Budapest University of Technology and Economics

Bulletin
2020-2021
Study in the European Union

Study at BME

Your future career begins at the Budapest University of Technology and Economics
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Photos: János Philip, József Tóth, István Oravec, György Ádám Horváth

This Catalogue provides information on the programs and services of the Budapest University of Technology and Economics. Curricula, courses, degree requirements, fees and policies are subjects to revision. Specific details may vary from the statements printed here without further notice.
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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 2020/2021 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 Mechanical Engineering</td>
</tr>
<tr>
<td>Mathematics</td>
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<table>
<thead>
<tr>
<th>MSc/MA* programmes</th>
<th>Faculty</th>
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<tbody>
<tr>
<td>Applied Mathematics</td>
<td>Faculty of Natural Sciences</td>
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<tr>
<td>Architecture</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>
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<tr>
<td>Environmental Engineering</td>
<td>Faculty of Chemical Technology and Biotechnology</td>
</tr>
<tr>
<td>Finance*</td>
<td>Faculty of Economic and Social 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 Natural Sciences</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 Mechanical 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>
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<tr>
<td>Logistics Engineering</td>
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# Tuition Fees for 2020/2021 academic year

<table>
<thead>
<tr>
<th>Course</th>
<th>Faculty</th>
<th>For non-EU citizens EUR/semester</th>
<th>For EU citizens EUR/semester</th>
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</thead>
<tbody>
<tr>
<td>Preparatory</td>
<td>Pre-engineering</td>
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<td>Preparatory</td>
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<tr>
<td>BSc</td>
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<td></td>
<td>Faculty of Electrical Engineering and Informatics</td>
<td>3200</td>
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<td>Faculty of Natural Sciences</td>
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<tr>
<td>MSc</td>
<td>Faculty of Civil Engineering</td>
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<td></td>
<td>Faculty of Architecture (10 semesters)</td>
<td>3200</td>
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<tr>
<td></td>
<td>Faculty of Mechanical Engineering</td>
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<td></td>
<td>Faculty of Architecture (4 semesters)</td>
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<td></td>
<td>Faculty of Economic and Social Sciences</td>
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<tr>
<td>MSc for graduates of external higher education institutions</td>
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<td>3500</td>
<td>3200</td>
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<tr>
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<td>Faculty of Mechanical Engineering</td>
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<td>Faculty of Chemical Technology and Biotechnology</td>
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<td></td>
<td>Faculty of Transportation Engineering and Vehicle Engineering</td>
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<td></td>
<td>Faculty of Economic and Social Sciences</td>
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<tr>
<td>MSc for graduates of BME</td>
<td>Faculty of Mechanical Engineering</td>
<td></td>
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<tr>
<td></td>
<td>Faculty of Chemical Technology and Biotechnology</td>
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<td>Faculty of Natural Science</td>
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<td></td>
<td>Faculty of Transportation Engineering and Vehicle Engineering</td>
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<td></td>
<td>Faculty of Economic and Social Sciences</td>
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<tr>
<td>PhD*</td>
<td>Faculty of Civil Engineering</td>
<td>4500</td>
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<tr>
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<td>Faculty of Architecture</td>
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<td>Faculty of Electrical Engineering and Informatics</td>
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<td>Faculty of Natural Science</td>
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<td></td>
<td>Faculty of Transportation Engineering and Vehicle Engineering</td>
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<tr>
<td></td>
<td>Faculty of Economic and Social Sciences</td>
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</tr>
</tbody>
</table>

+ Application fee: 100 EUR
* For PhD application please contact the faculties: [http://www.bme.hu/faculties?language=en](http://www.bme.hu/faculties?language=en)

The University Bank Account Number for payments of application (only bank transfer accepted)
Bank name: National Bank of Hungary (MNB)
Bank address: H-1850 Budapest, Szabadság tér 6-8., Hungary
Bank account number: 10032000-01425279-01110009
Swift code: MANEHUHB
IBAN code: HU22 1003-2000-0142-5279-0111-0009
Beneficiary name: BME
Beneficiary address: H-1111 Budapest, Műegyetem rkp. 3., Hungary
2020/2021 ACADEMIC CALENDAR

**Fall Semester: All accepted Preparatory Beginners**

<table>
<thead>
<tr>
<th>Event</th>
<th>Dates</th>
</tr>
</thead>
<tbody>
<tr>
<td>Preparatory Classes (Math, Physics) for Placement Test</td>
<td>24 – 27 Aug 2020</td>
</tr>
<tr>
<td>Placement Tests: Math (31.08.), Physics (1.09.)</td>
<td>31 Aug – 1 Sept 2020</td>
</tr>
<tr>
<td>Placement Test Results Posted Outside Student’s Office</td>
<td>4 Sept at 12 am 2020</td>
</tr>
<tr>
<td>Registration week</td>
<td>31 Aug – 4 Sept 2020</td>
</tr>
<tr>
<td>Orientation Program</td>
<td>31 Aug – 4 Sept 2020</td>
</tr>
<tr>
<td>Newly enrolled regular and Exchange Students</td>
<td></td>
</tr>
<tr>
<td>First day of classes</td>
<td>7 Sept at 8:15 am 2020</td>
</tr>
<tr>
<td>Opening ceremony</td>
<td>17 Sept (Thursday) 2020</td>
</tr>
<tr>
<td>Last Day of Classes</td>
<td>11 Dec (Friday) 2020</td>
</tr>
<tr>
<td>Examinations in fall semester of 2020/2021</td>
<td>21 Dec 2020 - 26 Jan 2021</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>31 Aug – 4 Sept 2020</td>
</tr>
<tr>
<td>First Day of Classes</td>
<td>7 Sept 2020 (Monday)</td>
</tr>
<tr>
<td>Opening ceremony</td>
<td>17 Sept (Thursday) 2020</td>
</tr>
<tr>
<td>Last Day of Classes</td>
<td>11 Dec 2020 (Friday)</td>
</tr>
<tr>
<td>Week of repeats</td>
<td>12 Dec 2020 – 18 Dec 2020</td>
</tr>
<tr>
<td>Examination Period</td>
<td>21 Dec 2020 – 26 Jan 2021</td>
</tr>
<tr>
<td>Last Day of Final Exams</td>
<td>29 Jan 2021</td>
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</table>

**Spring Semester: All Students**

<table>
<thead>
<tr>
<th>Event</th>
<th>Dates</th>
</tr>
</thead>
<tbody>
<tr>
<td>Orientation Program</td>
<td>1 Feb - 5 Feb 2021</td>
</tr>
<tr>
<td>Newly enrolled regular and Exchange Students</td>
<td></td>
</tr>
<tr>
<td>Registration in Central Academic Office</td>
<td>1 Feb – 5 Feb 2021</td>
</tr>
<tr>
<td>First Day of Classes</td>
<td>8 Feb 2021 (Monday)</td>
</tr>
<tr>
<td>Last Day of Classes</td>
<td>14 May 2021 (Friday)</td>
</tr>
<tr>
<td>Week of repeats</td>
<td>17 May – 21 May 2021</td>
</tr>
<tr>
<td>Examination Period</td>
<td>25 May – 21 June 2021</td>
</tr>
<tr>
<td>Last Day of Final Exams (Check with your Faculty!)</td>
<td>2 July 2021</td>
</tr>
</tbody>
</table>

**Days off for All Students**

<table>
<thead>
<tr>
<th>Event</th>
<th>Dates</th>
</tr>
</thead>
<tbody>
<tr>
<td>Student Day and Sports Day</td>
<td>23 Sept 2020 (Wednesday)</td>
</tr>
<tr>
<td>Hungarian Revolution of 1956</td>
<td>23 Oct 2020 (Friday)</td>
</tr>
<tr>
<td>Students’ Scientific Conference</td>
<td>12 Nov 2020 (Thursday)</td>
</tr>
<tr>
<td>Open day</td>
<td>27 Nov 2020 (Friday)</td>
</tr>
<tr>
<td>Winter holiday</td>
<td>24 Dec 2020 – 3 Jan 2021</td>
</tr>
<tr>
<td>National Day</td>
<td>15 March 2021 (Monday)</td>
</tr>
<tr>
<td>Good Friday</td>
<td>2 April 2021 (Friday)</td>
</tr>
<tr>
<td>Easter Monday</td>
<td>5 April 2021 (Monday)</td>
</tr>
<tr>
<td>Spring Holiday</td>
<td>1 - 7 April 2021 (Thursday to Wednesday)</td>
</tr>
<tr>
<td>Whit Monday</td>
<td>24 May 2021 (Monday)</td>
</tr>
</tbody>
</table>
Agencies and representatives in the target countries

Azerbaijan

CELT Colleges
Anar Gurbanzade Study Abroad Coordinator
Mammad Abdinayev 6, Flat 12, AZ 1001, Baku, Azerbaijan
+994 12 4926853; +994 55 6447280
admissions@celt.az; www.celt.az

Cameroon

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Tel: 00237 242 10 77 57
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E-mail: interconsulting77@yahoo.fr
http://www.gicinterconsulting.com

China

Shenyang EU-SINO Education Information Consulting Co., Ltd.
Mr. Chen Qilin Director
Room 1407, Ouya Liangying Business Building, No.1 Jia, Nanjingnian St., Heping Dist., Shenyang City, Liaoning Province, China.110001
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Web: www.studyinhungary.org
E-mail: eusino_edu@hotmail.com

Mohar Global Services (MGS)
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8911 GD Leeuwarden
The Netherlands
Tel.: 0031 – 616 – 563 – 733, 0031 – 616 – 941 – 160,
0097-143-050-614
Fax: 0031 – 588 – 434 – 932
www.letsostudyabroad.com
Email: abubakar.ejaz@letsostudyabroad.com

Jifulang Consultation Services Ltd
CEO: Ms. YE Li
Physical address: Chongqing city, Yubei district, Baihua Rd.6, Wanke Tixiangjun 11-1-7-15, Zip: 401121, China
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Contact: Ful op Ferenc, fulop@inbox.com , +613206017976 (+36302121210)

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Mr. Sofocles Moussoulos President
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Telephone: 02-781644
Fax: 02-773111
moussoulos@cytanet.com.cy

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+971 52 9092360

Gyanberry Training and Education FZ LLC
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E-mail: ashraf.mohamed@saudieng.org
E-mail: ashrafelsayed@gmail.com
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Georgia

PRIME STUDY Educational Consulting Agency
Davit Mikieladze
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E-mail: info@primestudy.ge
www.primestudy.ge

Ghana

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Amen D. Kpodo-Tay (Hon. Consul of Hungary)
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phone number: +233-20 341 3550
mobile number: +233-20 341 3550
E-mail: ghanakonzul@gmail.com

India

Active synergy consultants.P. Ltd
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phone number: 097714215496, 9779841356489
Email: info.activesynergy14@gmail.com
www.asc.com.np
(recruit students from India, Bangladesh, Sri Lanka and Nepal)

Angel Management Consultant (CEO)
Asif Syed director
Master Mind, V, No. 716, 717 Royal Palms, Aarey Milk Colony
Goregaon East, Mumbai 400065 India

7
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Fax:+98 21 8898 1392
habibi@daneshpuyan.com

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Mobile: +98 912 707 20 83
E-mail: info@open-iran.com
www.open-iran.com

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Fax: +9821 22211424
info@majarestan.com; www.majarestan.com

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Upper Than Motahari Cross
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fax number: 0098 21 88419594
Email: info@study3000.com
Website: www.study3000.com

Avicenna International College
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phone number: +36703171424

Yekta Maktab Ibn Sina / Avicenna International School
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phone number: +36704397497

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Netanya, 42504 P.O. Box 8552, Israel
Fax: 972-9-8858287
Mobile: 972-57-4450445
info@uis.co.il; www.uis.co.il

Kazakhstan
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named after Konir Mandoki
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Republic of Kazakhstan
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Email: sedupost@gmail.com

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Pervin Mirza
Al Ghawali Complex
Sharq Kuwait
Tel.: +965 65777066
pervin.mirza@kapicotravels.com]

United Placement Services
Waleed Sheikh
address: Hawally, Block 2 , Othman street,
Mubarak complex, floor 3, office 15, Kuwait
phone number: 00965 22633136

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Oasis Abroad Study Services & Consultancy Pvt.
Mr. Ram Thapa
Bagbazar 31,
44600 Kathmandu, Nepal
phone number: +977-9851160282

Active synergy consultants. P. Ltd
Ram Sharan Dhakal
Bagbazar 31,
44600 Kathmandu, Nepal
phone number: 097714215496, 9779841356489
Email: info.activesynergy14@gmail.com
www.asc.com.np
(recruit students from India, Bangladesh, Srilanka and Nepal)

White rabbit educational consultancy
Mr Bikash Deuba
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phone number: +977 014268102 / 9841463790

Tridev Education Service Pvt Ltd
Surendra Kharel
Dillibazar 32,
44600 Kathmandu, Nepal
Dillibazar Height (Opposite to Padma Kanya School)
phone number: 9861199325
Contact no: +977-9861199325 / +9779861199325
PO. Box: 11946

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University of Wyoming
Em trends
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Laramie, WY 82071, USA
Tel: +1 307 766 5600
Fax: +1 307 766 4298
E-mail: trends@uwyo.edu
Website: www.uwyo.edu
AGENCIES AND REPRESENTATIVES IN THE TARGET COUNTRIES

Nigeria
ALMERC
Dr. A.B.E. Nnuji Chairman
11, Calcutta Crescent, Apapa, Lagos
5th Avenue, ‘G’ Close House 16, Festac Town Lagos, Nigeria
Telephone: 234-(0)-1-7741243, 4342421, 234-803-3075781
E-mail: aloynnuji@yahoo.com

Chetzit Global
Mr. CELESTINE GANDU
address: 19 Buruku Road, Narayi, Kaduna
phone number: +2349097514222
mobile number: +36706368774
E-mail:info@chetzitglobal.com
Website: www.chetzitglobal.com
Facebook: https://www.facebook.com/chetzitglobal/

DREAM EDUCATION.HU
Ms. Linda Abia-Okon Managing Director
Tel.: +234 817 999 9909; +36702011 999
Office: 61, Jose Marti Crescent, Asokoro, ABUJA, Nigeria
E-mail: linda.abia.okon@dreameducationhungary.com;
http://www.dreameducationhungary.com

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Amadi Chukwudi David
No. 3 NGURU road barnawa kaduna,
80001 Kaduna state, Nigeria
phone number: +2349096065025

Y2GO Ltd
Richard Morgan Managing Director
World of Achievers Limited
Y2Go Limited
Mob UK: +44 77 10 763 474
Mob Nigeria: +234 7038 05 6665
Mob Ukraine: +38 0632 651 050
Skype: morgan.richard14
E-mail: morganrichard1164@yahoo.com.sg
richard@morganproperty.uk.com

Forintstud Agency
Jack Daboma Ibibo
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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 M.Sc degree (10 semesters) students have to accumulate min 300 credit points.
- For M.Sc 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 system worldwide and, eventually, mutual international recognition of degrees.

**Pre MSc – Preparatory Course for the Master’s Program**

The year program called Pre MSc Course precedes the Master’s Program. The pre MSc program is offered for students who have earned BSc degrees in other schools of architecture and could legally join the Master’s Program, but could not successfully complete the entrance exam of the Master’s Program. Based on the different kind of BSc studies there might be differences in their preparedness. The aim of the Program is to equal these differences and prepare the students for the Master’s Program.

Students are offered to join the courses of the Integrated MSc Program. There are two kinds of courses in the program; obligatory and suggested courses. Successful fulfilment of all the obligatory courses is equal to a successful entrance exam. Suggested courses are tendered to develop the skills of students in various fields.

*Note: The Faculty of Architecture reserves the right of changing the Curricula.*

**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
- City 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)
## Curriculum of Integrated MSc Program

### 1-10. semester

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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
# Offered courses for the pre-MSc Program among the courses of the Integrated MSc Program

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

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

Minimum number of credits for MSc degree: 120
Description of General Courses in Architecture

Basic Mathematics 1

BMETETOPB22

Computer Literacy 1

BMEEPAGG101
General information about computing, computers, and peripheral devices. Input, output and data storage. Methods of problem solving on computers. Algorithms and programs. Basic elements of a programming language, such as symbols, datatypes, statements, control structures and elementary I/O. Practical work on a computer; development and running of small programs. Text editor and translator.

