also provided. The students practice the basics of the traffic modeling through Matlab/Simulink and SUMO traffic simulator.
### Project Management
**BMEGT20M420**
*Dr. Zoltán Sebestyén*

The subject introduces students with the terminology, basic tools and techniques related to project management. The curriculum briefly summarizes the basic knowledge needed to manage a project, in a structured way, to the extent of the subject.

### Automotive R&D processes and quality systems
**BMEKOGGM711**
*Dr. Zsolt Szalay*

The aim of the course is to get students acquainted with the processes in the automotive industry, the research and development, and the relevant regulations. Students will gain insight into the standards and process models required by the automotive industry related to development processes. Within the subject, students can get acquainted with the flow elements, their structure and their relationships. In addition, within the framework of the subject, students can get acquainted with the quality management methods that support the development.

### Legal Framework of Autonomous Vehicles
**BMEGT55M420**
*Dr. Anikó Grad-Gyenge*

The objective of the course is to introduce the students into the legal environment of the autonomous vehicles, including especially the basic principles and guidelines and the present and possible future framework of these laws. Autonomous vehicles in the recent legal environment, esp. a) public law and private law questions. Autonomous vehicles in the private and public laws, legal frameworks of administrative laws, registrations, torts and product liability, warranty, software-law issues, risk-management, contract-management, insurance issues, b) Data protection (privacy) and data safety issues c) relevant criminal law issues. Autonomous vehicles in the recent legal environment. Criminal issues, and criminal liability; Autonomous vehicles in the Future. a) Types and definitions of autonomous and automated cars. Minimum requirements, technical compliance standards. b) Future use of autonomous cars and its possible effects on law - use in controlled environments, ride services, etc. c) Human - machine interface and its legal problems; new requirements - e.g. driving licence standards for the human ""element"" of the system.

### MSc Diploma Thesis II.
**BMEKOKAM554/BMEKOGGM554**
*Dr. Péter Gáspár / Dr. Zsolt Szalay*

### Human Factors in Traffic Environment
**BMETE47M000**
*Kornél Németh*

The purpose of the subject is to present the human factors involved in transport. The following topics are of the utmost importance: Overview of human risk factors, basic concepts of transport, presentation of the test methodology of vehicle driving behavior and description of its models. Overview of human visibility, visual attention and search processes, in particular the overhead resulting from parallel processing. Human-specific aspects of spatial navigation.

### Machine vision
**BMEKOALM702**
*Dr. Tamás Szitányi*

Machine vision is one of the most important measure of intelligent road transport. It allows you to track the movement of complex movement and complex traffic participants, continuously analyze situations and locations. The processing and semantic evaluation of the video stream extracted through the camera gives basic information to the autonomous leadership. The subject is about capturing, analyzing and interpreting visual information: extracting high-level image descriptors from lower-level visual characteristics.
Description of M.Sc. Subjects
Master Section in Vehicle Engineering

Advanced Driver Assistance Systems
BMEKOGGM657
Dr. Zsolt Szalay
(4 credits)

Advanced Flight Theory
BMEKORHM620
Dr. József Rohács

Advanced materials and technologies
BMEKOGGM601
Dr. Krisztián Bán
(5 credits)

Aircraft design and production I.
BMEKOVRM629
Dr. Dániel Rohács
Aircraft development philosophies.: the role of aviation in economy, major problems of aviation and aeronautical industry, goodness factors and their changes during development processes, general development process, technology transfer, development and design methods, control of the development processes. Computer aided design processes. Specific aspects of using the CATIA. Surface modeling. Development and design of the aircraft gas turbines. and their parts. (4 credits)

Computer aided design
BMEKOJSM605
Dr. László Lovas
Control theory
BMEKOKAM142
Dr. József Bokor
The course provides deepening of knowledge in control theory. Provides theoretical knowledge, and discusses modern tools, which are necessary in later engineering practice. This is introduced through different examples, taken from vehicle and transportation systems. (3 credits)

Environment Sensing in the Vehicle Industry
BMEKOKAM656
Dr. Tamás Bécsi
The course aims the introduction of the main sensor technologies of the vehicle industry. Among these, Ultrasonic, radar, Lidar, and camera based methods are discussed. (4 credits)

Instrumental tests for motor vehicles, measurement technology
BMEKOGGM668
Dr. Bálint Szabó
Based on the requirements of the current vehicle engineer education this subject gives a deep knowledge on methods of vehicle tests and measurement systems. Methods and tools of vehicle dynamical tests are introduced. It focuses on the dynamical measurements of the vehicle subsystems like brake system, steering system and the suspension. According to the present requirements of vehicle developments the demonstration of the testbench based HIL tests are part of the education. Besides the vehicle dynamical measurements, it is essential to get familiar with the fuel consumption measurements and with the emission tests performed on roller test bench. To introduce the modern engine testing methods, engine test bench measures will be carried out during the course. Alongside the development related test, the latest diagnostic measurement methods will be introduced as well. (4 credits)

Machine Intelligence
BMEK0ALM644
Dr. Tamás Szirányi
This subject teaches the students basics of machine intelligence in order to understand and be capable to apply them. (4 credits)

Measurement techniques and signal processing in vehicles
BMEKOKAM635
Dr. Alexandros Soumelidis
Provides knowledge about the instrumental measurement and evaluation of the vehicle parameters. Furthermore introducing sensing and measurement principles, signal processing, traffic measurement. Theory of sensorfusion, sensor networks of the vehicle dynamics measurement. State estimation, parameter estimation, Kalman-filter. Applications in vehicle control systems. (8 credits)

Mechanics of superstructure materials
BMEKOJSM663
Dr. Péter Béda
Modeling of materials. Role of the constitutive equation, principles of its building. Types of material laws, typical behavior issue from experiments. Presentation and study of elastic and plastic bodies. Rheological models. Application examples. (4 credits)

Numerical methods
BMEKOVRM121
Dr. Rohács József

**Operation of railway vehicles**

*BMEKOVM409*

Dr. József Csiba

Service processes for railway vehicles. Vehicle input, the actual service timing and vehicle output as components of a random service process. Inventory problems in the operation of railway vehicles, the theory of minimum cost-storing and purchase. Statistical theory of the operating system of railway vehicles based on the technical state. Analysis of the operation reliability of railway vehicles, reliability-based operation/maintenance (RCM system). Railway vehicle diagnostics, vehicle diagnostics and stationary equipments, stations. Systems for identifying of vehicles and their operational modes. Operational properties of braked trains, braking-difficulties, dynamical- and thermal processes. (3 credits)

**Practice in technology of manufacturing and materials in vehicle industry**

*BMEKOGGM648*

Dr. Krisztián Bán

(4 credits)

**Programming in C and Matlab**

*BMEKOKAM603*

Dr. Tamás Bécsi

The course aims the introduction to programming in C and Matlab languages. (4 credits)

**Railway vehicle system dynamics**

*BMEKOVRM608*

Dr. Zoltán Zábori


**Requirements for superstructure designers**

*BMEKOJS662*

Dr. Péter Béda

Manufacturer’s requests for vehicle superstructure designers. Manufacturer’s rules for superstructures and assembling. National and international laws. Preparation for manufacturing. (4 credits)