Geometrical Constructions 1

BMEEPAGG111

Freehand Drawing 1

BMEEPRA01
Introduction to the basic laws of perspective, one and two vanishing-point systems, proportions through the drawing of simple installations of modular geometrical elements. Basic techniques of shading, tonal interpretation of the effects of light.

Freehand Drawing 2

BMEEPRA201

Design skills 1.

BMEEPRA111
The Basic formal components of Buildings: walls, beams, pillars, floors. Their appearance and formal varieties. The Basics of spatial compositions. The idea of the architectural space and its typology.

Basic Mathematics 2

BMETETOPB23

Computer Literacy 2

BMEEPAGG201
Introduction to computers, operating systems and computer networks. Browsing and organizing information through Internet, use of Internet based communication. Computers in architectural office: word processing, using spreadsheets, creating presentations. Basics of pixelgraphics and image manipulation.

Geometrical Constructions 2

BMEEPAGG211

Fundamentals of Structures

BMEEPSTG201
Introduction: requirements of the built environment. 1st site visit: an existing, functioning building. Parts of buildings. Discussion of experiences of the 1st site visit: functions and requirements of parts of buildings. 2nd site visit: a construction site. Loadbearing parts of buildings. Discussion of experiences of the 2nd site visit: functions and requirements of loadbearing parts of buildings. The notion of safety. 3rd site visit: laboratory testing of structural members (brickwork column, reinforced concrete beam). Loads and responses when beeking loaded. Discussion of experiences of the 3rd site visit: structural members; ways of becoming unfit for use: rupture, loss of stability (overturning, sliding, buckling), excessive cracking and deformations. 4th site visit: laboratory testing of structural materials. Yield and rupture. Collection of strength measurement data. Discussion of experiences of the 4th site visit: statistical evaluation of measurement data. The notion of safety, safety factors of materials and loads. 5th site visit: a project bureau. Graphical presentations of buildings. Architecture and structure. Results of structural analysis. Discussion of experiences of the 5th site visit: Parts and kinds of documents. Scales and graphical symbols. Modelling of structures, structural projects. 6th site visit: ready structure construction site. Discussion of experiences of the 5th site visit: modelling of structures. The static model.
Basic Tools of Building Constructions

Construction is the realization of architecture. Building construction classes will help students master the control of this realization process, through the learning of academic principles behind practical construction theory. Design must be realized through techniques founded on proper methods and principles of building construction. Course develops a basic understanding of building construction vocabulary, drafting symbolism, various building systems and building components and their interactions. To be able to select appropriate building systems and detail solutions for design tasks.

Design skills 2.

Developing the skills of students to read 2D architectural drawings. To develop skills to transfer 2D drawings to 3D expression. To develop skills to transform the 3D reality into 2D projection drawings.

Fundamentals of Architectural Design

Introduction to the grammar and vocabulary of architecture design, and the basic factors on which the creative process of design depends. The course intends to identify the fundamental principles of the profession and to provide guidance on the attitude of mind that will help students in developing their individual approach to design problems in the future.
### Description of Integrated MSc Program Subjects

<table>
<thead>
<tr>
<th>Subject</th>
<th>Code</th>
<th>Description</th>
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<tr>
<td><strong>Mathematics EP1</strong>&lt;br&gt;BMETE90AX33</td>
<td>This course covers the elements of single variable calculus and linear algebra. Special emphasis is put on the concepts of linear algebra which are later used by architects in structural design. These are the systems of linear equations, matrices and determinants with their properties. From the elements of calculus, the limit of sequences, the differentiation, the integration and applications belong to the course material. (4 credits)</td>
<td><strong>Introduction to Structural Design</strong>&lt;br&gt;BMEEPSTA101</td>
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<tr>
<td><strong>Descriptive Geometry 1</strong>&lt;br&gt;BMEEPGAGA102</td>
<td>Analysys of relative position of spatial elements in multi-view system; intersection of line and plane, pair of planes. Auxiliary projections, intersection of polyhedron and plane, pair of polyhedrons, Representation of regular polyhedron by means of transformations. Revolution of plane, metrical problems. Contraction of shadow. Oblique and orthogonal axometry. Perspective, Images of circle and sphere. Intersection of sphere and plane. (5 credits)</td>
<td><strong>Drawing and Composition 1</strong>&lt;br&gt;BMEEPRAA101</td>
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<tr>
<td><strong>Introduction to Building construction</strong>&lt;br&gt;BMEEPESOA101</td>
<td>This subject introduces all major building construction components (walls, foundations, floors, roofs, skeleton frames, stairs, ramps, doors and windows) and primary building engineering service systems. During lectures, the building is considered as a composition of spaces with different functions, separated by special surfaces. The course aims to introduce and explain the grammar of architectural design through practical tasks, such as the survey of one’s own flat. Concurrently, the basic dependant factors of the creative design process are described. Students are acquainted with technical terminology as well as the role and use of various construction solutions including their classifications. The above shall assist students with both starting independent design exercise work and the continuing of building construction studies in greater detail. (2 credits)</td>
<td><strong>Introduction to Architecture</strong>&lt;br&gt;BMEEPUIA101</td>
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<tr>
<td><strong>History of Architecture I. (The Beginnings)</strong>&lt;br&gt;BMEEPEPA101</td>
<td>The course gives an overview of the architecture in the first period of the evolution of human culture. The classes follow chronology – mainly in the first part of the course – with focusing on the development of building constructions and the development of settlements. Prehistory: Palaeolithic human claim to space, from the cave to the hut. Building activity of Neolithic peasants, one-celled houses and fortified settlements. Introduction to building construction in the Near East and Europe. In the second part the course gives an overview of the vernacular architecture of the world. Native architecture: comparative outline of the architecture of hunting, pastoral and farming peoples. Construction, building materials and decorations. Native American, African and European architecture. The practical lessons show details were delivered in the lecture before. The drawings drawn by students help them to understand the colourful world of common and rural architecture. (3 credits)</td>
<td><strong>Space Composition</strong>&lt;br&gt;BMEEPKOA101</td>
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</table>
opportunity to discuss the evaluation of the Greek and Ro-

temporary demand of the sacral, the dwelling and the palace archi-

menting and formation of the European architecture of the four

tics, axonometry, surfaces. Representation in multi-view system, axonometry and perspec-

Before introducing to the evaluation of architecture we

The intended task of the subject is to investigate the evalua-

Descriptive Geometry 2

Building Constructions 1

Statics

History of Architecture 2 (Antiquity)

Building Materials I

Drawing and Composition 2

Residential Building Design 1

Basics of Architecture

Architectural planning is a creative process, typified mainly by an end result that is either one-of-a-kind in its details or uncommon as a whole. Hence, the design path is unique in and of itself. In the case of design activity, instruction does not only impart basic knowledge of the profession (the masonic and practice of which is a requirement of the design process), but also develops creative skills. The Fundamentals of Architecture class consists of weekly practice; before receiving each assignment, however, there is a general lecture held for all that year’s students. Within the subject, architectural pupils encounter tasks that require architectural-based problem solving and creative troubleshooting. Classes of 25-28 pupils are run by 3-4 main instructors. In the course of the semester, there are several small planning tasks to be solved, modelling, architectural drawing, and technical drawing with equipment. Design tasks are built around a unifying theme or motto. (6 credits)
during the laboratory sessions and study the physical and mechanical properties of building materials. (3 credits)

**Architectural Informatics 1**

**BMEEPAGA301**

Informatics in the architectural office. Solving common tasks of the architectural practice with the extensive use of word-processors, spreadsheets, and other applications. Numerical solutions of mathematical problems in the architectural practice. Communications through Internet-based applications. Presence on the Internet. The subject expects ECDL-level knowledge in Word processing and Spreadsheets. (2 credits)

**Building Physics**

**BMEEPGEA301**


Introduction to Thermal Bridges, Definition of Self-Scale Temperature, two applications of SST, Definition of Apparent Thickness, Generalized model of wall corner, generalized model of wall corner temperature, Example: estimation of wall corner temperature. Moisture transfer

Definition of Moist air, Dalton’s Law, Moisture content, Saturation vapour pressure, Relative humidity, dew point, dry and wet bulb temperatures, Specific Enthalpy, Moisture balance, Mechanism of vapour transfer, Scope of calculation, Vapour conductivity and resistance, Overall vapour resistance of multilayer wall, Overall vapour transfer, Design consideration, example.

Introduction to Solar Architecture

Indirect Solar collecting walls. Mass walls: principles, surface, shading, energetic operation, delaying, losses, operation in summer, irradiated solar energy, examples, simplified thermal model. Example: calculation of thermal balance of a mass wall

Solar Design Strategies


**Strength of Materials 1**

**BMEEPSTA301**


**History of Architecture 3 (Medieval)**

**BMEEPETA301**

The architecture of the Late Roman Empire. The born of Christianity and its Necessity architecture\(^\text{a}\). The born of the monumental Christian architecture – Early Christian architecture in Rome. – Early Christian architecture in the eastern Provinces: Palestine, North Africa, Syria – Late Roman and Oriental traditions. Early Byzantine architecture in Thessalonica and in Constantinople. Load bearing structures of the Early Christian period. Different types of barrel vaults, Roman-type cross vault. – Syrian influences in Armenia. The Iconoclasm and the aftermath in Greece. Architecture in the radius of influence of Byzantium. The comparison of the basilicas in Rome and in Syria. – Ravenna. The penetration of Christian architecture into barbarian Europe – Scattered monuments\(^\text{b}\). Byzantine vaulting systems. The main stream of the Romanesque architecture: the Carolingian architecture with the evangelizer Benedictine movements, the three periods of the German-Roman Empire. The Langobard architecture in North-Italy. The Romanesque vaulting systems: Romanesque cross vault, Sexpartite vaulting, groin-rib vaulting, Squire-bayed and free vaulting systems – the pointed arch. Basilica and false basilica\(^\text{c}\) type space organization. – The retrospective interregional influences in Romanesque architecture. – Antique influences. Byzantine influences. The progressive interregional influences in Romanesque architecture – monastic movements: Benedictine and Cistercian, Norman Imperial\(^\text{d}\) Romanesque architecture. Morphology of medieval detailing. The Early French Gothic cathedrals. – The flourishing period of the French cathedrals, and its influences in South-France, in England, in Germany and in Italy. Interregional influences in gothic architecture: Cistercian gothic formations, the Franciscan and Dominican movements. – The special characteristics of English and German gothic architecture. Late gothic vaulting systems: Cylindrical (or net vaults) and Spherical (or stellar) vaults. Halls and false halls – Civic movements in Late Gothic in Germany and the proto-renaissance in Italy. Medieval secular architecture. (3 credits)

**Drawing and Composition 3**

**BMEEPRAA301**

This subject introduces students to professional specific applications of the drawing skills they acquired so far. Classes present drawing methods for the representation of reality irrespective of the given point of view, from any other one. Students learn to consciously apply perspective in drawing small-scale models as tall buildings, and develop various graphic skills by practising the architectural graphic representation of masonry, stone, wooden and glass surfaces and those of materials. A creative modeling task assigned
to students is building an autonomous construction, which focuses on the relations of materials and volume, internal space and the phenomenon of transparency. During model building, problems of space, form and structural arrangement are investigated; while at graphic elaboration, great emphasis is laid on the representation of materials, fluency in perspective drawing and abstraction. (4 credits)

Public Building Design 1

BMEEPKOA301

Our basis for public building design methodology, the function of public buildings and technical requirements, achieved via a knowledge of architectural history and precedent of type. The course pattern will analyze important examples of Hungarian and International public buildings regarding architectural space, architectural form, the use of materials and structures, in relationship to various environmental factors. (2 credits)

Residential Building Design 2

BMEEPPLAA301

This course is the design course of the residential building design studies, with the same content for both the integrated MSc and the BSc education. The theoretical knowledge of the course of Residential Building Design 2, is based on the lectures of Residential Building Design 1. The course is held once a week, for 6 hours, in the form of studio sessions and consultations. The central element of the course is the dwelling, students design a detached single family house and smaller design tasks during the semester. The main aim is the acquisition of basic knowledge on the subject of housing, the practical application of this knowledge and the assessment of the relations of dwelling and building, as well as building and environment. Students encounter one of the first complex design projects during the course of Residential Building Design 2. In an architects practice the detached family house is one of the smallest projects in size and scale, it is also the most personal design task, with dynamically changing demands. The main project of the semester, the detached family house, has multiple midterm presentations, where students present their projects and open ended discussions are initiated into the topic of residential building design. The course ends with a project hand-in at the end of the semester. (6 credits)

Building Constructions 2

BMEEPESA301

The subject deals mainly with pitched roof constructions, roof coverings and different types of foundations – the latter with consideration to waterproofing solutions. During seminar lectures the principles and details of shallow and deep foundations are introduced, according to functional and load bearing requirements of various building constructions as well as subsurface water and soil type effects. Also introduced are the functions and primary principles of different pitched roof constructions such as: traditional roof, rafter type (modern) roof, purlin and truss type roof as well as contemporary methods of carpentry. Further explanation is provided on occupied (built-in) attic constructions with focus on principles, layers, ventilation, windows and lighting. The main types of roof coverings are shown, such as concrete and clay tiles, flashings and metal roof coverings with special attention to principles and details. (4 credits)

Sociology for Architects

BMEGT43A044

Dr. János Farkas, Dr. Adrienne Csizmady


Architectural Informatics 2

BMEEPAGA401

Fundamentals of vector graphics, two-dimensional (2D), and three-dimensional (3D) Computer Aided Design (CAD) systems. Application of Cartesian and polar coordinate systems. CAD principles from simple 2D drafting to the developing of architectural drawings with the use of layers and library elements (blocks). 3D modelling of geometrical shapes and architectural details. (3 credits)

Building Constructions 3

BMEEPESA401

General and detailed review of the structures of the elevation constructions. The most important aim of the subject is the analysis of the external separating constructions. Principles of the continuity of the protecting levels depending on the position in the structure. Multi-layer external separating walls, construction methods of the elevation claddings and elevation coverings, the ordinary and special external doors and windows. Complementary structures for the external doors and windows, especially the shading devices. Requirements for the external separating structures and performances of the different constructions. Building physics: heat and vapour physics, acoustic features of the external separating structures. (4 credits)

Strength of Materials 2

BMEEPSTA401

Strength of materials is a compulsory engineering subject for second year students in architecture. The goals of the subject are to show how to - determine the deformations of load-bearing structures - find the internal forces of statically indeterminate structures.

In addition to theoretical methods, we also show examples in structural engineering. (6 credits)

History of Architecture 4

BMEEPETA401

Brunelleschi and the early renaissance architecture in Tuscany. The evolution of the renaissance palace in Florence and in the Northern regions of Italy. The architect and scholar Leon Battista Alberti, Bramante and to the influence of his circle in the first half of the 16th century, Michelangelo Buonarroti architect. Renaissance in Lombardy and Venice. Mannerist architecture. The late sixteenth century: Palladio and Vignola. Urban development and early baroque architecture in Rome under Pope Sixtus V. The architecture of Lorenzo Bernini and Francesco Borromini. Baroque in Venice and in Piemont. Architecture in France in the 16-17th centuries. Baroque in central Europe; Austria, Bohemia and Germany. (3 credits)
Drawing and Composition 4

**BMEEPRAA401**
The main topic in the syllabus of the subject is the 'analytic' representation of external spaces: students learn how to recognise the invisible geometrical-structural relations below the surface of buildings through preparing 'X-ray drawings'. Not only the views but also the sections of buildings are studied in order to understand and grasp the gist of the architectural structure behind the view, and to prepare such 'X-ray drawings' that represent more complex architectural compositions than what the eyes can see. Students prepare drawings on external sites (such as the Museum of Fine Arts, the Great Market Hall, and the assembly halls of BUTE and Corvinus University) to investigate the options of perspective drawing and the versions of plane representation of large spaces. (2 credits)

Design Methodology

**BMEEPKO402**
Design Methodology deals with theoretical and practical methodology of architectural design flow. The point of theoretical Design Methodology is the design itself as a process that can be modeled. The process of architectural design thus can be compared to an informatics system, so for making the method more clear. Practical Design Methodology is closely connected to the Public Building Design 2 process itself, extending it with special design factors and details. Through analyzing existing buildings and fictional situations interesting practical problems and solutions can be discussed. With the help of invited practicing architects, special methods of new facilities and building- reconstruction are presented, along with the design of technologically or structurally determined buildings. Because of its importance, sustainability, free access and ecological design will be touched along whole study. (2 credits)

Architecture of Workplaces 1

**BMEEPPIA401**
The history of industrial architecture, the history of Hungarian industrial architecture. Load-bearing structures of halls and of multi-storey buildings. Size standardization. Constructions of space separation, facades, subsystems of space separation constructions (foundations, roof structures, intermediate floors, external wall systems, finishes. Characteristic architectural requirements, social facilities. Logistics: transport, storage. From location to layout, emplacement of industrial plants. Design methodology, re-use, reconstruction, Offices. (2 credits)

Public Building Design 2

**BMEEPKO401**
Target of the exercise, how to realize the general architectural design of a public building without loss of focus regarding the types collective characteristic. What does the studio hope to achieve? The architectural design of a smaller public building, with assistance from architect consultants. The student should learn the process from within regarding the architectural design process and the unusual stress placed upon development of space / manipulation of form whilst considering their approach to solving real environmental problems.