**Road safety, legislative environment, human factors**

*BMEKOGGM653*

Dr. Gábor Melegh

Legal studies: an extract from the constitutional law, substantive and procedural civil law, criminal law, criminal procedural law, driving offences, issues of damages claims. Human factors in road traffic: personality characteristics, behaviours, human health protection, generational problems, effects of weather and seasons, special related questions of vegetation and fauna, damages caused by wild animals. Personal injuries: the human body, physiological particularities, classification of injuries, examination of accidents in the light of injuries, examination of blood alcohol concentration, examples of medical investigation of accidents. (4 credits)

**Ship design**

*BMEKOVRM615*

Dr. Győző Simongáti

The course aims at introduction of the process of ship design, the design spiral, determination of main particulars, lines planning, optimisation techniques, conceptual design, preliminary design methods, tonnage calculation, etc. (5 credits)

**Simulation of technical systems**

*BMEKOALM645*

Dr. Gábor Bohács

The subject introduces to the students software background which can be used as a virtual reality to support engineering decisions. (4 credits)

**Surface Engineering**

*BMEKOGGM647*

Dr. Tamás Markovits


**Suspension design**

*BMEKOGM613*

Dr. Bálint Szabó

Analysis of forces acting on wheel using modern tyre-models, knowing objective functions of static and dynamic geometrical parameters of tyres, necessary for design. Geometrical design of tyre suspension, structural design of each parts of suspension (rods, arms, ball joints, rubber mountings). Vibration analysis of vehicle, geometrical and structural design of elements of suspension (coils, springs, shock absorbers, stabilizers, motion boundary elements) in regard to requirement systems of suspensions. Dynamical analysis of braking vehicle in order to determine design requirements; methods for proportioning brake force between axles; design of conceptual schema of brake system; geometrical, structural, thermo- and fluid dynamical design of each parts. Determination of initial data needed to design the steering system using dynamical analysis of steering; design of steering mechanism; geometrical and structural design of elements of steering systems (tie rod, track rod, steering-gear, steering wheel and axle, ball joints). (4 credits)

**Theory of Ships III.**

*BMEKOVRM616*

Dr. Győző Simongáti

The aim of the course is to introduce the special cases of stability for the students. Topics are: deterministic and probabilistic damaged stability methods, grounding, docking, stability of floating cranes, split barges. (3 credits)
Vehicle operation, reliability and diagnostics

**BMEKOVRM602**

**Dr. József Csiba**


Accident analysis I., forensic processes

**BMEKOGGM654**

**Dr. Gábor Melegh**

Technical causes of road traffic accidents, malfunctions of vehicles and engines; the most occurring malfunctions of vehicles and its engines, causing great damages. Identifying the root causes of accident from incurred damages, ascertainment of the technical responsibility, conclusions, options of accident avoidances. Role of vehicles, explanation of technical malfunctions, analysis of road traffic accidents occurred for technical reasons, contribution of subjective causes. Evaluation of accident forms: Main forms of accident and conclusions deductible from conditions after accident. Accidents attendant on hitting pedestrians, fundamental calculation methods, evaluation of hitting pedestrian overstepping form covering, accidents occurred in reduced visibility, experimental reconstruction of traffic accidents. Vehicle collision: substantial formulas of crashes, crash-calculation by analytical and graphical methods; deformations of vehicles and pictures of damages, energy grid. (4 credits)

Aircraft analysis I.

**BMEKOVRM631**

**Dr. Károly Beneda**

The aim of the course is to introduce the analysis techniques of aircraft and powerplants. (4 credits)

Aircraft design and production II.

**BMEKOVRM630**

**Dr. Balázs Gáti**

Aircraft Design II. (4 credits)

Computational fluid- and thermodynamics

**BMEKOVRM606**

**Dr. Árpád Veress**

The goal of the present subject is to prepare students for the state of the art application of CFD calculation methods in the vehicle engineering with including thermodynamics and heat transfer. (4 credits)

Construction of vehicle manufacturing systems I.

**BMEKOGGM649**

**Dr. Tamás Markovits**

(4 credits)

Design methods of drive systems

**BMEKOALM646**

**Dr. Gábor Bohács**

This subject aims to introduce the construction and materials handling machines' specific drive systems, construction and examination methodology. (3 credits)

Design of material handling machine design

**BMEKOKAM627**

**Dr. Gábor Bohács**

Design and norming of material handling machines. Capacity and power requirement calculation for machines of bulk materials. Design of material handling machines for unit loads, especially forklifts and cranes. (5 credits)

Design of pleasure craft

**BMEKOVRM625**

**Dr. Győző Simongáti**

The course aims at introduction of the specialities pleasure craft design. (4 credits)

Diesel and electric traction

**BMEKOVRM610**

**Dr. András Szabó**

Design properties of railway Diesel engines, dynamical processes of injection and control systems. Turbocharging systems of railway diesel engines. Design properties of Diesel-hydraulic and Diesel-electric powertrain system design, machine-group optimization, transient operation processes. Drive dynamics of electric traction units, electro-mechanical, controlled systems. Analysis of the work done and energy-consumption, hydraulic/electro-dynamic braking of trains of Diesel and electric traction units, and their optimization. (5 credits)

Discrete Control Design

**BMEKOKAM658**

**Dr. Péter Gáspár**

The course aims the presentation of discrete control theory. Besides the theoretical and mathematical design aspects, implementation issues are also discussed. (4 credits)

Dynamics of vehicle, active- and passive safety

**BMEKOJGM641**

**Dr. Gábor Melegh**

Analysis of the forces acting on the wheels, state of the art tyre-models, static and dynamic geometric characteristics of tyre from the point of view of traffic safety. Analysis of force and moment conditions of transmission systems, examination of dynamic parameters of mechanical and hydrodynamical torque converter. Geometry of tyre suspension, load of each elements of suspension. Vibration theory of vehicle, parts of suspension. Dynamic analysis of vehicle braking; methods for proportioning brake force between axles of vehicle; conceptual schema of different types of brake systems; geometrical-, mechanical-, heat-
and hydrodynamics loads of single part.
Dynamical analysis of steering, geometrical and mechani-
cal design of parts of steering systems (tie rod, track rod,
steering gear, steering wheel and axle, ball joints),
Review of software solutions applicable for making vehicle
dynamic models; examination of longitudinal and trans-
verse vehicle dynamics, methods for controlling vehicle dy-
namics. Dynamical examination and modelling of vehicle’s
roll over process.
Active and passive components of vehicle safety: control
systems of vehicle dynamics, introducing systems which are
suitable to mitigating consequences of accidents. Detailed
review of sensors and actuators which are parts of these
systems. Uses of data stored in these systems’ ECUs for re-
construction of an accident. (4 credits)

Electronics – electronic measurement sys-
tems
BMEKOKAM103
Dr. Géza Szabó
The subject gives basic knowledge of electronics and elec-
tronic measurements and their application in different areas
of transportation. It summarizes the operational modes of
basic components and basic circuits and describe how one
can design and apply them. It gives an overview of electric
and mechanical measurements and how the results of mea-
surements can be processed
(4 credits)

Engine design I.
BMEKOGGM670
Dr. Huba Németh
Grouping of engine simulation methods. Wave action en-
gine models and its equations. Flow filed, pressure drop
and heat transfer in the intake and exhaust systems. Flow
splits. Flow on intake and exhaust valves. Constructional
and geometrical design of combustion chambers. Set up of
bore-stroke ratio, valve diameters, and compression ration
values. Modelling of combustion processes, and its main
parameters. Wall heat transfer models. Mechanic losses and
friction models. Determination of charger pressure and fuel
rate for given performance targets. Set up of the charger
and its cooperation with the engine. Reduced charger maps.
Control of charging systems.
Mechanical and thermal loads of the reciprocating engine
pistons. Geometric and construction design of pistons. Wrist
pin design. Dimensioning methods. (4 credits)

Fixing and sealing
BMEKOGGM650
Dr. Krisztián Bán
(4 credits)

Machines of construction material produc-
tion
BMEKOALM672
Dr. Gábor Bohács
Computer aided construction of crushing machines. Mo-
tion equations of vibrating sieves. Construction of concrete
mixers. Reinforcing steel processing equipment sizing and
system control features. (5 credits)

Mechatronics, microcomputers
BMEKOKAM604
Dr. Péter Gáspár
Introducing the modern computer systems and the operat-
ing principles of robots. Numeral systems CPU arithmet-
ics, operations and algorithms with binary numbers. CPU
architectures, tasks and operation. Computer networks: pro-
cocols, devices for wired and wireless communication.
(4 credits)

Ship motions
BMEKORVM624
Dr. Győző Simongáti
The course aims to introduce students to the dynamics and
transient phenomena of ship motions, and to the dynamics
of equipments which may effect on ship motions. (4 cred-
its)

Structural vibrations
BMEKOJSM665
Dr. Péter Béda
The second order Lagrange equation equation for holo-
nomic and scleronomic conservative systems. The exis-
tence of stable equilibrium. Small oscillations, frequencies
approximate definition. Vibrations of rods, axes, strings and
membranes. Basics of modal analysis. Methods for nonlin-
ear oscillation problems. (4 credits)

Structure analysis
BMEKOGJSM609
Dr. Péter Béda
Theory and practice of the finite element method. Linear,
elastic and plastic material modeling. Mechanical and ther-
al analysis. Eigenfrequencies and vibrations. Topological
structure optimisation. Study and verification of the opti-
mized model. (4 credits)

Superstructure preliminary design
BMEKOJSM664
Dr. László Lovas
Construction, special links. Connections among square
tubes, sheet metal and elastic covers. Connection between
vehicle frame and rigid superstructure with given function.
(4 credits)

System technique and analysis
BMEKORVM129
Dr. István Zobory
Vehicle and machine analysis using system theoretical ap-
proach. System characterisation by means of graphs. Hi-
erarchy of system structures: emements, element-groups,
machine, machine group. Characterisation of complex en-
geineering systems by block-diagrams, structure graphs and
signal-flow graphs. Description of the system connections.
Construction of the input-output system equations by using
the system operator. Application of Lagrangean and Ham-
iltonean procedure. The general theorey of linear dynamic
systems. Weighting function, transition function in the time
domain. Convolution theorem. Complex frequency func-
tion in the frequency domain. Periodic, aperiodic and sta-
tionary stochastic excitations, wdhth SISO and MIMO sys-
tems. Determination of the system response. Analysis of the
coherency conditions. (4 credits)
Traction mechanics

**BMEKOVRM619**

Dr. István Zobory

Factors of train motion. Tactive effort, braking force, track force. The tractive and braking forces applied in the control system influencing the torque conditions of the rotating components. Determining the train-weight that can be started, the construction Koreff-figure. Detreming the speed-timing diagrams by means of simulation using dynamical models. Taking into account the limit force that can be transferred through the rolling contact, without macroscopic sliding. The longitudinal dynamics of trains. Dynamics of train-tearing. Dynamics of special train motions: shunting, marshalling, hump. Energy demand of train motion, simulation of energy consumption with Diesel- and electric traction. Outlook to the sphere of problems of energy optimum train control, basic principle for the application of traction and braking forces, the numerical layout of the optimum train control. (3 credits)

Transmission system design

**BMEKOGJM612**

Dr. Huba Németh

Main parameters of vehicle mechanics. Construction of an arbitrary selected transmission component (clutch, gearbox or final drive), set-up of functional dimension based on vehicle dynamic calculations, geometrical construction of all components, structural dimensioning of gears, shafts and bearings for load and lifetime, construction and dimensioning of actuation mechanisms, design of housings and fixation points. (4 credits)

Vehicle automation systems

**BMEKOOGM659**

Dr. Zsolt Szalay

(4 credits)

Vehicle system dynamics and control

**BMEKOVRM636**

Dr. István Zobory

Analysis of dynamical models apt for examining the main motion of vehicles and vehicle-strings, as well as traffic flows. The non-linear dynamic model of the force transfer in rolling contact with regard to stochasticity coming from tribological properties. Motion equations of lumped parameter models capable for vibrations describing vehicle system. The forces and motion excitation, as well as parametric excitations. The stochastic ordinary differential equation system of the discrete dynamical system. Construction of motion equation systems of distributed parameter vehicle systems. The stochastic partial differential equation system of the distributed parameter dynamical system. The vehicle dynamical systems as a controlled or regulated section. Formulation of some typical vehicle dynamical task for control, with operation-technical explanation of the control signals. The vehicle control problem formulated by model based methods. Methods apt for designing vehicle control. Failure detecting in the vehicle control system. Design of vehicle control of reconfiguring and fault-toleranting character. Design of integrated control and inspection control. Case studies concerning controlled vehicle dynamical systems. (8 credits)

Accident analysis II., simulation methods

**BMEKOOGM655**

Dr. Gábor Melegh

Description of crash-models used in software solutions for accident reconstruction. Examination and analysis of complete regular and irregular vehicle motion process with simulation methods.

Specifying the parameters which are necessary for simulation; conmitment the circle of questions answerable by available parameters and data in a concrete case. Interpretation of probabilistic ascertainmentments. Parameter sensitivity analysis of simulation results.

Evaluation, analysis and explanation of results provided by simulation software; plausibility of results. (5 credits)

Analysis of Aircraft II.

**BMEKOVRM632**

Dr. Balázs Gáti

(7 credits)

Computer aided manufacturing

**BMEKOOGM618**

Dr. Zoltán Pál

(4 credits)

Construction machinery design - project

**BMEKOALM674**

Dr. Gábor Bohács

Theory of mechanical construction of the building machines. Handling special load cases of the building industry’s tasks. Preparation of a complex task relating construction machines. (5 credits)

Construction mechanization project planning methods

**BMEKOALM673**

Dr. Gábor Bohács

Management of construction projects from mechanization aspects. Compilation of machine chains and systems. Capacity planning and scheduling. Determining operational parameters of earthwork machines and other construction machinery. (5 credits)

Construction of vehicle manufacturing systems II.