Communication of this architectural design is the key to making a successful presentation and your ideas should encompass dialogue with client (class tutors), relationship to the surrounding environment both built and natural, understanding of trends, financial awareness and understand-

**Building Constructions 4**

**BMEEPES401**

Flat roofs. Classification, general design aspects, basic construction principles (inclination and geometry of the water collecting areas) according to the impacts on the roofs. Arrangement of roofing layers. Requirements concerning to the different constructions, layers, materials, building physics. Waterproofing (membranes, coatings), applied materials and their features. Technologies and details. Tracking type and terrace roofs, green roofs. Flooring. Effects and requirements. Layers, subsystems, acoustical evaluation. Substructures of floor coverings and their technical features. Classification according to the materials, specifications. Waterproofing against domestic and industrial wet effects. Drywalls, suspended ceilings, internal wall coverings. Labelling systems, design aspects, effects, requirements, basic structural principles. Internal separating structures of residential buildings satisfying acoustical requirements, connecting details of slabs, floorings and stairs. Principles of primary building engineering service systems and building constructions of sanitary block. (4 credits)

**Design of Load-Bearing Structures**

**BMEEPSTA101**

Basic conceptual and computational design methods of load-bearing structures are discussed for reinforced concrete-, steel-, timber and masonry buildings. The main goal is to gain knowledge about structural design problems and principles of structural design in order to understand how and why the load-bearing structure influences the work of an architect. (6 credits)

**History of Architecture 5 (19th century)**

**BMEEPET501**

The period of this History of Architecture subject is the “long nineteenth century” from the 1750s to the 1910s. In this era the architecture and the art turned to the past, to the previous styles using them in a new approach. The architects had discovered the history of art and artistic liberty at the same time. At the turn of the 20th century the art and also the architecture searched for new ways instead of using historical architectural elements or motifs. The changes led to the Modern Movement when buildings were being erected without decoration or ornaments in the first quarter of the 20th century. This period was divided into different eras, but these types of periodization were different in different countries and changed in the course of the 20th century. Beside the question of styles 19th century is important not only because of the appearing of new structures and materials in the architecture but because of the great development in the field of the functional planning. While following the timeline, the classes concentrate on the development of the styles in several areas of Europe (Great Britain, France, Germany, Russia) looking out to the United States of America too, because there the styles reflected the European ones. (3 credits)

**Drawing and Composition 5**

**BMEEPRAA501**

In this semester students apply their previously acquired skills in the most complex architectural representation: in drawing after imagination. After practising the representation of reality and preparing creative perspective drawings (with the help of the real view, which could not be drawn from real points of view), students in this course prepare fully detailed, external and internal perspective views of buildings of various size, based on plans (e.g. ground plans, sections, elevations), using their experience and creative imagination, applying conventional graphic techniques. Students have to accomplish a modelling task during the semester, which improves creative thinking. (2 credits)

**Urban Design 1**

**BMEEPUIA501**

The subject is the theoretical course of the fifth semester. The goal is to introduce students to the theoretical background of Urban Planning and Design with specially focusing on the knowledge and skills necessary for the successful participation in the Design courses later on in the curriculum. The course deals with the historical background, fundamental theories, basic typologies, most wide spread urban forms and basic sustainability aspects of the urban environments worldwide. (2 credits)

**Architecture of Workplaces 2**

**BMEEPIPA501**

Architecture of Workplaces 2 is the main practical course of the Department for Industrial and Agricultural Building Design. The aim of the course is to summarize the acquired architectural-technical knowledge, to prepare for the complex architectural thinking before the Complex Design course, to develop independent thinking, capability of decision and cooperation in team work. There are two design tasks during the semester. The first one is a small intervention; the second task is a rather more complex task. The overall net area of the buildings to be designed is about 800 m². The semester starts with the presentation of the programs and a site visit. (6 credits)

**Economics 1. (Microeconomics)**

**BMGT301004**

Objectives and description of the course: The aim is to allow students to understand today’s economic environment. After having finished the course, students should understand the key concepts of microeconomics (e.g. opportunity cost, supply and demand, market equilibrium, prices, cost functions, profit, competition and monopoly), master a basic set of tools of economic analysis and demonstrate the ability to apply them to simple practical problems. This course is primarily designed as an introduction to microeconomic theory for undergraduate students pursuing a bachelor’s degree in engineering. Both the course and the recommended textbook are accessible to students without a strong math background. Integral calculus is not used and the most important ideas are also demonstrated in graphs. (2 credits)
Construction Management 3 (Planning of Construction Technology)

BMEEPEKA701

The goal of the subject is to present information on the planning of elementary construction technologies related to superstructures and finishing work. The subject introduces how to apply recent innovations of building technologies during design and realisation. It gives a basic knowledge to evaluate construction options and make appropriate decisions about technology. There are case studies of building technologies used in construction of loadbearing structures, finishing and cladding works. The practical part contains workshops on planning of construction technologies: connection of structures and technologies, volume calculation, resource estimation, scheduling and construction site planning. (4 credits)

Building Service Engineering 2

BMEEPEG601


Building Constructions 5

BMEEPEST602

This subject introduces the students to the precast reinforced concrete, steel and the timber load bearing construction systems of the big span halls and their special additional structures by a system- and performance-based approach. Details both of heavy elevation and roof slab structures made of prefabricated r.c. sandwich panels and lightweight external constructions are presented. Specific flooring, big size doors and partitions of industrial and commercial halls are shown. It is also an objective to present the special construction rules and the service system aspects of the buildings of lightweight system and their particularities in the terms of building physics and fire protection. Additional information is presented about multilevel precast r.c. skeleton frames, its typical technical details and the structural solutions of mass produced blocked and panel load bearing systems in case of residential buildings. The main object of the course is to explain the constructions of one storey high big span halls. Students practice knowledge transmitted during the presentations and workshops in their semester projects on basis of the whole complexity of previous studies. (4 credits)

Preservation of Historic Monuments

BMEEPET611

The course gives an overview on history and theory of the architectural preservation in Europe and Hungary. Presents the evaluation of the way of thinking from purism to the modern practice of restoration. It is an important part, when national and international documents and theoretic papers are discussed, form Morris and Ruskin’s work, over Boito’s “Prima carta del restauro” (1883) to Krakow Charter 2000. Following the historic part some technical aspects of preservation are discussed, i.e. surveying methods and techniques, non-destructive and destructive building archaeological methods etc. The brief introduction to building archaeology helps to understand the importance of theoretic reconstruction of independent building phases of the historic monument. The detailed discussion of the topic is part of the Preservation of historic buildings 2 – Building archaeology elective subject. The third part is dealing with architectural and design-methodological questions of preservation. Especially the architectural problems of presentation of archaeological heritage, the reuse and functional problems of industrial and vernacular buildings for modern purposes. (2 credits)

History of Architecture 6

BMEEPET601

The course gives an overview of the architecture in the 20-21st centuries. The classes follow chronology with focusing on the works of some great architects: Modernism and Modern Movement. Architecture between the two world wars – De Stijl, Bauhaus, Russian Constructivism, Less is more – Architecture of Ludwig Mies van der Rohe, Toward a New Architecture – Architecture of Le Corbusier. The Nordic Classicist Tradition – Architecture of E. G. Asplund and S. Lewerentz. Alvar Aalto and the modern Finnish architecture. In the second part the course picks up some relevant architectural trends: New Empiricism, New Humanism, New Brutalism and the Team X, the way from large housing estates to architecture without architects. Unfolding post-modern architecture, participation and the Las Vegas strip, Colin Rowe’s studio, Critical Regionalism. The third part concentrates on timely problems: new materials or the multi-sensorial experience of space and surface, Rem Koolhaas’s Dirty Realism, new technology and digital perception, architecture of seduction. (3 credits)

Drawing and Composition 6

BMEEPRAA601

The main topic in the syllabus this semester is the intuitive representation of internal and external spaces: this subject aims at teaching students perspective representation at a higher level (applying 3-6 vanishing points). While drawing the streets and squares of the Buda Castle and the internal spaces of some atmospheric old public building sin Budapest (e.g. Saint Stephen Cathedral, Opera House, Hungarian National Museum) students investigate invisible geometrical and structural relations and improve their drawing skills (applying lead pencil, ink and crayon techniques). The objective is not to simply represent a naturalistic view as a camera, but to prepare a drawing of the architectural structure of a real space after grasping the gist of the composition. (2 credits)

Department’s Design 1

BMEEPUIQ601

A special urban design course focusing mainly on urban public space design with the help of invited lecturers and landscape designer consultants. The course is a partly theoretical and partly practical where students get acquainted with special issues and problems of public space definition, basic notions and tools of public realm and public space design. In the design assignment students deal with a smaller spatial entity, where they start from the analysis of the urban problem and provide a possible solution for the publicly attainable zones in between buildings. (3 credits)
Urban Design 2

BMEEPUIA601

Urban Design 2 is the main practical course of the Department of Urban Planning and Design. On-site investigation and the planning process of the studio work create an experimental laboratory for urban interventions. After the analysis of large-scale urban environment, the task is to prepare an urban design concept for a large urban unit and later develop it into an urban scaled architectural design (development plan / master plan). In the classroom, Hungarian and international students work together, which gives the opportunity to compare different perspectives, visions and exchange of experiences. The site of the design task is the same urban environment for all students. The studio work includes common site visits, lectures and project presentations. (6 credits)

Special Load-Bearing Structures

BMEEPST1601

The subject introduces the special load-bearing structures, such as large span, tall and spatial structures. We introduce the trusses, box-beams, wall-beams and arches as large span structures. We show the static behavior of tall buildings: the concept of the vertical and horizontal load-bearing structures. The behavior of spatial structures is the main topic of the semester. We introduce the RC shells, the brick-shells, the cable and textile membranes, space-trusses, grid shells (4 credits)

History of Architecture Global (basic)

BMEEPETO699

The complex exam (BMEPETO699) is mandatory for students following the new education system. The complex exam comprehends the architecture of classical antique, the medieval, the Early Modern (renaissance and baroque) and the 19th century periods. The main purpose of the exam is to summarise main tendencies in history of architecture that determined the forming of the architectural space in different historic periods. Exam topics are based on the History of Architecture 1 - 5 courses, a list is available in the department (credit).

Economics 2. (Macroeconomics)

BMGET301924

The aim is to allow students to understand today's economic environment. After having finished the course, students should understand the key concepts of macroeconomics (e.g. national income, unemployment, inflation, budget balance, exchange rates and the balance of payments), master a basic set of tools of economic analysis and demonstrate the ability to apply them to simple practical problems. (2 credits)

Construction Management 2

(Building Project Management)

BMEEEPKK601

The subject introduces the investment process from emerging the idea through tendering until the hand-over and use. It shows the role and tasks of an architect in different phases of a construction process. It gives an introduction of real estate investment, basics of project management. The relationship between costs, time and quality: scheduling, planning and estimating and the procurement methods are revealed. There are case studies in the field of construction projects, their preparation and performance, planning, organising leading and commanding of works.

Main topics: Building project management: Participants of the construction; Start-up of the construction project - architectural competition; Tendering and contracting; Scheduling, networks; Cost estimation; Post occupancy evaluation (4 credits)

Building Constructions 6

BMEEPEST721

This subject introduces the students to the precast reinforced concrete, steel and the timber load bearing construction systems of the big span halls and their special additional structures by a system- and performance-based approach. Details both of heavy elevation and roof slab structures made of prefabricated r.c. sandwich panels and lightweight external constructions are presented. Specific flooring, big size doors and partitions of industrial and commercial halls are shown. It is also an objective to present the special construction rules and the service system aspects of the buildings of lightweight system and their particularities in the terms of building physics and fire protection. Additional information is presented about multilevel precast r.c. skeleton frames, its typical technical details and the structural solutions of mass produced blocked and panel load bearing systems in case of residential buildings. The main object of the course is to explain the constructions of one storey high big span halls. Students practice knowledge transmitted during the presentations and workshops in their semester projects on basis of the whole complexity of previous studies. (4 credits)

History of Art

BMEEPETT721

Beginnings of the art: the pictures of the cavemen. – Ancient art of the East: Egypt. – Classical art of the Antiquity: Greek and Roman art. – Early Christian and Medieval art. – Renaissance and Baroque art. – The art at the age of Enlightenment: Gothic revival, Classical revival, Classicism. – Romanticism, Realism, Impressionism, Postimpressionism. (2 credits)

Drawing 7

BMEEPRAO702

The course examines the relationship between colour and colour, colours and humans, and between colours and the built environment. Technical introduction of pigments, behaviour of colours when mixing pigments, the basic techniques of painting. The role of colours in the creative character and in the thoughtfully built environment. Presentation of the exterior architectural colour design, colour preferences and theories in the different historical periods. The concept and conditions of colour harmonies, guide to the effective use of the different harmony-theories. The use of colour design in everyday projects (authentic colouration in historic renovation, aesthetic urban rehabilitation, etc.) Students learn the architectural use of colour design through a series of projects, from the manual techniques of painting to digital colouration (2 credits).

Department’s Design 2

BMEEPRA701

This subject based on interior design. The design process focuses on abstract formal approach. Students create different 3D possibilities in the first half of the semester, then they analyse them. The project becomes in this way interior
design. The design project based on the fundamental decisions and 3D modelling, which are completed by manual works. (3 credits)

**Departmental Design 3**

**BMEEPEXX711**

Department Design 3 for students is one a semester design course in English, organized by the Departments of Design in. The object of the course is to introduce a multilevel design method for students from general urban concept to the design of an architectural element. A comprehensive urban-architectural design based on the analysis of the urban tissue, cultural heritage, architectural details is going to give a common frame for individual architectural proposals. Teamwork and individual work will constantly implement and define each other. The semester will also give space to work on some contemporary questions in architecture, like the sustainability of an established urban environment, the relationship and social aspects of public and private spaces, the effects of landscape design and design of public spaces buildings. (8 credits)

**Building and Architectural Economics**

**BMEEPEKA0801**

Aim: investigate the economic side of a real estate development emphasizing the social cost and benefit of development. This module concentrates economical computation models, theories dealing with real estate valuation. There is a homework concerning with calculation, valuation of a real estate development. Successful submission is required for the module acceptance. Written mid-semester test as indicated, minimum pass grade required. Following main topics are discussed: construction cost, estimates, time value of money, building life cycle cost, measuring the worth of real estate investments. (2 credits)

**Real-Estate Development**

**BMEEPEK0626**


**History of Architecture in Hungary 1**

**BMEEPET0801**

The subject History of Architecture in Hungary 1. aims to present and analyze the architecture of historic Hungary in European and domestic context from the history of Pannonia to the end of Baroque. The principle of the presentation is the chronological interdependence, however, particular attention is given to the main trends within the different periods as the main stylistic tendencies or external and internal factors that determine the historical and architectural context. A great emphasis is given to the exploration of the connections between the European and Hungarian history of architecture. Lecture topics include: The beginnings of architecture in the Carpathian Basin. Roman architecture in Hungary. Early medieval architecture in Hungary - Christian Architecture between West and East. The flourishing Romanesque and the beginnings of Gothic Architecture. The rise of Gothic Architecture - architecture in towns and Gothic architecture of the orders. The beginning and the first period of the renaissance till the middle of the 16th century. The architecture of fortified palaces and fortifications. The renaissance architecture in Transylvania. The beginnings of the baroque in Western Hungary in the 17th century. The High Baroque in Hungary. (2 credits)

**Drawing 8**

**BMEEIPRAQ80**

‘Identity Design’ has become unavoidable in the self-management of today's architects. It determines the entire character, the image of a business and affects its efficiency. Identity Design symbolises the integrity, the personality of the author and at the same time reflects the quality of the work. During the course, students will have the opportunity to design their own logo, business card and graphic portfolio. The different parts of the project are to be unified by a thorough graphic layout which also reflects the designer's identity and personality. A wide range of different visual techniques and graphical tools will be introduced to help achieve the best outcome (2 credits).