**BMEKOOGM651**

Dr. János Takács

(5 credits)

Design and testing of railway vehicle systems

**BMEKOVRM607**

Dr. András Szabol

Design methods of material handling systems

**BMEKOALM642**
Dr. Gábor Bohács
Characteristics of structure and operation of material handling systems. Mechanical connections and communication issues among the systems’ components. Identification methods for bottlenecks. Planning operational strategy of material handling system. Safety in material handling systems. (5 credits)

Design of material handling machines - project

**BMEKOALM643**
Dr. Gábor Bohács
During the classes students learn most relevant issues of materials handling equipments’ mechanical construction. Construction of a selected materials handling machine is also carried out by students. (5 credits)

Design of Vehicle Automation Systems

**BMEKOKAM661**
Dr. Tamás Bécsi
The course aims the strengthening of project design skills through a large individual student project. (7 credits)

Engine design II.

**BMEKOGGM671**
Dr. Huba Németh

Measurement systems in vehicle manufacturing

**BMEKOOGGM652**
Dr. Pál Bánlaki

Mechatronic design of vehicle systems

**BMEKOOGGM622**
Dr. Zsolt Szalay
System design methods. SIL and HIL simulation methods in system design and testing. Printed circuit board design introduction. Main loads on mechatronic components. Vibration loads and its design methods. Thermal loads and its design methods. Electronic loads and its design methods. (5 credits)

Sesons types, selection and design. Actuator types, selection and design. Pneumatic, hydraulic and electro-mechanic actuators. Selection and design of actuators. (5 credits)

Production process quality assurance in the vehicle industry

**BMEKOGGM611**
Dr. Zsolt Stukovszky
(2 credits)

Project

**BMEKOVRM633**
Dr. Árpád Veress
In this subject the students have the possibility either to work as a trainee at an aircraft design office or get involved in a project running at our department. (3 credits)

Project work

**BMEKOVRM628**
Dr. Győző Simongáti
In this subject the students have the possibility either to work as a trainee at a ship design office or get involved in a project running at our department. (2 credits)

Project management in automotive industry

**BMEKOKKM617**
Zoltán Nagy
Project management can play an important role in the current wave of product development reengineering taking place in the automotive industry. In this course those special project management processes and tools can be studied which are necessary during automotive product development. (2 credits)

Reliability, Safety and Security in the Vehicle Industry

**BMEKOKAM660**
Dr. Balázs Sághi
The aim of the course is to provide the students with theoretical and practical knowledge about the approach and methods for designing reliable, safe and secure vehicle systems. (3 credits)

Research and development process in the vehicle industry

**BMEKOGGM614**
Dr. Zsolt Stukovszky
(2 credits)

Ship hydrodynamics

**BMEKOVRM626**
Dr. Győző Simongáti
The subject aims to introduce the basic analytical and numerical methods for calculation of ship resistance, water velocity and pressure distribution around hull. International and practical recommendations for numerical calculations of ship hydrodynamics. (4 credits)

Ship strength

**BMEKOVRM621**
Dr. Győző Simongáti
The course aims to explain numerical methods for calculating ship strength, and to introduce the verification calcula-
tion methods of ship strength according to the legal regulations, international standards and classification societies. (4 credits)

**Superstructure control technics**

**BMEKOJSM666**

*Dr. Ferenc Pápai*

Traditional hydraulic drives. Electrohydraulic drives, sensors, actuators. Presentation of the onboard electronic devices. Definition of stability and overload criteria. Accident prevention. (5 credits)

**Vehicle evaluation, traffic environment**

**BMEKOGJM640**

*Dr. Gábor Melegh*

Students know the basics tasks and expectations connected to making damage survey, determination of the repair costs and depreciation after repairs (or betterment). They are informed of the related disciplines, which directly or indirectly connected to these questions. Knowledge about different types of vehicle insurances.

Detailed review of catalogue systems used for vehicle evaluation and calculating repair cost.

Examination of special questions of maintainability and deterioration of vehicles.

Solving specific vehicle evaluation problems with statistical methods.

Human factors of driving road vehicles, reaction time, perception and perceivability. (5 credits)

**Vehicle simulation and optimisation**

**BMEKOVJM437**

*Dr. Ferenc Kolonits*


The functional areas and roads setting - the possibilities and the processing pathes. Graph theoretical analysis of the failure groups. Production data structures for vehicle system reliability analysis. The statistical processing programs to connect preparation. (5 credits)

**Vehicle superstructure design**

**BMEKOJSM667**

*Dr. László Lovas*

Superstructure construction regarding the needs of manufacturable design and tooling. Optimization of superstructures (weight, rigidity, manufacturing). (5 credits)

**Vehicle system informatics**

**BMEKOVJM437**

*Dr. Ferenc Kolonits*


The functional areas and roads setting - the possibilities and the processing pathes. Graph theoretical analysis of the failure groups. Production data structures for vehicle system reliability analysis. The statistical processing programs to connect preparation. (5 credits)
Description of M.Sc. Subjects
Master Section in Transportation Engineering

Control theory
BMEKOKAM142
Dr. József Bokor
The course provides deepening of knowledge in control theory. Provides theoretical knowledge, and discusses modern tools, which are necessary in later engineering practice. This is introduced through different examples, taken from vehicle and transportation systems. (3 credits)

Decision making methods
BMEKOKKM221
Dr. Zoltán Békefi
Introduction of the most important methods of operations research and their applications in the transport sector. (5 credits)

Intelligent transport systems
BMEKOKUM205
Dr. János Tóth
The components of intelligent transport systems. The application of ITS on highways and in urban transport. Supporting private and public transport by road and passenger information systems. Traffic management systems. Geographical Information Systems (GIS) in transport. The features and planning principles of GIS databases in transport. The methods of positioning, tracking systems. The vehicle detection and identification systems. Route planning methods. Fleet management. (5 credits)

Mathematics MK
BMETE90MX59
Dr. Sági Gábor
(4 credits)

Road Safety
BMEKOKKM222
Dr. János Juhász

Transport automation
BMEKOKAM202
Dr. Balázs Sághi
Main topics of the subject include: Basic principles of safety. Development of safety-critical systems System life cycle models Safety requirement specification, safety criterion Hazard and risk analysis techniques Safety integrity of systems Safety analysis Failure management of safety critical systems Introduction to formal techniques, Petri nets (4 credits)

Transport Economics
BMEKOKGM201
Dr. Ferenc Mészáros
Analysis of EU transport strategies in different modes. Monetarising and internalising of transport externalities. (4 credits)

Air Traffic Management (ATM)
BMEKOVRM224
Dr. Dániel Rohács
The course aims at introduction to the basic principles of air traffic control, the categories of airspaces and the main methods and support systems of ATC. The course examine the most important human factors and the main researches. (3 credits)

Communications, Navigation and Surveillance (CNS) I.
BMEKOKAM226
Dr. Dóra Meyer
The aim of the subject is to provide deeper knowledge on planning and operating of air transportation related navigation systems, facilities or devices that have been operationally released to be used either by airspace users (e.g. ground navigation facilities) directly, or are used in the provision of operational air traffic management services. (3 credits)

Controlling systems in transportation
BMEKOKGM215
Dr. Ferenc Mészáros
Introduce the technical, legal, economic, financial, social and institutional frameworks and directives that control operation and improve integration, development of transportation system in European Union. Promoting their domestic adaptation and application. (6 credits)

Electronics – electronic measurement systems
BMEKOKAM103
Dr. Géza Szabó
The subject gives basic knowledge of electronics and electronic measurements and their application in different areas of transportation. It summarizes the operational modes of basic components and basic circuits and describe how one can design and apply them. It gives an overview of electric and mechanical measurements and how the results of measurements can be processed (4 credits)

Forwarding Management 1
BMEKOKKM132
Dr. Ferenc Mészáros
History and attributes of freight forwarding, international agreements, different contract types, rules of extra ordinary freight forwarding, legal framework of customs, tasks of national and international forwarding services. (5 credits)
The course aims at introduction to the basic principles of modern computer architectures, and especially computer systems and communication techniques which are of high importance in transportation. (3 credits)

**Information connection of the vehicle and the track**

**BMEKOKAM104**

**Dr. Tamás Bécsi**

The subject gives an overview of information transmission between infrastructure and vehicles, both logically and physically. Examples are given for railway, road and air transportation sectors. (3 credits)

**Material handling and warehousing processes**

**BMEKOALM225**

**Dr. Gábor Bohács**

The specific properties and main groups of the materials in the logistics systems. The functions of the packaging, packaging nation’s economic role. The classification of packaging, packaging materials - different materials, packaging materials, packaging accessories. Cargo unit creation. Characteristics of the material handling systems, the main groups, material handling tasks, material flow characteristics. The main groups of material handling machines and techniques. Performance and reliability of the material handling systems. Calculation of the material handling time. Material handling process examination. Secondary analysis, layout planning. Conventional storage systems, high bay warehouse systems. Order picking. Statistical sampling procedures. Tenders. (4 credits)

**Meteorology**

**BMEKOVRM231**

**Dr. Rohács Dániel**

The course aims at introduction to meteorological phenomenas and conditions, the structure of the atmosphere and other important aviation weather informations. (3 credits)

**Modelling and control of vehicles and traffic systems**

**BMEKOKAM233**

**Dr. István Varga**

Design of road traffic systems and traffic modeling practice with state-of-the-art design software:
- microscopic modeling with VISSIM,
- advanced use of VISSIM via COM programming with MATLAB,
- macroscopic traffic planning (classical four-step approach) with VISUM
- application of MATLAB for freeway traffic modeling and control,
- introduction to the application of QGIS. (6 credits)

**Numerical methods**

**BMEKOVRM121**

**Dr. Rohács József**


**Smart City**

**BMEOKKM227**

**Dr. János Tóth**

Smart city introduction, land use functions and models, city planning, utilization of social media, Internet of Things, wireless sensor networks, Smart Grids, lighting, best practices. (3 credits)

**Transport informatics**

**BMEOKKM223**

**Dr. Csaba Csicszár**

The subject is based on Transport information systems I. and II. Main topics: modelling of con-cepts, relations and regularities in information systems and applying of these models in trans-portionation. The structure and operation of the transportation organizations and operational con-trol processes (preparation, execution and accounting) are also lectured. (5 credits)

**Transport Infrastructure Management**

**BMEOKKM228**

**Dr. Ferenc Mészáros**

Role of transportation networks and regulatory policies. Asset valuation, asset management techniques and systems. Operation contracts, risk sharing and management. Tasks in adaption to climate change and sustainability principles. (3 credits)

**Transport modelling**

**BMEOKKM229**

**Dr. János Tóth**


**Transport operation**

**BMEOKUM206**

**Dr. Péter Mándoki**

Planning of intermodal node. Infrastructure and vehicles of different transport modes. (5 credits)

**Air Traffic Control**

**BMEKOVRM235**

**Dr. Dániel Rohács**

The course aims at introduction to the basic principles of air traffic management, the history and the main methods of ATM. The course examine the most important elements of the management system, the advantages and disadvantages and the researching of ATM. (4 credits)
Case study

**BMEKOVRM237**

Dr. Dániel Rohács
The students have to participate in one of the R+D projects of the faculty. (3 credits)

City logistics

**BMEKOALM244**

Dr. Bóna Krisztían
The main types of transport goods in the city supply networks. The rule of city logistics in the global logistics networks, the definition of last mile problem. The application of transporting systems in the city logistics. Loading technology in the city logistics. The rule of logistics providers in the city supply, the integration of city logistics in the gateway conception. The urban consolidation centres ans x-docks. The control and organisation of city logistics in big cities. Best practises in worldwide. Application of modelling techniques is the organisation and operation of city logistics systems. Informatics in city logistics. (5 credits)

Communications, Navigation and Surveillance (CNS) II.

**BMEOKKM239**

Dr. Rita Markovits-Somogyi
The course aims at introduction to the systems of navigation, surveillance and data process. The course examine the basic principles of voice communication, the data technologies of air traffic control and complement of the knowledge of course CNS I. (4 credits)

Engineering of transport automation systems

**BMEOKAM234**

Dr. Balázs Sághi
The aim of the subject is to provide deeper knowledge on planning of transportation systems. Rules, legislation basics, guidelines for different domains are introduced, planning phases are touched and project work is expected from students. (6 credits)

Environmental effects of transport

**BMEOKKM230**

Dr. János Tóth
Transport-environment, factors of environmental impact, the problem of sustainability. Mitigation of environmental impacts of transport, regulations, policies, tendencies, practices. Local and international case studies. EIA, decision making, preparation of decisions on the field of transport infrastructure development. Integration of transport and land use. Environmental conflicts of freight transport, intermodality and transit policies. Environmental costs of transport, the case of externalities, prices and changes. Urban transport, opportunities of sustainable urban environmental management, integration of environmentally sound mobility forms. Demand management, parking and road charges. Requirements of fuel efficiency, alternative fuels, energy efficient and environmentally enhanced vehicles. (4 credits)

Financing techniques in transportation

**BMEOKKKM236**

Dr. Zoltán Békéfi
Concepts of financing: financing goals (development, operation); financing options: budget, private or public-private partnerships (PPP); loan, bond, lease and their characteristics. Project analysis and evaluation methods. Project identification, technical preparation, traffic forecast and modelling. Risk assessment needs. Feasibility studies, cost-benefit analysis, financial, social, legal, regulatory and technical compliance criteria. The identification of project risks. Definition of government, regional and local priorities. The role of the partners in the project financing. Communication tasks. The media’s role for accepting the project financing methods by the society. Optimizing fees and tariffs. Financial structures and models. Contracts. (5 credits)

Forwarding Management 2

**BMEOKKM133**

Dr. Ferenc Mézsáros
Mode specific knowledge of freight forwarding management (road, rail, aviation, inland waterway and maritime, combined and LTL transport). (5 credits)

Forwarding marketing

**BMEOKKM135**

Dr. Botond Kővári
Marketing concepts, overview of resources. Market analysis methods. Product mix reviews. Advertising strategies. (4 credits)

Human resource management in transportation

**BMEOKKM238**

Dr. Botond Kővári
Applied human resource challenges, especially in transportation. Motivation, team working, carrier planning (3 credits)

Management of transport and logistic services

**BMEOKGM217**

Dr. Botond Kővári
The main aim of this course is to develop and implement performance measurement in a transport or logistic organization with the help of a balanced KPI (key performance indicator) system. (6 credits)

Passenger transportation

**BMEOKUM208**

Dr. Csaba Csiszár
Characterization of passenger transportation systems, properties, planning process. Evaluation of system. Modelling of motion process in regional area. Qualitative system of passenger transport, service levels. Planning of system elements of passenger transport (local and inter-town), in individual and public transport. Overview and summary of properties of the advanced, so called “transitional” passenger transportation modes (e.g. car-sharing, bike-sharing, car-pooling, chauffeur service, demand responsive transport) in system and process-oriented approach. (5 credits)