**Urbanism**

**BMEEPI10805**

The goal of the course is to get students acquainted with the multidisciplinary characteristics of Urban Studies. The semester is divided into two blocks dealing with: urbanisation processes in the world, in Hungary and Budapest; the issues of contemporary urbanity; related fields of science and planning tools in various field of the profession. In the series of lectures professors of the Department of Urban Planning and Design and some invited experts of various fields are presenting lectures on various topics. On the end of the semester, you have to present a specific urban topic of your home city. (2 credits)

**Contemporary Architectural Offices**

**BMEEP03893**

This subject is about contemporary Hungarian architecture. The course is set up of weekly lectures or a site visits by a famous/talented Hungarian architects. The lectures are Hungarian language, for the international students it will be translated by an interpreter. For execution of the subject an essay is to be written about one of the lectures. The topics will be personalized for everyone during the last lecture. (2 credits)

**Residential Design and Contemporary Competitions**

**BMEEPLA0897**

Through the study of actual, current public commissions, this class provides a perspective on contemporary Hungarian residential building design praxis. Also, through past projects, it presents the main changes over recent years. The aim is to complement lectures in the Residential Building Design 1 course by acquainting students with as many concrete examples as possible – of contemporary Hungarian architectural creations and, primarily, of the bubbling,
fertile, and often controversial world of public commissions. The highlighted standpoint and aim is for students to observe architectural praxis in today’s Hungary, even if that is through more or less successful answers to questions that are posed. Another goal is for students to develop a routine of following public commissions, as well as an understanding of the procurement system, where to find such opportunities, and the rules and methodology regarding tenders. The hidden aim, by engaging with the given public tenders within the course, is to develop an active discourse among pupils on the basis of the evaluation and ‘judgement’ that follows. (2 credits)

**Complex Design 1**

**BMEEPXXT811**

Students must develop a plan to the level requested for permit or for a large-scale project, to the depth of an investment program plan. Part of the building must be developed to the construction plan level. Students must also prepare dossiers of structural calculation, work details, mechanical installations and the organisation of the construction site and consult with staff members of various departments for assistance. Students can select their project as well as their Studio Master. (10 credits)

**Construction Law**

**BMEEPEKO901**

The subject introduces the legal environment of construction projects: contracts, building permit, permission of use, etc. (2 credits)

**Design of Reinforced Concrete structures**

**BMEEPSO0655**

The subject introduces students into the way of design of approximate dimensions, joints and structural solutions of reinforced concrete structures. Invited lecturers expose some of the most significant recent investments in reinforced concrete in Hungary. The aim of the course is to develop the ability of students - on the basis of EUROCODE 2 - to adopt architectural dimensions and to evaluate the effect of the chosen architectural lay-out onto the structural solution. (2 credits)

**Drawing 9**

**BMEEPRAT901**

The course provides a wide selection of representation techniques from traditional pencil drawing to collage, and from architectural geometry to computer aided visual rendering. The offered courses cover variable areas of basic architectural graphics, from which students have the opportunity to choose. (2 credits)

**Architectural Interiors**

**BMEEMPKO905**

The primary object of the Interior Architecture course is to examine the range of theories behind development of this spatial type, undertaken in the form of a lecture course and practical exams. Students will also be involved in a closed competition held in parallel with students on the Hungarian course. The lecture course is to be broken down into individual study areas which are to be introduced by visiting academics, architects and interior designers over a course of 12 - 13 weeks as follows:
- General concept of space.
- General concept of architectural space.
- Sacred / Communal / Personal space.
Theory of Design

BMEEEPETO921

The course aims at awakening and strengthening the students’ abilities, interest, to reflect on architectural design, in accordance with their own cultural background, in the original spirit of theorizing: thinking of, looking at, with freedom and criticism. Considering the special and unique position of this continuous reflective activity as an operative and constitutive part of the architectural design practice, the course not only picks up special themes of history and contemporary discourses, but also concentrates on mobilizing the students practical and theoretical skills, already acquired during their previous studies. (2 credits)

History of Architecture in Hungary

BMEEEPETO901

The course gives an overview of Hungarian architecture from the end of the 18th century up to now. While following the timeline, the classes concentrate on the main problems of the investigated periods, like the question of historicism, international and national sources between the 2 Wars, socialist realism in the 1950s, technology and high-rise in the 1960s, built environment in the 1970s, post-modernism in the 1980s. As the problem of identity (national or regional architecture) is a recurrent theme through the whole period, the course pays a special attention to it. (2 credits)

Description of MSc Subjects

Drawing 7

BMEEPRAO702

The course examines the relationship between colour and colour, colours and humans, and between colours and the built environment. Technical introduction of pigments, behaviour of colours when mixing pigments, the basic techniques of painting. The role of colours in the creative character and in the thoughtfully built environment. Presentation of the exterior architectural colour design, colour preferences and theories in the different historical periods. The concept and conditions of colour harmonies, guide to the effective use of the different harmony-theories. The use of colour design in everyday projects (authentic colouration in historic renovation, aesthetic urban rehabilitation, etc.) Students learn the architectural use of colour design through a series of projects, from the manual techniques of painting to digital colouration (2 credits).

Urbanism

BMEEPUI0805

The goal of the course is to get students acquainted with the multidisciplinary characteristics of Urban Studies. The semester is divided into two blocks dealing with: urbanisation processes in the world, in Hungary and Budapest; the issues of contemporary urbanity; related fields of science and planning tools in various field of the profession. In the series of lectures professors of the Department of Urban Planning and Design and some invited experts of various fields are presenting lectures on various topics. On the end of the semester, you have to present a specific urban topic of your home city. (2 credits)

City Design 1

BMEEPUI081V1

Theoretical course of the second semester of City Design specialization. The goal of the course is to introduce students to the theoretical background of Urban Planning and Design with specially focusing on the knowledge and skills necessary for the successful participation in the courses later on in the curriculum and to give a stable knowledge and vocabulary for professional work with focusing on the basic notions of the profession. Covered topics: Definitions, context, procedural types; Scales, typologies, basic tools of planning and design; Origins and history, the very basis of urban history, Future and possibilities – scenarios and possibilities for the future (2 credits)

Environmental Design

BMEEPUI092V3

A special urban design course focusing mainly on urban public space design with the help of invited lecturers and landscape designer consultants. The course is a partly theoretical and partly practical where students get acquainted with special issues and problems of public space definition, basic notions and tools of public realm and public space design. In the design assignment students deal with a smaller spatial entity, where they start from the analysis of the urban problem and provide a possible solution for the publicly attainable zones in between buildings. (4 credits)
Urban Research
BMEEPUI1MV3
The aim of the course is to deepen the knowledge acquainted in BSC about research methodologies used in urban studies and planning. The first part of the course is integrated with the project of Complex Design and aims to analyze the urban environment of the project. In the second part of the semester, students have to elaborate an essay about the housing situation of their home cities and a presentation of a contemporary project on this field. (6 credits)

Sociology For Architects
BMEGT43A044
The course aims at giving an insight for the students into the nature of major social phenomena by demonstrating their main characteristics and their key interpretations in social sciences through the standard as well as the most up-to-date frameworks, methods and results with a clear and distinct focus on urbanisation and urban affairs. Major themes discussed during the course are Modernisation, Society and People, The Social Perspective, The Foundation and Construction of the Society, Social Stratification, Economy and Society, Community and identity, Social Institutions, Transformations of the Society, Globalisation, Urbanisation and Society, Metropolis and urban changes, Urban space and place. (2 credits)

Hungarian Cities
BMEEPUI0423
The aim of the subject is to familiarize with the characteristics of Hungarian cities and urban development processes. The subject intends to combine the benefits of lectures and lessons; providing the opportunity for active involvement. With the participation of invited speakers, you can hear about the most important periods of Hungarian city history and urban planning features, especially in the context of today’s processes. In the remaining classes we deal with the morphological (graphical) analysis of the selected Hungarian settlements. Morphology not only provides an excellent approach to understanding the history of urban development, but it is also worth exploring and learning from a methodological point of view. (2 credits)

City Design 2
BMEEPUI2V1
The theoretical and practical course of the third semester of City Design specialization. The goal of the course is to deepen the knowledge of students in the field of Urban planning and design through theoretical lectures and practical tasks. The semester is organized around an actual urban planning assignment, where real planning skills will be developed, but the task will be followed by theoretical lectures that will provide the background of the skills. The course deals with issues of sustainability, smart cities and is based on the practicalities of professional practices. (6 credits)

Studies For Chief Architects
BMEEPUI2V2
During the course the students are introduced into the theoretical basics of politics, political-governmental decision making, as well as into the socio-political and institutional framework of sustainable local/urban development. We will examine the economic, political-governmental, institutional and cultural factors, their effect on local decision making, relations between the various levels of territorial/ regional levels as well as examine the most important policy areas in EU context. The course is also testing this background in a real Hungarian municipality decision making context, where students through practical tasks will face real urban development problems. (5 credits)

Digital Cities
BMEEOFTMEP1
The course provides an in-depth practical experience of the methods, data and information available to urbanists through investigation of live projects in the built and natural environment. The students will learn how to use the spatial modelling and analysis techniques and identify new data and technologies platforms and apply to design, plan and manage a contemporary city. (3 credits)
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/

**Bachelor in chemical engineering**

The BSc degree course in chemical engineering provides the appropriate skills and knowledge in chemistry, chemical engineering and economic sciences. The degree holder should be able to manage chemical technologies, conduct analytical tests, intermediate and final quality control, and can take part in R&D, planning, and public administration. Part of the education is specialisation in a branch.

Applicants of interested in chemical engineering are welcome. Entrance exams include chemistry or physics and mathematics. A B2 level (according to CEFR) of English is required. A one year long pre-engineering study is also possible if needed (see the relevant chapter of this bulletin).

Students in the BSc chemical engineering program receive a thorough core curriculum. These include natural sciences as chemistry, mathematics and physics, and engineering fundamentals as unit operations, process control. We assure, that our students besides a profound theoretical knowledge, can acquire up-to-date laboratory skills, get acquainted with the machines and apparati used in the chemical industry, know
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 specialization 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.
Doctoral 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 member, 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 successful 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 dominating (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
## Curriculum of BSc Subjects
### General Subjects

<p>| Subject                                                                 | Code                  | Credits | 1 | 2 | 3 | 4 | 5 | 6 | 7 | Requisities                   |
|-------------------------------------------------------------------------|-----------------------|---------|---|---|---|---|---|---|-------------------------------|
| English for Chemical Studies 1.                                          | BMET63ECS1            | 3       | 0/4/0f |
| English for Chemical Studies 2                                          | BMET63ECS2            | 3       | 0/4/0f |
| Mathematics A1a - Calculus                                             | BMET90AX00            | 6       | 4/2/0e |
| General Chemistry                                                       | BMEVESA101            | 5       | 4/0/0e |
| General Chemistry Calculations for Chemical Engineers                  | BMEVESA104            | 4       | 0/3/0p |
| General Chemistry Laboratory Practice                                   | BMEVESA209            | 5       | 0/0/6p |
| Computing                                                              | BMEVESA103            | 2       | 0/2/0p |
| Chemical Eng. Fundamentals                                             | BMGEVGAV03            | 2       | 2/0/0e |
| Chemical Engineering Practice                                          | BMGEVGAV04            | 3       | 0/1/2p |
| Micro- and Macroeconomics                                              | BMGT30A001            | 4       | 4/0/0e |
| Mathematics A2c                                                        | BMET90AX17            | 6       | 4/2/0e |
| Mathematics A3 for Chemical Engineers and Bioengineers                  | BMET90AX18            | 4       | 2/2/0e |
| Physics 1 - Mechanics                                                  | BMET14AX15            | 4       | 2/2/0e |
| Inorganic Chemistry                                                    | BMEVESA208            | 3       | 3/0/0p |
| Inorganic Chemistry Laboratory Practice                                 | BMEVESA301            | 3       | 0/0/4p |
| Organic Chemistry I.                                                   | BMEVESA301            | 5       | 3/2/0e |
| Chemical Technology                                                    | BMVEKA203             | 3       | 2/0/0p |
| Physics 1 Electrodynamics                                               | BMET14AX04            | 2       | 2/0/0e |
| Physics Laboratory                                                      | BMET14AX05            | 2       | 0/0/3p |
| Organic Chemistry II.                                                  | BMEVESA401            | 4       | 3/0/0e |
| Analytical Chemistry                                                   | BMEVESA302            | 5       | 4/0/0p |
| Physical Chemistry I                                                   | BMVEKA304             | 5       | 1/1/0e |
| Plastics                                                               | BMVEKA306             | 5       | 2/0/2p |
| Organic Synthesis Laboratory Practice                                   | BMEVESA402            | 4       | 0/0/5p |
| Analytical Chemistry Laboratory Practice                                | BMEVESA403            | 4       | 1/0/4p |
| Physical Chemistry II                                                  | BMVEFAA405            | 4       | 2/1/0e |
| English for Chemical Studies 3                                          | BMET63ECS3            | 3       | 0/4/0f |
| English for Chemical Studies 4                                          | BMET63ECS4            | 3       | 0/4/0f |
| Medicines                                                              | BMEVESA403            | 3       | 2/0/0e |
| Colloid chemical approach to nanotechnology                            | BMVEFAA409            | 3       | 3/0/0p |
| Environmental Chemistry and Technology                                  | BMVEKA403             | 4       | 3/0/0e |
| Organic Chemical Technology                                            | BMVESTA411            | 3       | 2/0/0e |
| Organic Chemical Technology Practice                                    | BMEVESA412            | 3       | 0/0/4p |
| Chemical Unit Operations I                                             | BMVEKA410             | 6       | 3/2/0p |
| Business Law                                                           | BMET55A001            | 2       | 2/0/0p |
| Design of Experiments                                                   | BMEVMA606             | 3       | 2/1/0p |
| Hydrocarbon Technology                                                 | BMVEKA506             | 3       | 2/0/1e |
| Biochemistry                                                           | BMVEB3A01             | 4       | 3/0/0e |
| Physical Chemistry Lab. Prac.                                           | BMVEFAA306            | 3       | 0/0/4p |
| Chemical Process Control                                               | BMVEVMA504            | 5       | 2/1/1p |
| Chemical Unit Operations II                                            | BMVEKFA512            | 6       | 2/1/4e |
| Management and Business Economics                                      | BMET20A001            | 4       | 4/0/0p |
| Industrial Safety                                                      | BMEVESA101            | 2       | 2/0/0p |
| Quality Management                                                     | BMVEKFA615            | 4       | 3/0/0p |
| Chemical Unit Op. Practice                                             | BMVEKFA613            | 3       | 0/0/4p |
| Electives (Humanities)                                                 | 2 subjects            |         |     |     |     |     |     |     | BMEKFA512                      |
| Specialization                                                         | 26                    |         |     |     |     |     |     |     | BMEKFA512                      |
| Thesis                                                                 | BMVE..A999            | 15      | 0/0/14p |
| Summer Practice                                                        | BMVE..A888            | 0       | 6 weeks/s |
| Electives                                                              | 10                    |         |     |     |     |     |     |     | BMEKFA512                      |</p>
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Curriculum of BSc Subjects of Specialization
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Analytical Chemistry

BMEVESEA302
Dr Róbert E Gyurcsányi
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

BMEVESEA403
Dr Róbert E Gyurcsányi, 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

BMEVEBEA301
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 Eng. Fundamentals

BMEGEVGAV03
Statics of rigid and elastic bodies. Materials of mechanical structures. Machine elements: fasteners, seals, vessels, pipes and pipe accessories, bearings, couplings, chain,

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 measurement devices 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 Hőrvölgyi, 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 the 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 become 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 environment on 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 Technology
BMEVEKFA506
Dr Ákos Fürchte
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 Csontos
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

Inorganic Chemistry Laboratory Practice

Micro- and Macroeconomics

Management and Business Economics

Mathematics A1a - Calculus

Mathematics A2c

Medicines

Organic Chemical Technology

Organic Chemical Technology Practice
Organic Chemistry I.