Project

**BMEOKAM242**

Dr. Balázs Sághi
Project work (3 credits)
<table>
<thead>
<tr>
<th>Course Title</th>
<th>Code</th>
<th>Instructor</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Project Management in Transportation</strong></td>
<td>BMEKOKKM241</td>
<td>Zoltán Nagy</td>
<td>This course is an introduction to project management in the transportation sector and basic concepts and tools for developing the student’s skills. During this course are presented the most relevant concepts on the formulation and preparation of different transport developing projects and their scheduling and control techniques. Students work with different models and tools for setting professional goals, time management, teamwork and communication techniques. (2 credits)</td>
</tr>
<tr>
<td><strong>Safety in Air Traffic Control</strong></td>
<td>BMEKOKAM243</td>
<td>Dr. Dóra Meyer</td>
<td>The aim of the subject is to provide deeper knowledge on planning of safety certification in air traffic control. Rules, legislation basics, guidelines for different domains are introduced, planning phases are touched. (3 credits)</td>
</tr>
<tr>
<td><strong>Signal Processing in Transport</strong></td>
<td>BMEKOKAM211</td>
<td>Dr. József Bokor</td>
<td>Introducing the microcontroller architectures used extensively in transportation systems. Embedded system design, and software development. Digital signal processing: A/D and D/A conversion, filtering and DSPs. Safety critical hardware and software design and implementation. (5 credits)</td>
</tr>
<tr>
<td><strong>Supply and Distribution Processes</strong></td>
<td>BMEKOALM240</td>
<td>Dr. Gábor Kovács</td>
<td>The basics of organizing supply chains (SCM), enterprise logistics system. The organization of the material supplies, material analysis methods (ABC, XYZ), supply strategies (synchronized, by stocking, on request), material planning methods (Gozinto graph, BOM). The inventory systems and processes (rotation indicators), inventory valuation (FIFO), inventory model (EOQ). Distribution systems, demand forecasts (simple methods). Production logistics (MRP, APS, Kanban, Lean). The definition and main tasks of the reverse logistics. (2 credits)</td>
</tr>
<tr>
<td><strong>Trade, Financial, Accounting Techniques</strong></td>
<td>BMEKOKKM138</td>
<td>Dr. Ferenc Mészáros</td>
<td>General principles of international trade, stakeholders and their relationships, trade transactions. Set and elements of the banking system, frequent financial transactions of freight forwarders. Accounting obligations and techniques of freight forwarding companies, balance sheet and profit and loss statement. (3 credits)</td>
</tr>
<tr>
<td><strong>Traffic Flow</strong></td>
<td>BMEKOKUM204</td>
<td>Miklós Kózel</td>
<td>Analysing, modelling and planning of traffic flow on road transportation network, in consideration of passenger and goods transport. Probability distributions, vehicle in winding way, phasing of traffic lights, road markings, traffic signs, pedestrian flow, traffic calming zones (4 credits)</td>
</tr>
</tbody>
</table>
### Description of M.Sc. Subjects

#### Master Section in Logistic Engineering

**Control theory**  
**BMEKOKAM122**  
**Dr. Péter Gáspár**  
The course provides deepening of knowledge in control theory. Provides theoretical knowledge, and discusses modern tools, which are necessary in later engineering practice. This is introduced through different examples, taken from vehicle, transportation and logistics systems. (5 credits)

**Lean management**  
**BMEKOALM322**  
**János Kosztolányi**  
Methods of continuous improvement. The teamwork, establishment of suggestion systems, the role of motivation. Main brainstorming methods, the advantages and disadvantages of each method. Introduction and application of problem finding tools, methods for failure analysis, applicability of the main methods. Data request for failure analysis methods. The basics of standardization, the steps of making standard processes, the zero failure concept (jidoka, Poka-Yoke), production equalization in lean management: mathematical methods for Heijunka. Process development methods, and techniques. The importance of changeover time, methods for the reduction of changeover time in the companies. The basics of ergonomics, types of workplaces from the aspect of ergonomics, the steps of REBA analysis. Lean office methods and tools. The basics of Six Sigma method, mathematical background, the levels of quality. Description of six sigma analysis, evaluation of the results. The relationship between six sigma and lean. (4 credits)

**Logistics controlling**  
**BMEKOKKM330**  
**Dr. Szabolcs Duleba**  
The primary task of logistics controlling is managing all logistics activities using comprehensive measures on all levels of a company with the provision of information processing systems based on the management’s information needs. After the completion of this module, the graduate will have the knowledge and an understanding of the fundamentals and characteristics of reporting systems for logistics, logistics accounting and cost accounting, activity-based costing, strategic logistics controlling and logistics benchmarking. (3 credits)

**Logistics information system planning**  
**BMEKOALM321**  
**Dr. Jenő Tokodi**  
Logistics information system (LIS) databases. LIS planning, IT representation of system elements, purchase orders, sales, production, quality assurance. System and software planning methods, IT representation of data formats, schemes, process description, Service oriented architecture, webservises, interfaces, Enterprise Service Bus, Orchestrating. ERP webservises, workbench, dictionary, business warehouse, reporting. BI systems. Transactional database. (5 credits)

**Mathematics ML**  
**BMETE90MX60**  
**Dr. Gábor Sági**  
(5 credits)

**Planning of extra-logistics networks**  
**BMEKOALM337**  
**Dr. Krisztián Bóna**  

**Algorithm Design**  
**BMEKOKAM326**  
**Dr. Tamás Bécsi**  
The course aims the introduction of algorithm theory and numerical complexity. (5 credits)

**Automation of logistics systems**  
**BMEKOALM325**  
**Dr. Gábor Kovács**  
This subject introduces integration of logistics automation into the higher levels of corporate governance. Communication possibilities in PLC networks are also addressed. Introduction of industrial communication protocols and interfaces. Effects of humans, identification and quality checking on automation. (5 credits)

**Demand planning and inventory management**  
**BMEKOALM328**  
**Dr. Krisztián Bóna**  
Specific resource planning areas in the enterprise logistics. Mathematical modeling in the demand planning process, model identification and parameter optimisation. Mathematical modeling in the inventory planning process, select inventory models, optimisation of control parameters, inventory control systems. Measurement of demand and inventory planning efficiency. Specific planning tools of ERP systems. The role of inventory and demand planning in the S&OP process. (5 credits)

**Enterprise logistics project 1.**  
**BMEKOALM339**  
**Norbert Antal**  
Within the framework of the course, project groups are formed from the students, which are led by mentors. The project topics may include: operations management, complex project tasks, R&D tasks, based on the interests of student’s. During the contact hours, the students consult with their mentors, moreover, each week brief report is held. The students present the problems and the suggested solutions, they practice the techniques of discussion, argumentation, and persuasion. (4 credits)

**Forwarding Management 1**  
**BMEKOAKM132**  
**Dr. Ferenc Mészáros**  
History and attributes of freight forwarding, international
agreements, different contract types, rules of extra ordinary freight forwarding, legal framework of customs, tasks of national and international forwarding services. (5 credits)

**Forwarding project 1.**

**BMEKOKKM338**

Dr. Ádám Török

Executive knowledge in managing freight forwarding companies. (4 credits)

**Logistics planning softwares**

**BMEKOALM336**

Dr. Jenő Tokodi

Classification of softwares in logistics planning. Introduction of software tools in corporate process planning, including designing flow chart (EPC, BPMN), Gantt chart, Fishbone diagram. The functions of computer aided design softwares, basic components, transformations, dynamic blocks, scaling, managing layers. Standard symbols of logistics components. Basic of spatial designing. Project management softwares. (3 credits)

**Numerical optimization**

**BMEKOVRM334**

Dr. József Rohács


**Process planning**

**BMEKOALM331**

Dr. Gábor Kovács


**Simulations planning**

**BMEKOALM335**

Dr. Krisztián Bóna

The types of models, the basics and mathematical rudiments of modelling, stochastic and deterministic processes, and the main process properties. The definition of computer based simulation modelling and the application in the logistics system planning. Simulation algorithms and programming. Simulation and optimization, simulation based optimization methods. The simulation softwares and simulators. Application of simulation based optimization methods in logistics. Application of artificial intelligence in specific logistics optimization problems. Development of simulation systems and models in intra- and extra logistics systems. (3 credits)

**Technical logistics project 1.**

**BMEKOALM333**

Dr. Gábor Bohács

During the classes students of the technical logistics specialization learn advanced engineering planning systems, and their relation to the expert field of logisticians. (4 credits)

**Construction of logistics machinery**

**BMEKOALM324**

Dr. Gábor Bohács

Introduction of main constructional issues of continuous and discontinuous operating materials handling machines. (3 credits)

**Control of transport logistics**

**BMEKOALM341**

Dr. Gábor Bohács

The components of the transport logistics control systems. Summary of GIS funds. Operational control problems and tasks of the transport logistics systems. Mathematical modelling techniques, decision supporting of transport logistics control systems. The mathematical model of transportation network. The shortest path search methods. The exact and the provisional planning. Modelling of routes: direct routes, collecting and distributing routes. The traveling salesman problem (TSP) and the vehicle routing problem (VRP). Soft computing methods. The IT architecture of the freight control systems. The mobile devices. The connection between the freight exchanges and the transport logistics control systems. (3 credits)

**Enterprise logistics project 2.**

**BMEKOALM343**

Norbert Antal

As the continuation of the Enterprise logistics project 1., the project groups get operations management tasks, complex project tasks or R&D tasks, based on the interests of student’s. The task can be the continuation of what are launched in Enterprise logistics project 1., however, a new task also can be started. During the contact hours, the students consult with their mentors, moreover, each week brief report is held. The students present the problems and the suggested solutions, they practice the techniques of discussion, argumentation, and persuasion. (7 credits)

**Forwarding Management 2**

**BMEKOKKM133**

Dr. Ferenc Mészáros

Mode specific knowledge of freight forwarding management (road, rail, aviaton, inland waterway and maritime, combined and LTL transport). (5 credits)

**Forwarding marketing**

**BMEKOKKM135**

Dr. Botond Kővári

Marketing concepts, overview of resources. Market analysis methods. Product mix reviews. Advertising strategies. (4 credits)
Forwarding project 2.
**BMEKOKKM342**
Dr. Ferenc Mészáros  
Executive knowledge in managing freight forwarding companies. (2 credits)

**Integrated material flow systems**  
**BMEKOALM332**  
Dr. Gábor Bohács  
Traditionally materials handling systems are separated from technology. There are however special applications, such as assembly lines in the electronic industry where the material handling systems are in strong integration with the technological equipment. During the classes these special machines are addressed. (4 credits)

**Planning of plant logistics systems**  
**BMEKOALM327**  
Dr. Krisztián Bôna  
The specific properties and planning process of plant logistics systems. The main steps and tasks of logistics planning, the plant layout planning techniques and methods. The specific plant layout topologies. Optimization and heuristic methods in plant layout design. How to create a logistics system plan in case of a plant logistics system? The material flow system architecture in a plant. The planning steps of the material flow systems in a plant. The methodology of material flow system planning, the main heuristic an optimization models. Analytical queueing theory and simulations methods in the planning of plant logistics systems. Integration of the basic arguments of lean in the planning process. (5 credits)

**Planning of warehousing systems**  
**BMEKOALM323**  
Dr. Krisztián Bôna  
The main material flows and processes in a warehouse. Specific logistics system planning methodology of warehousing systems. The typical logistics technology variations of storing. Planning of transporting connections and loading technology. Planning the dimensions of loading bays, and preparation areas of warehouses. Order picking methods and systems. The technology of order picking. Planning of order picking process. Planning the topology and layout of storage systems. How to create a logistics system plan of a warehousing technology? (5 credits)

**Production planning & scheduling**  
**BMEKOALM329**  
Dr. Krisztián Bôna  
Theory of production planning and scheduling. Main topics, goals and constraints in the production systems, the system architecture of production control. Modelling of products and production technology. Connection points to the customer orders and forecasts. Then main production strategies. Production and capacity planning. The time view of production scheduling, the long, middle and short term planning. The informatics of the production planning and scheduling. Production planning and scheduling algorithms. The rule of production planning in the S&OP process. (4 credits)

**Technical logistics project 2.**  
**BMEKOALM340**  
Dr. Gábor Bohács  
During this subject students perform and complete a technical logistics project in groups. These can originate from either the industry or from defined research and innovation tasks. (7 credits)

**Trade, Financial, Accounting Techniques**  
**BMEKOKKM138**  
Dr. Ferenc Mészáros  
General principles of international trade, stakeholders and their relationships, trade transactions. Set and elements of the banking system, frequent financial transactions of freight forwarders. Accounting obligations and techniques of freight forwarding companies, balance sheet and profit and loss statement. (3 credits)
Pre-Engineering Course

The Budapest University of Technology and Economics (BME) is one of the leading universities in Europe and a member of CESAIER (Conference of European Schools for Advanced Engineering Education and Research), with a high admission standard.

The Hungarian secondary schools have very high level final exam in mathematics and physics, one of the highest in the world, as it has been proved through international competitions. Very often, there is a gap between the Hungarian and foreign students’ secondary school’s education program as far as the preparation for engineering studies are concerned. Many students are not trained enough to solve complex problems.

Therefore the Pre-Engineering Course is designed to help students develop the basic skills necessary to successfully pursue engineering studies at the Budapest University of Technology and Economics or any other engineering or science-oriented university with high academic standards.

The program lasts one academic year and offers intensive instruction in mathematics, physics, and English language. In addition, students are introduced to conceptual approaches in engineering.

New students at the Budapest University of Technology and Economics take a required Placement Test on the week before the academic year starts (see the Academic Calendar). Based on the results of this test, students will either be accepted into the first semester of the undergraduate program (BSc), or will be instructed to the Pre-Engineering Course prior to the undergraduate program.

Students who think they would benefit from the profound preparation of the Pre-Engineering Course may simply register for the Pre-Engineering Course (without taking the Placement Test).

Exams are given at the end of each semester of the Pre-Engineering Course. Students who achieve at least good results at the end of the second semester can begin their first year engineering studies at the Budapest University of Technology and Economics without taking the Placement Test.