**BMEVESZA301**

Dr. Lidlók Móczár, 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. This subject is the completion of the subject Organic Chemistry I. (4 credits)

Organic Chemistry II.

**BMEVESZA401**

Dr József Kupai, Dr Lidlók Móczár, 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

**BMEVESZA402**

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

**BMEVEKA304**

Dr Mihály Kállay, Dr Krisztina László

The course is part of the compulsory curriculum. A theoretical and practical introduction to 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

**BMEVEFAA405**

Dr András Sziliágyi, 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

**BMEVEFAA506**

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 methods in thermodynamics and reaction kinetics. Laboratory work and measurements of physico-chemical properties of materials will be accompanied by determination of experimental errors using statistical methods, and introducing some basic skills in experimental design. (3 credits)

Physics 1 - Mechanics

**BMETE14AX15**


Physics 1 Electrodymanics

**BMETE14AX04**

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, refractive 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

BMEEVEFAA306

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

BMEEVEAAA708

Dr Róbert E Gyurcsányi
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

BMEEVEAAA611

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 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
BMEVESKA504
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
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)

Chemical and Process Engineering

Chemical Production Control
BMEVEKTA707
László Rácz
Learning chemical processes from design operation and product delivery. Treatment of side products and wastes . Liability and operability study. Quality insurance. Studying chemical processes from the design of operations all the way until product delivery. The subject also gives an overview about the treatment of side products and wastes. It also discusses liability and operability of chemical processes as well as the problems of quality insurance. (3 credits)

Computer Process Control
BMEVEKFA709
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)

Environmental Benign Chemical Processes
BMEVEVMA607
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, 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 is explained. (4 credits)

Hydrocarbon Technology and Catalysis
BMEVEKFA503
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
BMEVEVMA605
Dr Endre Rév
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
BMEVEKFA502
Dr György Pátzay

Industrial Pharmaceutics

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, 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
BMEVESKA504
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)

Organic Chemistry Laboratory Practice II
BMEVESKA605
Dr Gábor Hornyánszki
Students are to acquire a mastery of the methodology of lab-
oratory practice necessary to complete tasks in the fields of the pharmaceutical industry and the research-development sector of the organic chemical industry, and to successfully participate in the MSc studies. The aim of the laboratory practice is to carry out organic chemical reaction sequences, to learn about modern organic reactions, procedures and separation techniques, and to learn the requirements of conducting independent research (this involves the demonstration and practice of the structure elucidation of organic compounds, as well as the introduction of the methods of current organic chemical literature search, online search, the use of monographs and series, and the practice of the application of softwares). (5 credits)

**Pharmaceutical Technology I.**

**BMEVESTA704**

**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 followings: 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**

**BMEVESZ777**

**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**

**BMEVESTA607**

**Dr Gábor 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**

**BMEVESTA606**

**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**

**BMEVESTA705**

**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**

**BMEVESTA508**

**Dr György Kegelevich**

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**

**BMEVEMGA603**

**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**

**BMEVEFAA602**

**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**

**BMEVEFAA601**

**Dr Álfréd 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-
ing related to the production, processing and application of ceramic functional materials. A further aim of the course is to present – from the perspective of materials science – the ability of modern industrial ceramics and their associated systems to satisfy the demands of the modern economy. (2 credits)

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. (3 credits)

Physical Chemistry of Surfaces  
BMEVEKA603  
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, nanoindentor) (3 credits)

Theory of Testing Methods in Material Sciences  
BMEVEFAA708  
Dr Mihály Kállay  
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; Thermforming machines and tools; Practical work: Visits in manufacturing plants. (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; Thermforming 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  
BMEVEMGA551  
Dr Béla Pukánszky  
Textile Technology

Chemical Technology of Textiles I.

BMEVEMGA617

Dr Emília Csizsár

Preparatory processes: desizing, scouring, bleaching, carbonization; 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.

BMEVEAA718

Dr Emília Csizsár, 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

BMEVEAA510

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

BMEVEMGA515

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

BMEVEMGA512

Dr Judit Borsa

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

Project Work

BMEVEAA777

Dr Álfréd 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)
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
BMEVEMB301
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 biindustrial 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 Höltzl
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)

Design of Experiments 2
BMEVEKFM209
Péter Kunovszki, Dr Sándor Kemény
To learn one of the most important and widely used statistical methods, the analysis of variance. To deepen the knowledge attained in the introductory course about factorial designs. (3 credits)

Environmentally Benign and Catalytic Processes
BMEVEKFM210
Dr Edit Székely
The aim of the course is to give an overview of current environmental regulations, environmentally benign and industrially applied catalytic technologies and the trends of their development from the aspect of chemical engineers. The students gain insight to selected innovative processes and technologies and develop a broader understanding of the selection of a suitable technology for a given purpose. (5 credits)

Material Science Analysis Methods
BMEVESAM202
Dr Imre Miklós Szilágyi
The course will give a broad overview on the measurement methods used in materials science involving nanotechnology, inorganic chemistry, polymers, biomaterials, organic materials. During the laboratory practices students will get both theoretical knowledge and practical experience about a large number of analytical methods and instruments. (4 credits)

Materials science: traditional structural materials and polymers
BMEVEFAM110
Dr Alfréd Kállay-Menyhárd
Materials science explores the relationship between the processing technology, the structure and the properties of materials with the aim of meeting the requirements of specific applications. The goal of the course is to offer information about the structure, properties and behaviour of the most frequently used structural and functional solid materials. The course demonstrates the importance of the design, production and shaping of materials and products through real-life examples. The course discusses in detail the structure-property correlations of plastics, metals and ceramics, as well as structural and functional solid materials based on renewable resources. This course also highlights the important similarities and differences between the studied structural materials. (4 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 Gyurcsányi
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, agro- and fine chemical, cosmetic and food industries) 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 biological processes, the formation of metal containing bio-complexes, the toxicity of some inorganic compounds, bioactive compounds with inorganic ions used in pharmaceuti-cal 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, amino 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 technologies, the relevant biodegradable polymers, macromolecular bases of pharmaceutical technologies (such as the prepa-ration of nanocapsules, implants and their ap-plication). Special emphasis is put on the manufacturing technologies of bio-composites. 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 different 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  
BMEVEKFIM302  
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, fissile 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  
BMEYMBBM501  
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  
BMEVEKFIM501  
Dr Edit Székely, Dr László Mika, Katalin Koczka, Ildikó 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  
BMEVEKFIM503  
Dr Iván Gresits, Dr Ákos Fürcht  
To discuss the importance of crude oil, as primary energy source. To present the crude oil pre-cressing 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 Dénes Zsibeberth  
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  
BMEVEKFIM104  
Dr Edit Székely, Dr László Mika, Katalin Koczka, Ildikó 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 beside 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 Hőrölgyi  
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 Pätzay, 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)
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## Environmental Engineering
### Curriculum of MSc Subjects - Environmental Technology Spec.

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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 Krisztiina 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 Kösi
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 Mártá Lázi
(4 credits)

Engineering Ecology

BMEEOVKMKM1
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 suitably 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 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

BMEVEBM214
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

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)
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 concern the 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 Pávölgyi
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 shows the role of technology and engineering 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

BMEVEKF304
Dr György Páztay
(3 credits)

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 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

BMEEOVKMK5
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. The
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 Nagypáľ-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 Kósi*

(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**

**BMEEOVKMKM1**

*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 Vigh*

(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
obtained through monitoring network design, introduction of sampling methods and instruments, analytical methods, biometric, 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 mathematical modeling for description of processes and for simulation of optimal operations. (3 credits)

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)

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 examination even via case studies targeting amendment of contaminated (environmental) elements, primarily contaminated soil, ground water, degraded soils and remediation of contaminated (environmental) elements, primarily contaminated soil, ground water. Within this topic the focus will be on 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. (3 credits)

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)

Technology Management

BMEGT20M410

Dr Béla Pataki

The program shows 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 co-operate with the business side of the organization (e.g. with the marketing department). (3 credits)

Database systems*

BMEEOFTM151

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)

Energy Efficiency and Certification*

BMEGÉÉEMKK3

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)

Conventional and New Technologies of Energy Production

BMEVEKFM304

Dr György Pátzay

(3 credits)

Waste Management*

BMEGÉÉEMKK2

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)

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.
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)

**Operation of chemical processes**

**BMEEVFM305**

Teaching the basics of operation and control, so that the environmental engineers will become able to work in a team with process engineers to design and complete the control structure of any process. The theoretical subjects are demonstrated in the frame laboratory practices. (3 credits)

**Drinking water and wastewater treatment plants**

**BMEEOVKMV61**

The course aims to provide theoretical and practical knowledge in the field of applied technologies at drinking water and wastewater treatment plants. The first part of the semester deals with drinking water treatment technologies. (1) water bases and contaminants in the raw water, (2) disinfection of drinking water, iron, manganese, arsenic and ammonium ion removal technologies, (3) removal of dissolved gases and solid particles from drinking water, (4) complex technologies for drinking water treatment. The second part of the semester deals with wastewater treatment technologies: (1) the definition of wastewater, (2) mechanical wastewater treatment, (3) basics of chemical wastewater treatment, the removal of phosphorous and nitrogen from wastewater, (4) sludge formation during wastewater treatment, aerobic and anaerobic treatment and disposal of sludge. (3 credits)

**Modern Environment-friendly Transportation Systems**

**BMEOVJM955**

Dr Gergely Tulipánt

The students should acquire and get an overall picture about the environmental questions which determine the transport in the present environmental burden and they should handle the total transport system in unified, environmental point of view. They should familiarize with the relevant modern knowledge for reduction of environmental pollution. (3 credits)

**Environmental toxicology**

**BMEMVMBM401**

Dr Mónika Molnár

Environmental toxicology is one of the most important tools in the modern, risk-based environmental management, as 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 test organisms used in aquatic and terrestrial ecotoxicology. (3 credits)

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

**BMOKMV951**

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)

**Technical Acoustics and Noise Control**

**BMGEÁTMKK3**

Dr János Gábor Vad

(3 credits)

**Technologies in the chemical industry**

**BMESZM206**

Dr Alajos Grün

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 environmental protection are also discussed via case studies. (3 credits)

**Planning of Studies**

**BMEEVEKFM403**

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.

The Budapest University of Technology and Economics has close relationships with Hungarian and foreign companies in the civil engineering fields, who are interested in the research and development of civil engineering structures and design methods. Out of the approximately 1200 students who study at this Faculty, 200 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
### Curriculum of BSc in Civil Engineering

#### Core subjects (8 semesters)

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## Curriculum of BSc in Civil Engineering
### Specialization in Structural Engineering

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## Curriculum of BSc in Civil Engineering
### Specialization in Infrastructure Engineering

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|----------------------------------------------|--------------------------------|----------|---------|---|---|---|---|---|---|---|----------------------------|
| **Infrastructure CAD Course**               | BMEEOUVAI45                    | 1        |         |   |   |   |   |   |   |   | EOUVAI41                   |
| **Water Chemistry and Hydrobiology**        | BMEEOVKAI43                    | 3        |         |   |   |   |   |   |   |   | EOVKAI43                   |
| **Legal Aspects of Water and Environment**  | BMEEOVKAI45                    | 2        |         |   |   |   |   |   |   |   | EOVKAI41                   |
| **Hydraulics 2**                            | BMEEOVVAI42                    | 3        |         |   |   |   |   |   |   |   | EOVVAT42                   |
| **Highway and Railway Structures**          | BMEEOUVAI44                    | 5        | 3/4/0/E |   |   |   |   |   |   | 5/4/0/E                   | EOUVAI41 |
| **Highway and Railway Design**              | BMEEOUVAI43                    | 5        |         |   |   |   |   |   |   |   | EOUVAI41                   |
| **Public Works 2**                          | BMEEOVKAI45                    | 5        |         |   |   |   |   |   |   |   | EOUVAI41                   |
| **Urban Environment**                        | BMEEOVKAI42                    | 3        |         |   |   |   |   |   |   |   | EOVKAI42                   |
| **Water Quality Management**                | BMEEOVKAI44                    | 3        |         |   |   |   |   |   |   |   | EOVKAI41                   |
| **Hydrology 2**                             | BMEEOVVAI41                    | 3        |         |   |   |   |   |   |   |   | EOVVAT41                   |
| **Transportation Networks**                 | BMEEOUVAI42                    | 3        |         |   |   |   |   |   |   |   | EOUVAI42                   |
| **Highway and Railway Laboratory Course**   | BMEEOUVAI44                    | 1        | 3/0/0/M |   |   |   |   |   |   | 3/0/0/M                   | EOUVAI41 |
| **Water Resources Management**              | BMEEOVVAI43                    | 3        |         |   |   |   |   |   |   |   | EOVVAI41                   |
| **Hydraulic Engineering Field Course**      | BMEEOVVAI44                    | 2        |         |   |   |   |   |   |   |   | EOVVAI41                   |
| **Infrastructure Design Project**           | BMEEODHAI41                    | 6        |         |   |   |   |   |   |   |   | 6/0/0/M                   | EOVTAI41 |
| **Public Administration and Land Registry** | BMEEOUVAT44                    | 3        |         |   |   |   |   |   |   |   | GTSAI001                   |
| **Earthworks and Drainage of Transportation Infrastructures** | BMEEOGMAI41 | 3 |         |   |   |   |   |   |   |   | EOGMAI43                   |
| **Technical Internship**                    | BMEEODHAI42                    | 0        |         |   |   |   |   |   |   |   | EOVVAI41                   |
| **Highway Planning and Design**             | BMEEOUVA-E1                    | 3        |         |   |   |   |   |   |   |   | EOUVAI43                   |
| **Water Damage Prevention and Water Use**   | BMEEOVVA-F1                    | 5        |         |   |   |   |   |   |   |   | 5/4/0/E                   | EOVVAI43 |
| **Drinking Water and Wastewater Treatment** | BMEEOVKA-H1                    | 4        |         |   |   |   |   |   |   |   | 4/3/0/E                   | EOVKAI41 |
| **Railway Planning and Design**             | BMEEOUVA-E2                    | 3        |         |   |   |   |   |   |   |   | EOUVAI43                   |
| **River Basin Management**                  | BMEEOVVA-F2                    | 3        |         |   |   |   |   |   |   |   | EOVVAI43                   |
| **Environmental Impact Assessment**         | BMEEOVKA-H3                    | 3        |         |   |   |   |   |   |   |   | 3/3/0/E                   | EOVKAI43 |
| **Transportation Facility Design Project**  | BMEEOUVA-QP                    | 6        |         |   |   |   |   |   |   |   | EOUVAI41                   |
| **Hydraulic Engineering Design Project**    | BMEEOVVA-QP                    | 6        |         |   |   |   |   |   |   |   | EOVVAI41                   |
| **Urban Water Infrastructure Design Project** | BMEEOVKA-QP                   | 6        |         |   |   |   |   |   |   |   | EOVKAI41                   |
| **Diploma Project**                         | BMEEODHA-QD                    | 24       |         |   |   |   |   |   |   | M                          | EOUVAQ-P |
## Curriculum of MSc in Civil Engineering
### Structural Engineering

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<td>Tunneling</td>
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<td>BMEOGMMGM52-2</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
BMEEOOTMAT41

Mathematics A1a - Calculus
BMET90AX00
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**

**BMETE11AX13**


**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 shear strength). (4 credits)

**Introduction to Strength of Materials**

**BMEEOTMAT42**

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 shear, 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
BMETE90AX02

Surveying Field Course
BMEOAFAT43
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
BMEOEMAT44

Geoinformatics
BMEOOFTAT43
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 geographic 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
BMEOOHSAT41

Structural Analysis I.
BMEOOTMAT43

Railway Tracks
BMEOOUVAT41
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 lines, curves and transition curves, superelevation, vertical curves. Elements of the substructure and superstructure. Rails, sleepers, rail fastenings, ballast, subgrade, strengthening of the subgrade. Setting up 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
BMEOOVKAT41
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:

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)

Rocks  
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/contracting 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 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

**BMEEOHSA544**


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.

**BMEEOEMAS41**


Building Construction II.

**BMEEOEMAS43**


Steel and Composite Structures

**BMEEOHSA47**

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

**BMEEOHSA42**

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

**BMEEOHSAS43**


Laboratory Practice of Testing of Structures and Materials

**BMEEOHSA46**

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 constructional 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

BMEEOAFAS42

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 practices 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 practic 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
The aim of this course is that students learn and apply skills and be aware of the principles and basis of methods of optimization and digital signal processing. It also serves as the basis of the subsequent MSc subjects on modelling, design and programming. (3 credits)

### Building Design Projectwork

**BMEEOHSA-AP**

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 signal processing. It also serves as the basis of the subsequent MSc subjects on modelling, design and programming. (3 credits)

#### Numerical Methods

**BMEEOFTMK51**

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

#### Diplomas Project

**BMEEODHA-AD**

(24 credits)

Elective option:

### Reinforced Concrete bridges

**BMEEOHSA-B2**

structural geology and seismicity with special emphasis on the Carpathian basin. The lectures will help in learning the detection methods of seismic waves and acquire the information content of the seismograms. By completing the course the students will be able to determine the parameters that are necessary for appropriate seismic design. Engineering seismological approach will help the students to place the structures in the geological environment allowing the minimal risk and reducing the cost by proper seismic design. (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 materials to their properties, related physical-chemical processes, possibilities in modelling, relationship 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**
**BMEEOTMMS51**
The goal of the subject is to present the theoretical bases of the finite element method and its practical application to typical structural engineering problems. The classic approach to the finite element method will be followed in presenting the basic idea of the method, the element types, the applied interpolation functions, the various matrices and the basic steps of their construction, the resulting system of equations and the solution techniques of it. All these will be demonstrated and practiced through examples, showing how the various structure types (trusses, beams, frames, plates, shells, 3D solids) can be analysed. An introduction to nonlinearity from various sources will be given, with special focus on the effect and handling of geometric nonlinearity. Beside the static problems, the application of the finite element method to some heat transfer problems of the structural engineering practice will also be discussed. (5 credits)

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

**Structures 1**
**BMEEOHSMSS51**
The objective of the subject is the modelling of beams, membranes, plates and the simplest circular shell structures. The most important analytical solutions, the basics and assumptions of numerical solutions are introduced. It’s presented that the different structural considerations can be implemented in the design codes and regulations. The fundamental membrane solutions, shear lag effect, effective width, shear deformation, second-order effects and large deformations, anisotropy and the vibration of floors are also analysed. The main focus of the subject is the analysis of plates and slabs. (5 credits)

**Numerical modeling project**
**BMEEOOTMMSS5P**
The goal of the subject is that the students solve a civil engineering problem the complexity of which is in accordance with the level of the MSc course and with the credit and time-frame of the subject. The problem should be solved by high level application of some analytical or numerical method (e.g., finite element method). The problem is solved by the individual work of the student, helped by a tutor. (5 credits)

**Structures project**
**BMEEOHSMSS5P**
The objective of the course is that the student shall solve a structure-specific problem, by which his/her problem solving skills are improved, gains the skill of literature review, aims the comprehensive thinking. Aim is that the student becomes able to efficiently solve problems arising during design or research tasks. The subject of the study can be any structure-related problem discussed and agreed with the supervisor; not exclusively: modelling, analysis and/or design of part of or whole structural system, experimental analysis; research, research and development or expert design task; based on individual problem statement or joining to ongoing research program. (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 numerical design methods. (5 credits)

**Decision Supporting Methods**
**BMEEEPKMST4**
The aim of the course is to familiarize students with some practically used or usable mathematical models in the field of construction management, scheduling and tendering process. The course covers a wide variety of topics dealing with least cost scheduling problems, multi attribute decision models, learning curves. There are two computational modeling tasks as homework assignments. Final grades will be based on the two assigned tasks 15-15% and test 70%. (2 credits)

**Accounting, Controlling, Taxation**
**BMEGT35M014**
The main issues of ‘window dressing’ and their interpretation through financial ratio analysis and interpretation. The cost, volume, profit analysis and its relationship with costing and pricing decision-making. The operational and capital budgetary process in an international context and its advisory role through the process of variance analysis. The best international accounting practice both at the functional,
planning and strategic stages. The wider developmental strategic and ethical international issues concerned with managerial accounting. (2 credits)

Engineering Ethics

BMEGT41M004

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)

Structural Dynamics

BMEEOHSMN-1

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)

Stability of Structures

BMEEOHSMT-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)

Nonlinear Mechanics

BMEEOHSMN-2

The subject is the continuation of the Strength of Materials subjects taught in the Civil Engineering BSc programme on the expansion and the generalization of its linear models. Its two main goals are:

A. The students will become acquainted with the approaches of nonlinear mechanics, its variables used in theoretical and numerical modeling, and the principal equations required for the formulation of nonlinear mechanical problems. The application of various nonlinear strain and stress tensors is analysed, furthermore the origination of the equations in the form of a general boundary and/or initial value problem or as a variational problem form the most important types of engineering structures.

B. The second important goal is to get to know the theoretical background required for the - primarily finite element - analysis of nonlinear problems, with an emphasis on the theoretical and practical differences between the linear and nonlinear analysis. (4 credits)

Plasticity

BMEEOHSMN61

The purpose of the subject is, that the students acquire the basic concepts and methods of plasticity. In the frame of this they will get to know the material models, yield and hardening conditions of plasticity. The torsion problem of prismatic bars, and planar problems of solids will be learnt through examples and applications. There will be an emphasis given to the plastic load bearing capacity of elastoplastic frame structure, and their limit states. (3 credits)

Nonlinear FEM

BMEEOHSMN62

The main goal in this subject is, that the students get to know the solution with the finite element method (FEM) of the nonlinear mechanical problems typical in engineering practice, alongside with the mathematical background of the solutions. The specialities of one- and multidimensional problems will be discussed. There will be interpreted the nonlinear behaviour of the most important 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 nonlinearity the students will learn the special techniques (finite strip method, finite volume method, boundary element method, meshfree methods, smooth and finite particle methods, etc.). As an organic part of the course, students will analyse case studies solved by computer simulation, in order to deeper understand the modeling techniques of various nonlinearities and connect theory and practice. (3 credits)

Analysis of Rods and Frames

BMEEOHSMN63

The goal of the subject is to get students to know the modelling 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)

Discrete Element Method

BMEEOHSMN64

The goal of the subject is to get students to know the basics of the concept and methodology of the discrete element methods (DEM) occurring in the structural engineering practice, and allow an insight to the operation of a discrete element software. Students will learn the most important variations DEM, th applied equations of motion, their numeric solution methods with the limits of applicability, advantages and disadvantages. Students will analyse the model of a simple engineering problem. (3 credits)
Structures 2
BMEEOHSM1-1
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
BMEEOHSM1-2
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
BMEEOHSM1-3
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
BMEEOHSM1-61
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
BMEEOHSM1-62
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
BMEEOHSM1-63
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
BMEEOGMMG1-1
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
BMEEOGMMG2-2
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
BMEEOGMMG3-3
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, and qualification of subgrades and subbases, design of monitoring systems and design based on observation. (4 credits)

Earthworks of Infrastructures
BMEEOGMMG4-4
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 and Informatics is the strongest faculty of BME. It has been re-
nowned for excellence in research and education throughout the 70 years of its existence. English-language
studies have been available to international applicants for already 35 years.

The number of our international students has greatly increased in the past few years. As a result, there
are over 400 full-degree and 80 non-degree international students registered in both semesters of the current
academic year.

We offer English-taught programmes in 2 study fields: electrical engineering and computer engineering,
and at 3 levels: bachelor’s (BSc), master’s (MSc), and doctoral (PhD). Our BSc programmes can be started
only in the autumn semester, while enrolment for our MSc and PhD programmes is possible in the spring
semester as well.

The BSc and MSc programmes are designed to provide an optimal balance between theory and practice.
For this, lectures are combined with practical and laboratory classes. Apart from taking courses, students are
expected to do supervised project work, and to write a thesis in a topic related to their chosen specialisation.
Graduates have sound background knowledge of the field on one hand, and proficiency in the latest tools
and methods applied in industry on the other hand.

The PhD programmes are substantially research-oriented. Various topics are announced to applicants
each year, in accordance with the ongoing research, development and innovation projects at the depart-
ments. The selection of students for the topics is highly competitive. Those accepted are assigned a supervi-
sor, who guide their research and publication work all through the programme and beyond. There are some
further elements incorporated in the curriculum, which proves to be a challenging blend of scientific and
academic activities.

BSc programmes

Length of studies: 7 semesters. Structure of studies:
The first 4 semesters comprise mainly foundation and core engineering subjects. The last 3 semesters
include specialization subjects, laboratory work and project work too. The curriculum contains English lan-
guage courses and basic studies in economics as well. In addition to these compulsory subjects, students are
to take elective subjects related to the field, and further electives in human and economic sciences.

For most of the subjects, there is a strict order in which they should be completed. There is a recom-
mended study plan showing the subjects and the connections by semesters. Following this ensures that the
amount of work is about the same every semester.

In the last semester, students should also write and submit a thesis. To earn the degree, they have to take
a final exam in 2 subjects, and defend their thesis.

Entry requirements:
• Completed (upper/higher) secondary education with an overall result of around 70% (of the maxi-
mum). This should be proven by a leaving certificate (diploma) and the transcript of all corresponding
records.
• Appropriate knowledge of English, proven by one of the accepted certificates (see the faculty web-
site).
• Sufficient knowledge in mathematics and physics, proven at online tests during the admission proce-
dure. (There is a minimum entry score separately for both tests.)

BSc in Computer Engineering
Students can choose from the below specializations to study from the 5th semester:
• “Software Engineering” deals with different aspects of the design and development of data-driven ap-
plications, and with the model-based and object-oriented design and development principles.
• “Infocommunications” focuses on networks allowing flexible and efficient information transfer and
processing. These form the basis of implementing a huge variety of services in informatics, telecom-
munications, and distributed service provider systems.

BSc in Electrical Engineering
Students can choose from the below specializations to study from the 5th semester:
• “Sustainable Electric Energetics” covers the design and safe operation of electrical energy transmis-
sion and distribution systems, the design and operation of electric machines, and operational prin-
principles and applications of low and high voltage switching devices.

- “Embedded and Control Systems” focuses on computer-based and application-oriented systems, which operate autonomously and have intensive information exchange with their physical-technological environment.
- “Infocommunication Systems” is concerned with telecommunication and computer network-based applications (voice, data, image, video, multimedia and composite social information systems).

MSc programmes

Length of studies: 4 semesters. Structure of studies:
The programme mainly comprises foundation and core subjects, specialization subjects supplemented by project work and laboratory work, and thesis design work. For several of these, there is a strict order in which they should be completed. In addition to the compulsory subjects, ten percent of the total credits are to be obtained from elective subjects, taken equally from those related to the field and from human and economic sciences.

Specialized studies start either in the 2nd semester (in case of autumn enrolment), or right in the 1st semester (in case of spring enrolment). Students must take both a main and a secondary specialization.

In the last semester, students should also write and submit their thesis. To earn the degree, they have to take a final exam in 2 subjects, and defend the thesis.

Entry requirements:
- Completed bachelor’s studies with an overall result of around 70% (of the maximum). This should be proven by the degree awarded and the transcript of all corresponding records.
- Appropriate knowledge of English, proven by one of the accepted certificates (see the faculty website).
- Sufficient knowledge in the chosen field, proven at an online test during the admission procedure. (There is a minimum entry score set for the test.)

MSc in Computer Engineering

Any main specialization can be combined with any secondary specialization.
Main specializations:
- “Applied Informatics” deals with different aspects of the design and development of data-driven applications, and with the model-based and object-oriented design and development principles.
- “Internet Architecture and Services” focuses on networks allowing flexible and efficient information transfer and processing. These form the basis of implementing a huge variety of services in informatics, telecommunications, and distributed service provider systems.

Secondary specializations:
- “Smart City”
- “Cloud and Parallel Systems”

MSc in Electrical Engineering

Any main specialization can be combined with any secondary specialization.
Main specializations:
- “Electric Power Systems” covers a wide range including the design and safe operation of electrical energy transmission and distribution systems, the design and operation of electric machines, and operational principles and applications of low and high voltage switching devices.
- “Multimedia Systems and Services” is concerned with telecommunication and computer network-based applications (voice, data, image, video, multimedia and composite social information systems).
- “Embedded Systems” focuses on computer-based and application-oriented systems that operate autonomously, and have intensive information exchange with their physical-technological environment.

Secondary specializations:
- “Smart City”
- “Smart Systems Integration”
- “Optical Communication”
PhD programmes

Length of studies: 8 semesters. Structure of studies:
Three-quarters of the total credits are given for doing research and producing publications. The remaining credits are evenly shared between completing taught doctoral subjects, which are meant to strengthen the disciplinary background of the research, and improving teaching skills by contributing to BSc/MSc courses or supervising BSc/MSc project work.

The doctoral programmes in Hungary consist of 2 phases. At the end of the first phase, students should take a complex review exam. It serves as an entry to the second phase, and aims at giving an account of both the knowledge gained from relevant studies and the status of the research. The findings should finally be elaborated in a dissertation, and defended in public. The dissertation can be submitted only after the credit requirements of the programme and the minimum publication requirements for the degree are fulfilled, but must be submitted within 3 years from the complex exam.

Entry requirements:
- Completed master’s studies with an overall result of at least 70% (of the maximum). This should be proven by the degree awarded and the transcript of all corresponding records.
- Appropriate knowledge of English, proven by one of the accepted certificates (see the faculty website).
- Sufficient background knowledge in the chosen field, proven at an online test during the admission procedure.
- Sufficient knowledge related to the selected research topic, proven at an oral interview via Skype during the admission procedure.
- Convincing supporting documents (see the list on the faculty website).

PhD in Computer Engineering
Major areas of research: infocommunications, algorithms, data security, data bases, and software technologies.

PhD in Electrical Engineering
Major areas of research: embedded systems, robotics, control, telecommunication systems, microwave technologies, electron devices, nanotechnology, antennas and propagation, power systems and energetics.

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

Dean of the Faculty: Dr. Charaf Hassan
Vice-Dean for BSc and MSc Education: Dr. László Suibert
Director of BSc and MSc programmes: Dr. Eszter Udvary
Vice-Dean for Scientific Matters and PhD Education: Dr. Gábor Horváth
Acting International Director: Dr. Balázs Illés
International coordinators: Ms. Nóra Demeter (BSc, MSc) and Ms. Kata Jámi (PhD)
SMOG-P is the world’s first 5 cubic cm-sized, functional space device, created at BME VIK.

Digital Rubik Cube illustrates the real and the virtual world together, the communications potential of 5G networks and the related engineering challenges.
### Curriculum of BSc Subjects in Electrical Engineering

<table>
<thead>
<tr>
<th>Subject</th>
<th>lectures/practical lectures/laboratory</th>
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</thead>
<tbody>
<tr>
<td><strong>Fundamentals in Natural Sciences (48 credits)</strong></td>
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<tr>
<td>Mathematics A1</td>
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<td>Mathematics A2</td>
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<td>Comprehensive Exam on Mathematics A1&amp;A2</td>
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<td>Mathematics A3</td>
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<td>Mathematics A4</td>
<td>TE90AX51 4 2/2/0/e</td>
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<tr>
<td>Physics 1</td>
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<tr>
<td>Physics 2</td>
<td>TE11AX22 4 2/1/0/e</td>
</tr>
<tr>
<td>Foundation of Computer Science</td>
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<tr>
<td>Informatics 1</td>
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<tr>
<td>Informatics 2</td>
<td>VIAUAB01 5 3/0/1/e</td>
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<tr>
<td>Electronics Technology and Materials</td>
<td>VIETAB00 6 3/0/2/m</td>
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<td><strong>Economics and Humanities (20 credits)</strong></td>
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<td>English</td>
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<td>Micro- and Macroeconomics</td>
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<td>Management and Business Economics</td>
<td>GT20A001 4 4/0/0/m</td>
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<td>Business Law</td>
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<td>Mandatory Humanities &amp; Economics 3, 4</td>
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<td><strong>Core Electrical Engineering Knowledge (89 Credits)</strong></td>
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<td>Basics of Programming 1</td>
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<td>Basics of Programming 2</td>
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<tr>
<td>Signals and Systems 1</td>
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<td>Introduction to Electromagnetic Fields</td>
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<td>Measurement Technology</td>
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<tr>
<td>Specialization subject 3</td>
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<tr>
<td>Specialization subject 4</td>
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<tr>
<td>Training project laboratory</td>
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<tr>
<td>Project Laboratory</td>
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<td>Bsc Thesis Work</td>
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<tr>
<td>**Free electives (10 credits)**¹</td>
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<tr>
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<td>Number of exams²</td>
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</tbody>
</table>

¹ 10 credits of free electives could be substituted by any subjects available.
² 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.