Students who will not continue their studies at the Budapest University of Technology and Economics can take any of the individual subjects on a credit basis. Acceptance of the credits depends on the student’s home institution.
### Description of Subjects

#### Description of 1st Semester Subjects (Fall)

**Introduction to Physics I**

**Mechanics**


**Electricity**


**Introductory Mathematics I**

**Algebra**


**Geometry**

Elements of geometry: circumference and area of geometric figures, surface area and volume of geometrical solids. Right triangle trigonometry. Law of cosines and sines. To solve a triangle. Trigonometric identities, equations. 4 hours/week.

(0 credit)

#### Description of 2nd Semester Subjects (Spring)

**Introduction to Physics II**

**Vibration, Waves, and Thermodynamics**


**Optics and Atomic Physics**

Optics: fundamental concepts of optics; reflexion, refraction, dispersion of light; coherence of light; light as electromagnetic wave; interference, diffraction, polarization; holograms. Atomic physics: photoelectric effect; wave particle dualism; hydrogen atom model. 2 hours of lectures with demonstrational experiments and problem solving practice 4 hours/week.

**Introductory Mathematics II**

**Algebra**


**Geometry**

Coordinate system. Distance and midpoint formula. To sketch a graph. Equations of a line. The circle. Quadratic functions and parabolas. Ellipse and Hyperbola. Trigonometric functions. Complex numbers. Complex algebra. 4 hours/week.

**Computer Algebra**

Compulsory English for Pre-Eng. Students

(0 credit)

Elective subjects (2nd Semester)

Computing

General informations about computers and peripheral devices. Algorithms and programs. PASCAL Programming Language. 2 hours/week.

Engineering Drawing

Rules and conventions of engineering drawing. Descriptive geometry. 2 hours/week.

Advanced Algebra

Workshop
Excursions - Solt
Graduation Speech

“Do not go where the path may lead, go instead where there is no path and leave a trail”

I am most honored to be called amongst many to give this speech on this special occasion. I stand here today to reinforce character and vision.

I started by grace and have finished by grace, and I thank God, my parents, my lecturers, my fellow graduating students, and of course you sited here as well as my friends, for this rare opportunity to stand before you. Have you ever sat in your mums chair at her office, and in her absence you had to sign the collection of a letter (your admission letter) which was delivered to her, and yet you did not know it was your admission letter to school abroad, I guess not, but that was me signing the collection of that letter more than four years ago.

Leaving your mother land to a foreign land to be educated should not be done without vision/dream. Four and half years ago I could have fallen prey to the lack of vision, stepping my feet into Hungary and listening to those who at the time had no vision telling me to be comfortable with the poorest of academic grades, and I thought to myself if the reason for being educated in this institution is to fall short of my expectations then I could have as well been home schooled, I decided not to speak with poor minds on serious issues for I had vision.

This group of graduates has been strong, tough and thriving, having clearer vision by the day, walking with any of them would leave a lesson of hard work and the ability to bend due to tough academic work and yet not be bent. Budapest University of Technology and Economics in my short experience is not a place for poor minds so I urge you to be visionaries if you must take the world by storm.

We are here today to celebrate the end of a very significant phase in life and the beginning of the next most important phase of a new life outside school. The world has been waiting for us and we are now ready for them. I believe that the lessons learnt here at BME, from the accomplishments/successes, failures and studies, means we now posses the skills to learn, aptitude to succeed, ability and creativity to make a difference, to work to meet world needs and to assist in solving the problems facing the society at large. Knowledge as we know is power and it is gotten from education, although it might seem expensive buy it, for ignorance is more expensive. This school has taught us the elements of character and vision, on this note I want to encourage all students to show character, have vision and pursue it, and if an opportunity of success has not knocked on your door build a door and keep in mind that neither success nor failure is final keep succeeding.

To accomplish great things today and in the future, we must not only dream, but also act, and not just act but plan and believe in our dreams and vision, for “the future belongs to those who believe in the beauty of their dream”, and “I hope your dreams take you to the corners of your smile, to the highest of your hopes, to the windows of your opportunities and to the most special places your heart has ever known”.

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Courses and Doctorate schools at BME

We offer undergraduate & PhD courses in:

- Architecture
- Architectural Engineering
- Civil Engineering
- Chemical Technology
- Electrical Engineering
- Information Technology
- Mechanical Engineering
- Mathematics
- Physics
- Cognitive Science

Doctorate Schools

- Géza Pattantyús-Ábrahám PhD School in Mechanical Engineering
- PhD School in Computer Science and Information Technology
- PhD School in Electrical Engineering
- Kálmán Kandó PhD School in Mechanical Engineering
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# 2019/2020 ACADEMIC CALENDAR

## Fall Semester: All accepted Preparatory Beginners

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

## Fall Semester: BSc/MSc Students

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

## Spring Semester: All Students

<table>
<thead>
<tr>
<th>Event</th>
<th>Dates</th>
</tr>
</thead>
<tbody>
<tr>
<td>Orientation Program Newly enrolled regular and Exchange Students</td>
<td>30 Jan - 1 Feb 2020</td>
</tr>
<tr>
<td>Registration in Students’ Office, Bldg. R 1.</td>
<td>5 Feb – 7 Feb 2020</td>
</tr>
<tr>
<td>First Day of Classes</td>
<td>10 Feb 2020 (Monday)</td>
</tr>
<tr>
<td>Last Day of Classes</td>
<td>22 May 2020 (Friday)</td>
</tr>
<tr>
<td>Delayed submission</td>
<td>25 May – 29 May 2020</td>
</tr>
<tr>
<td>Examination Period (Check with your Faculty!)</td>
<td>2 June – 29 June 2020</td>
</tr>
<tr>
<td>Last Day of Final Exams</td>
<td>29 Jan 2020</td>
</tr>
</tbody>
</table>

## Days off for All Students

<table>
<thead>
<tr>
<th>Event</th>
<th>Dates</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sports day</td>
<td>12 Sept 2019 (Thursday)</td>
</tr>
<tr>
<td>National Day 1956</td>
<td>23 Oct 2019 (Wednesday)</td>
</tr>
<tr>
<td>All Saints’ Day</td>
<td>1 Nov 2019 (Friday)</td>
</tr>
<tr>
<td>Students’ Scientific Conference</td>
<td>12 Nov 2019 (Tuesday)</td>
</tr>
<tr>
<td>Open day</td>
<td>29 Nov 2019 (Friday)</td>
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<tr>
<td>Free day</td>
<td>24 Dec. 2019 (Tuesday)</td>
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<tr>
<td>Free day</td>
<td>27 Dec. 2019 (Friday)</td>
</tr>
<tr>
<td>Good Friday</td>
<td>10 April 2020 (Friday)</td>
</tr>
<tr>
<td>Easter Monday</td>
<td>13 April 2020 (Monday)</td>
</tr>
<tr>
<td>Spring Holiday</td>
<td>14 – 17 April 2020</td>
</tr>
<tr>
<td>Labour Day</td>
<td>1 May 2020 (Friday)</td>
</tr>
<tr>
<td>Whit Monday</td>
<td>1 June 2020 (Monday)</td>
</tr>
</tbody>
</table>