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)
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.

<table>
<thead>
<tr>
<th>Subject</th>
<th>Code</th>
<th>Credits</th>
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<tr>
<td>Electric Power Transmission</td>
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<td>Electrical Machines and Applications</td>
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<td>Control of Electric Drives</td>
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<td>Sustainable Electric Energetics Laboratory</td>
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<td>Embedded And Ambient Systems</td>
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<td>Industrial Control</td>
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<td>Microcontroller Based Systems</td>
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<td>Embedded Operating Systems and Client</td>
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<td>Network Technologies and Applications</td>
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<td>Mobile Comm. Systems</td>
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<td>High Frequency System Techniques</td>
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<td>Radio Systems and Applications Lab</td>
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<td></td>
<td></td>
<td>0/0/3/m</td>
</tr>
</tbody>
</table>
## Curriculum of BSc Subjects in Computer Engineering

<table>
<thead>
<tr>
<th>Subject</th>
<th>lectures/practical lectures/laboratory</th>
</tr>
</thead>
<tbody>
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Specializations

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Applied Informatics Main Specialization

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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
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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
### Embedded Systems Main Specialization

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- y = practice hours
- z = laboratory hours
- r = requirement (e = exam, m = mid-semester mark)
## Curriculum of MSc Subjects in Electrical Engineering Multimedia Systems and Services Main Specialization

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- y = practice hours
- z = laboratory hours
- r = requirement (e = exam, m = mid-semester mark)
## Curriculum of MSc Subjects in Electrical Engineering

### Electric Power Systems Main Specialization

<table>
<thead>
<tr>
<th>Name</th>
<th>Code</th>
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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 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**

**BMEVIHIA08**

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**

**BMEVIHIA01**


**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**

**BMEVIHIA001**

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**

**BMEVIHIA001**

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**

**BMEVIHIA04**

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**

**BMEVIHIA02**

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**

**BMEVIVAA00**

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  
BMEVIHHAB01  
The course is a follow-up of Signals and Systems I. 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  
BMEVIVEAB00  

Introduction to Electromagnetic Fields  
BMEVIHVAC03  
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  
BMEVIHAIB02  
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  
BMEVIAUC05  
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  
BMEVIMIA01  
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  
BMEVIMIA12  
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**

**BMEVIHVCO5**

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 solve 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, and the popular communication systems used in embedded systems. (4 credits)

**Power Engineering**

**BMEVIVEA801**

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, organized 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**

**BMEVIVEAC00**

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**

**BMEVIVEAC01**


**Control of Electric Drives**

**BMEVIVEAC04**

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)

**Embedded Operating Systems and Client Apps.**

**BMEVIAUAC07**

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

**BMEVIIIAB05**

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'Hopital 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**


**Probability Theory**

**BMENVISZAB02**

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**

**BMENVISZAA03**

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. (~490) (5 credits)

**Introduction to the Theory of Computing 2**

**BMENVISZAA04**

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**

**BMENVIHAB00**

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)

**Theory of Algorithms**

**BMENVISZAB03**

The objective of the subject is to learn the basic methods and skills in the design and analysis of algorithms and to study the most important models of computations. Within the subject the students learn about the basic types of automata (finite, pushdown and Turing machine, all deterministic and nondeterministic) and their relationship to formal languages. They get acquainted with the basic complexity classes. Further algorithmic tools include linear and integer programming, dynamical programming, and sorting and searching techniques. (5 credits)

**Physics 1i**

**BMETE11AX23**

Electric fields, electric potential, capacitance and dielectrics, current and resistance, direct current circuits, magnetic fields. 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)

**Physics 2i**

**BMETE11AX24**

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)

**System Theory**

**BMENVIHAB00**

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 complex frequency domain. Examples for signal processing, communications 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

BMEVIEEAC00
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. 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 development 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

BMEVIIIAA02
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

BMEVIIIAB01
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

BMEVITMAC01
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

BMEVIMAB00
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

BMEVIEEAA00
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

BMEVIIIAA03
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. Next the 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 documentations 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
BMEVIAUAC00

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 of developing small application for Java Me 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. The students are presented the method of quick prototype development method. 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. Geometric modeling, Lagrange interpolation, Bezier approximation, B-Splines, NOBS and NORBS. 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-
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 computers and networked information 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)
Description of MSc Courses

Engineering Management

BMEVITMMB03

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 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

**BMEVISZMA04**

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

**BMEVIAUMA00**

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

**BMEVIAUMA01**

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

**BMEVIMIMA04**

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 us-

ing 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

**BMEVIAUMA02**

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

**BMEVIMIMA01**

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 are 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

**BMEVIAUMA03**

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

**BMEVITMMA01**

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

**BMEVIIIMB01**
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 details 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)

Electrical Engineering

**Smart City Laboratory**

**BMEVIIIMB04**
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**

**BMETE11MX33**
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**

**BMEVIMMA17**
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**

**BMEVIHVMA07**
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**

**BMEVIHMMA09**

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**

**BMEVIIMA07**

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**

**BMEVIUMMA09**

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**

**BMEVIHMMA11**

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**

**BMEVIHMMA12**

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**

**BMEVIHMMA07**

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**

**BMEVIHMMA01**

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, CPM, 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 character-
istics. (4 credits)

Foundations of Multimedia Technologies
BMEVIHIMA08

The course gives an overview of modern media communi-
cation system architectures, coding and modulation tech-
niques, media service customer behavior and user devices. This
course allows students to get acquainted with the cap-
pabilities of different media capture, storage, delivery and
display solutions. (4 credits)

Laboratory on Multimedia Systems and
Services 1
BMEVIHIMA10

The aim of this laboratory course is to extend the knowl-
edge learnt in Foundations of multimedia technologies lec-
ture 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
BMEVIEMA01

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
BMEVIEMA02

The purpose of the subject is to give information for the stu-
dents 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 act-
ing on the workers and the protection against their harmful
effects are also in the focus. Further topics ar also involved
in the subject, like special energy converters of renewable
energy systems, like double-fed asynchronous generator, mo-
tor. Special energy converters of large scale energy stor-
ing are also the part of the subject as well as the integration of
renewables into the renewable energy system. (4 credits)

Power System Transients
BMEVIEMA03

The course of the subject is to provide theoretical knowledge
and practical skills for computer based modelling of power
system transients including understanding physics of elec-
tromagnetic wave propagation on multiphase power lines,
being familiar with the origin of transients and their conse-
quences, 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
BMEVIEMA04

The aim of the course is to provide theoretical knowledge
and practical skills for understanding principles and settings
of protections used for party of failure in power systems,
power plants, industrial and communal systems, being
familiar with measurement technology, digital signal pro-
cessing, as well as intelligent protections and introducing
functions and constructions of operational and malfunction
automationics which provide reliable operation of the power
system. (4 credits)

Electric Energy Market
BMEVIEMA05

Aim of the course is to lecture the students the basic prin-
ciples, 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 com-
pleting the course the learnt basics of the methods and ap-
proaches 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)

Fundamentals of Smart Systems
BMEVIEMA04

The course aims to develop a detailed knowledge and criti-
cal 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 model-
ing and analysis by the use of a cutting edge simulation
tools. (4 credits)

System Level Design
BMEVIEMA05

The subject presents the design, implementation and veri-
fication of digital hardware. Various concepts and tools are
presented, including alternatives of digital system relatiza-
tion, automatization, silicon compilers, simulation methods,
System level modelling. The languages hardware modell
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
BMEVIEMA06

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**

**BMEVIEEM800**

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 wish 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 Services 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. Imre Norbert Orbulov
Vice-Dean (scientific and international affairs):
Dr. Csaba Hős
BSc Course Director: Dr. Axel Groniewsky
MSc Course Director: Dr. András Szekrényes
## Curriculum of BSc Subjects
### Process Engineering Specialization

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<th>Subject</th>
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| **7th Semester, Fall**                        |                     | BMEGT55A001 |    |    |    |    |    |    |    | p           |
| Business Law                                  | BMEGExXBSKSD        | 2       | 2/0/0 | | | | | | | p           |
| optional subject                              | BMEGExXBSKZ         | 3       | 2/0/0 | | | | | | | p           |
| Final Project                                 | BMGEVGBG03          | 3       | 1/0/1 | | | | | | | p           |
| Positive Displacement Pumps and Compressors   | BMGEVGBG16          | 3       | 2/0/1 | | | | | | | p           |
| Air Pollution Control, Wastewater and Solid Wastes Management | BMGEATBG04 | 3 | 3/0/0 | | | | | | | p           |
| Specialization elective subject               | BMGEExXBSY         | 2       | 3/0/0 | | | | | | | p           |
| **Total credits:**                             |                     |          | 31  | | | | | | |             |

**Criterion**

| Industrial Practice                          | BMGEExXBSYZ         |           |     |    |    |    |    |    |    |             |

*XX in the Final Project and Industrial practice code varies from department to department.*

*Requisities: e - exam, p - practical mark, ge - global exam, s - signature*
## Curriculum of BSc Subjects

### Engineering Design and Technology Specialization

<p>| Subject                                      | Code          | Credits | 1 | 2 | 3 | 4 | 5 | 6 | 7 | Requisites |
|----------------------------------------------|---------------|---------|---|---|---|---|---|---|-------------|
| <strong>1st semester, Fall</strong>                      |               |         |   |   |   |   |   |   |             |
| Mathematics A1a - Calculus                   | BMETE93BG01   | 6       | 4 | 2 | 0 | 0 |   | 0 |             |
| Technical Chemistry                          | BMEVEKFBXMK   | 3       | 2 | 0 | 1 |   |   |   | p           |
| Statics                                      | BMEGEMMBXM1   | 4       | 1 | 2 | 0 |   |   |   | p           |
| English for Mechanical Engineering 1         | BMEGT63EMS1   | 4       | 0 | 2 | 0 |   |   |   | p           |
| Physics for Engineers                        | BMETE11BG05   | 3       | 3 | 0 | 0 |   |   |   | p           |
| Introduction to Mechanical Engineering       | BMEGEVGBG01   | 4       | 2 | 1 | 1 |   |   |   | e           |
| Fundamentals of Mechanical Engineering Drawing | BMEGEGiBXGA | 5       | 3 | 2 | 0 |   |   |   | p           |
| <strong>Total credits:</strong>                           |               | <strong>29</strong>  |   |   |   |   |   |   |             |
| <strong>2nd Semester, Spring</strong>                    |               |         |   |   |   |   |   |   |             |
| English for Mechanical Engineering 2         | BMEGT63EMS2   | 2       | 0 | 1 | 0 |   |   |   | p           |
| Mathematics A2A - Vector Functions           | BMETE93BG02   | 6       | 4 | 2 | 0 |   |   |   | e           |
| Strength of Materials                        | BMEGEMMBXM2   | 4       | 2 | 1 | 0 |   |   |   | e           |
| Analysis of Technical and Economical Data   | BMEGEVGBX14   | 3       | 2 | 0 | 1 |   |   |   | p           |
| Materials Science and Testing                | BMEGEMTBGA1   | 6       | 4 | 0 | 1 |   |   |   | e           |
| Introduction to CAD                          | BMEGEGiBXCA   | 4       | 1 | 0 | 2 |   |   |   | p           |
| Mechanical Engineering Informatics           | BMEGEMiBXGi   | 6       | 1 | 0 | 4 |   |   |   | p           |
| <strong>Total credits:</strong>                           |               | <strong>31</strong>  |   |   |   |   |   |   |             |
| <strong>3rd Semester, Fall</strong>                      |               |         |   |   |   |   |   |   |             |
| Dynamics                                     | BMEGEMMBXM3   | 5       | 2 | 2 | 0 |   |   |   | e           |
| Mathematics A3 for Mechanical Engineers      | BMETE93BG03   | 4       | 2 | 2 | 0 |   |   |   | p           |
| Management and Business Economics            | BMEGT20A402   | 3       | 2 | 0 | 0 |   |   |   | p           |
| Materials Engineering                        | BMEGEMTBGF1   | 4       | 2 | 0 | 1 |   |   |   | e           |
| Machine Elements 1.                          | BMEGEGiBGG1   | 5       | 2 | 1 | 1 |   |   |   | e           |
| Measurement Technology                       | BMEGEMiBXMT   | 4       | 2 | 0 | 1 |   |   |   | p           |
| Engineering Thermodynamics                   | BMEGEEGBGD    | 4       | 2 | 0 | 1 |   |   |   | p           |
| Comprehensive Examination in Mathematics G   | BMETE93BG04   | 0       | 0 | 0 | 0 |   |   |   | ge          |
| <strong>Total credits:</strong>                           |               | <strong>29</strong>  |   |   |   |   |   |   |             |
| <strong>4th Semester, Spring</strong>                    |               |         |   |   |   |   |   |   |             |
| Vibrations                                   | BMEGEMMBXM4   | 4       | 2 | 1 | 0 |   |   |   | p           |
| Fluid Mechanics                              | BMEGÉATBG11   | 6       | 2 | 2 | 1 |   |   |   | p           |
| Machine Elements 2.                          | BMEGEGiBGG2   | 6       | 3 | 1 | 1 |   |   |   | e           |
| Manufacturing                                | BMEGEATBG01   | 5       | 1 | 1 | 2 |   |   |   | e           |
| Polymer Materials Science and Engineering    | BMEGEPtBGO1   | 6       | 3 | 0 | 2 |   |   |   | e           |
| Heat Transfer                                | BMEGEEGBGH    | 4       | 2 | 1 | 0 |   |   |   | p           |
| Mechanics Global Exam                        | BMEGEMMBGSZ   | 0       | 0 | 0 | 0 |   |   |   | ge          |
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XX in the Final Project and Industrial practice code varies from department to department.

Requisities:  e - exam, p - practical mark, ge - global exam, s - signature
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Specialization 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 Specialization

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List of abbreviations appearing in the curriculum:
lect – lecture; sem - seminar (classroom practice); lab - laboratory practice; cr – credits; p/e/s - practical mark/exam/signature

### Curriculum of MSc Subjects
#### Mechanical Engineering Modelling
##### Solid Mechanics Specialization

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## Curriculum of MSc Subjects  
### Mechanical Engineering Modelling  
#### Thermal Engineering Specialization

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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
Introduction to Mechanical Engineering

BMEGEVGBG01


Mathematics A1a - Calculus

BMETE93BG01


English for Mechanical Engineering I and II.

BMEGT63EMS1, BMEGT63EMS2

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 and 1 hour/2 credits.

Technical Chemistry

BMEVEKFBXMK


Physics for Engineers

BMEET11BG05


Materials Science and Testing

BMEGEMTBGA1


Mathematics A2a - Vector Functions

BMETE93BG02


Strength of Materials

BMEGEMMBXM2


Environmental Management Systems

BMEGT42A410

The course covers the topics relevant to the protection of environmental compartments, sources, genetic 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/4 credits.
Mathematics A3 for Mechanical Engineers

**BMETE93BG03**

Classification of differential equations. Separable ordinary differential equations, linear equations with constant and variable coefficients, systems of linear differential equations with constant coefficients. Some applications of ODEs: Sca-


Analysis of Technical and Economical Data

**BMGEVGBX14**


Machine Elements 2

**BMEGEGIBGG2**


Manufacturing

**BMEGEGTBG01**

The basic model of the machining system (WFMT system), introduction to the part modeling, to the fixtureing 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. 4 hours/5 credits.

Fluid Mechanics

**BMGEATBG11**

Theory and practical applications in the following topics: Newton’s law of viscosity. Gas, steam, liquid. Cavita-

tion, cavitation erosion. Comparison of gases and liquids. Lagrangian and Eulerian description of fluid motion. Path-

line, streamline, streakline, stream surface, stream tube. Steady, unsteady, quasi-steady flow. Continuity. Free vor-
tex. Dynamics. Euler equation. Bernoulli equation. Static, dynamic, total pressure and their measurement. Pitot probe, Prandtl probe. Volume flow rate measurements using con-

traction elements and deduced from velocity measurement. Comparison. Unsteady Bernoulli equation. Radial fan, Euler equation for turbomachines. Linear momentum equation, applications. Viscous fluids, Non-Newtonian fluids, rheology. Navier-Stokes equation. Similarity of flows. Hydraul-


Engineering Thermodynamics

**BMGEENBGT0D**


cics, exergy, losses due to irreversibility. Liquids and vapors. Equations of state. Two-phase systems. Basic cycles of pow-
er generation. Mixtures of gases, atmospheric (moisten) air. 4 hours/4 credits.

Polymer Materials Science and Engineering

**BMGEPTBG01**

The main goal of the Materials Science and Engineering is to introduce the students to the polymers as structural mate-

rials with emphasis on their differences from traditional en-

gies of thermosts. Rubber technology. Processing tech-
nologies of high strength, reinforced polymer composites. 5 hours/6 credits.

Measurement Technique of Processes

**BMGEVGBG03**

Physical quantities of processes and their measurements, indirect measurements and errors. Noise as stochastic process variable. Density and distribution function, cross-
correlation and autocorrelation. Fourier-transformation in data processing. Spectrum, detection periodic signals and noise. Measurement of time-dependent quantities, digital sampling. Data acquisition and data processing, Measures-
ments of characeristics of machines. Statistical hypothesis tests. 2 hours/3 credits.

Management and Business Economics

**BMGT20A402**

The course gives a conceptual understanding of the operations of companies and gives an overview of the main management philosophies. By demonstrating the applica-
tion of the tools used by managers, the course are helping the students as (future) employees to understand their working environment and to build their carrier in a company, and helps the (future) entrepreneurs and future team leaders, managers to work more effectively and efficiently. 2 hours/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 hours/2 credits.

Fluid Machinery  
**BMEGEVGBX01**  
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.

Transfer Processes  
**BMEGEÉEBG51**  
The course aims to teach to the students having already the basic knowledge of mathematics and heat transfer the theoretical bases of mass transfer and most important diffusion processes. The course focuses on the methods, equipment and practical applications of distillation, which is the most important diffusion process. The students have to individually solve numerical mass transfer and distillation problems. They have to make simple laboratory measurements for deepening their theoretical knowledge obtained. 4 hours/4 credits.

Processes and Equipment of Chemical Industry  
**BMEGEÉEBG61**  

Fluid Flow Systems  
**BMEGEVGBG13**  
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/4 credits.

Energy Processes and Equipments  
**BMEGEENBGBEB**  

Positive Displacement Pumps and Compressors  
**BMEGEVGBG16**  

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

Metal Forming  
**BMEGEMTAGE1**  
Laboratory: Flow curve and friction factor determination, testing of cold forming processes, design of die and forming technology, modeling of plastic forming. 3 hours/4 credits.

**Nondestructive Testing of Materials**  
**BMEGEMTAGE2**


**Novel Engineering Materials**  
**BMEGEMTAGE3**

The structure, properties of novel structural and functional materials used in mechanical and electrical engineering applications and their testing methods are discussed. The technological processes and their practical aspects are discussed. Fundamental concepts of material structures and the principles of material properties and their relations. Special attention is paid to materials used in the electronics industries including their production and technological usability. Basics of crystallography, crystal defects, dimensional effects, nano-, micro-, and macrostructures, multi-component systems. Thermal behavior, diffusion mechanisms. Phase transformations, heat treatments, recrystallization. Mechanical properties and their measurements. Types and properties of novel structural and stainless steels. Fundamental new concepts in steel development. High entropy alloys. Alloys used in biomedical engineering applications. Materials deterioration processes such as corrosion, fracture, fatigue (mechanical, thermal, etc.), creep, migration. Microscopy, electron microscopy, X-ray diffraction. Conduction properties, conductive, superconductive, resistive, and insulator materials. Semiconductor materials. Effects of material properties on semiconductor materials used in microelectronics and in integrated optoelectronics. Insulator, dielectric and ferro-electric materials. Production of semiconductor single crystals and the related measurement techniques (Hall, CV). Non-metallic materials in electrotechnics. Magnetic properties and the types of magnetic materials used in industrial applications. Intelligent materials. Shape memory and super elastic alloys. 2 hours/3 credits.

**Machine Design**  
**BMEGEAGMMD**


**CAD Systems**  
**BMEGEGAGCS**

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 intelliflies. 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). 2 hours/3 credits.

**CAD/CAM Applications**  
**BMEGEGTBG65**

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; CAD/CAM 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 (H/W/SW) and languages (formats), intermediate surfaces, languages, ISO CLDATA, ISO standard and advanced NC program languages, post processing (postprocessors and processor 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. 4 hours/4 credits.

**Design of Electronic Systems**

**BMEVIAUA040**

The course aims to give a general overview of the basics of electrotechnics and electromechanics to the mechanical engineering students. The course focuses on those aspects of basic electrical engineering, which are indispensable for mechanical engineers. Besides theoretical knowledge, the course provides strong practical skills in the aforementioned fields with the aid of labs and problem solving seminars. 4 hours/4 credits.

**Industrial Practice**

**BMEGEXXBSZ**

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 requirement)

**Heat Transfer**

**BMEGEENBGHK**

The subject aims to present the heat transfer modes including the basic mathematical description needed for quantitative representation. Discusses the solutions for steady state and transient heat conduction problems. It also focuses on the phenomenon of heat convection both with and without phase change, and presents the possibilities to determine the heat transfer coefficients in practical problems in natural and forced convection situations. It presents the background of boiling and condensation. Discusses the heat transfer in heat exchangers, and presenting their thermal design using the quantities of logarithmic mean temperature difference and NTU. Introducing the most important aspects of thermal radiation, including the Stefan-Boltzmann, Wien, Lambert and Kirchhoff laws, and demonstrating their practical application in particular situations. 4 hours/4 credits.

**Heat Engines G**

**BMEGEENBGGK**

The course aims to give a general overview about operation of equipments based on thermodynamical cycles and shows how real processes are running inside these equipments. Basics of combustion technology will be introduced also, because in most of the cases heat is gained from combustion. A lot of everyday life energy utilization procedure or system operation is made understandable e.g. principals of firing from camp-fires or domestic heaters to power station boilers, operation principals of air-conditioning, heat pump, steam- and gas-turbine internal combustion engine. Environmental effects and pollution if any will be introduced as well. 3 hours/4 credits.

**CAD Systems**

**BMEGEGBCS**

The aim of this subject is to prepare our students of solving engineering and design problems using up-to-date and effective modelling methods such as sheet metals, surface modelling, mechanisms and adaptive assemblies (e.g. toptop-down design, skeleton modelling, multid bodies etc.). The secondary goal is to show the up-to-date and effective way of deriving technical drawings from 3D CAD models using automatic and pre-defined aids. 2 hours/3 credits.

**Machine elements 1**

**BMEGEGIBG1**

This subject is dedicated to teach the basic principles, methods and problems of machine design. The aim is to prepare for solving easy construction problems individually: to create structural, mechanical and mathematical models, recognize the failure and damage modes, estimate the load and limit conditions, perform sizing and checking processes, especially on different types of joints, tubes and pipes, gaskets, springs, shafts. The course is directed towards future engineers who are interested in the mechanical design and its fundamentals and principles. The skill of students in solution of real engineering problems will be improved by discussing solved machine component related problems and design projects. 4 hours/4 credits.

**Machine elements 2**

**BMEGEGIBG2**

This subject is dedicated to teach the basic principles, methods and problems of machine design. The aim is to prepare for solving easy construction problems individually: to create structural, mechanical and mathematical
models, recognize the failure and damage modes, estimate the load and limit conditions, perform sizing and checking processes, especially on rolling bearings, different types of mechanical drives, couplings and clutches, drives, drive systems. The course is directed towards future engineers who are interested in the mechanical design and its fundamentals and principles. The skill of students in solution of real engineering problems will be improved by discussing solved machine component related problems and design projects. 5 hours/6 credits

**Machine Design I.**

**BMEGEGIBGMD**

Mechanical engineering design, development, behavior analysis (stress and stiffness analysis, reliability and service life estimates), knowledge of the behavior of mechanical structures, modeling opportunities, various aspects of the design. Learning the modeling of different characteristics, and of the finite element model creation process and the evaluation of the stress state practicing on simple structural elements. 2 hours/2 credits.

**Project work**

**BMEGEGIBGPW**

The aim of the course is to get acquainted with the complex, practice-oriented application of the knowledge acquired during the training, and to use it in teamwork for real industrial tasks. The subject is around the mid-term task, which is to study the operation, alternatives and technological suitability of a mechanical structure, and based on these, to design the structure with the help of the methodology typical in industrial practice using the complete modern engineering toolkit. The design task of the semester has to be carried out within the frame of teamwork. This gives an insight into the benefits and difficulties of collaboration, the practice of task scheduling, information sharing, and the project approach. The practice-oriented application of CAD / FEM / DEM systems is needed during the development of the task. 4 hours/4 credits.

**Introduction to CAD**

**BMEGEGIBXCA**

The course aims to introduce the basic terms and techniques of computer-aided design (CAD) and to show the usage of them. Across different software, students can practice the part and assembly modeling with the so-called exploded models moreover the digital drawing creation from 3D CAD models. Besides the practical aspects, the basic equations and the essential theoretical relations are also presented. 3 hours/4 credits.

**Fundamentals of Mechanical Engineering Drawing**

**BMEGEGIBXGA**

To introduce students to the standardized "international language" of technical communication, the most important rules of 2D mechanical engineering representation. Introducing the most common standard elements, screw connections, torque joints, component joints, tolerances and joints and practicing the standard 2D representation and dimensioning of these products, as well as knowing and using the basic build-ups of standard manufactured parts used in product modeling. Providing students with basic knowledge in reading technical data in further technical subjects and independently developing design and construction tasks. 5 hours/5 credits.

**Machine Tools and Manufacturing Systems**

**BMEGEGTAG92**

The subject introduces the students to the structural elements (e.g. actuators, guideways, servo motors, measuring equipment, etc.) and various types of the metal-cutting machine tools (e.g. lathes, milling machines, grinding machines, machining centres, etc.) and their technological and operational characteristics. The subject also introduces the basic concepts, types and layouts of manufacturing systems and the most important material handling equipment (e.g. conveyors, AGVs, robots, etc.) needed to build up manufacturing systems. 2 hours/3 credits.

**Manufacturing**

**BMEGEGTBG01**

The course aims to make the students familiar with the fundamental terms and information content of part manufacturing and assembly and to give a general overview of the fundamentals, machine tools, equipment and control of manufacturing processes. The course interprets the methods, tasks and steps of manufacturing process planning and quality control, and the economics of manufacturing. Modern manufacturing processes and systematics of production are described by the trends of industrial development, including the challenge of integration. Laboratories provide direct experience about operating and maintaining manufacturing processes and overall production. Problems and solutions of manufacturability are identified. 4 hours/5 credits.

**Application and Control of Robot Structures**

**BMEGEGTBMB62**

The course introduces the main types of industrial robots, delivers the knowledge of their selection and the design of robotic systems. The course describes the structure of flexible production cells, production systems, related control engineering, and programming methods. Students learn about the standardized performance characteristics related to industrial robots and about the methods of how to measure them. The aims that students can deepen their acquired theoretical knowledge through laboratory exercises. 4 hours/4 credits.

**Advanced Artificial Intelligence**

**BMEGEMIBGA1**

The course aims to give a general overview of advanced artificial intelligence, both in terms of theoretical understanding and from practical sides. The course focuses on fields such as fuzzy logic, machine learning, neural networks, deep learning, genetic algorithms etc. and provides an insight into the use of the fields above for resolving mechanical problems. Students during the course will learn modelling and data processing with the methods listed above. 4 hours/4 credits.

**Mechatronics Project**

**BMEGEMIBGBMP**

The course will give a general overview on projects in mechatronics. The students will work in groups or on individual assignments to design and realize practical projects applying the means of theoretical concepts, simulation tools, engineering drawing and practical constructive solutions. The projects will be realized under the supervision of a tutor with expertise in the fields required for the specific project. The aim is to have hands-on practice in real life projects that may be used afterwards in industrial tasks. 4 hours/7 credits.
Fundamentals of Optics

BMEGEMIBGOP

The aim of the course is to give an introduction and practical experience in technical and applied optics. The content covers the basics of wave and particle optics with special emphasis on optical measurement and instrumentation. Students of the course will be acquainted with the methods and tools in optical concepts, design, testing and data processing. The fundamental optical systems and instruments will be discussed with special focus on practical optical design and application of optical devices. The main competence to be acquired at the course is experience with optical tools to be applied in general engineering context. 3 hours/4 credits.

Mechatronics

BMEGEMIBMME

The purpose of this course is to introduce a unified Mechatronics approach of mechanical, electrical and computer controlled engineering and provide students with exact mathematical toolboxes that allows the mechanical, electrical and computer control parts of the mechatronic device to be modelled in a unified way. It introduces methods for describing the equations needed for the description of mechatronic devices in different approaches (mechanical and electrical), and highlights the advantages and disadvantages of each approach. It describes additional methods for analysing the operation of mechatronic devices, and finally addresses some basic issues in synthesis. 4 hours/4 credits.

Mechanical Engineering Informatics

BMEGEMIBMGI


Control Engineering

BMEGEMIBXIT

The subject’s object is to introduce the basic concepts of control engineering. The details include modeling methods of linear and nonlinear systems in time and frequency domain. The basics of Laplace-transform and it application are also discussed, with a special emphasis on modeling and control design. Basic forms of closed loop control, such as PID-compensation with an emphasis on quality requirements are detailed. Special forms of nonlinearities in control loops, e.g. on-off control, fundamentals of digital control and modern state space control are also mentioned. 4 hours/4 credits.

Measurement technology

BMEGEMIBXMT

The purpose of the course is to measure the geometric quantities typically encountered in mechanical and mechatronic systems and to process the measured data. Systematization of errors, their nature, origin, and ways to reduce their impact. Electrical measurement of non-electric quantities that changes over time. The structure of the measuring chain, the systematization of sensors and signal converters, the role of intermediate quantities, measuring procedures. Dynamic and frequency transmission errors. Basics of signal frequency analysis. Introduction to digital measurement technologies and rules for sampling. 3 hours/4 credits.

Mechanics global exam

BMEGEMMBGZ

The aim of the course is to provide students with the knowledge of the four semesters of compulsory mechanics subjects (e.g. Statics, Strength of Materials, Dynamics, Vibrations), to demonstrate their ability to understand mechanical problems, to apply their solution methods, and to prove the independence and responsibility through independent and professionally demanding problem-solving and also in verbal communication about Mechanics. 0 hours/0 credits.

Dynamics of robot mechanism

BMEGEMMBMRO

One of the two main goals is to acquaint the students with the structural, kinematic and dynamic analysis methods of robotic mechanisms and the related mathematical and numerical simulations methods. Mechanisms and robots are typically composed of numerous rigid bodies with intricate combination of mutual connections. The aim is to give tools to the students, with which they can confidently solve any problem that arises during the design or operation of robots. The second fundamental goal of the subject is to make the students familiar with a particular type of vibrations, which is not possible to handle by using our traditional physical sense. These unfamiliar, low frequency vibrations are caused by the coupling of the continuous-time physical system with the digital processors. The avoidance of these vibrations usually cause the decrease of the positioning accuracy. The course aims to acquaint the students with simple, practical and useful analytical design and analysis tools. 4 hours/4 credits.

Introduction to Artificial Intelligence

BMEGEGTBX01

The course is aimed at giving an up-to-date overview of the fundamentals of artificial intelligence (AI), with a special emphasis on methods which are applicable in production engineering. Primary focus is set on symbolic methods of AI, such as search, knowledge representation and various kinds of reasoning, as well as learning. Having a broad knowledge of the fundamentals of AI, the students will be prepared to higher-level studies in the details of cyber-physical production systems. 2 hours/3 credits.

Statics

BMEGEMMBXM1

The course aims to give a general overview of the main elements of statics and the corresponding numerical methods focusing on the problems related to mechanical engineering and mechatronics. The course focuses on the description of the axioms, the basic laws of statics and introduce the corresponding notations. It presents the mathematical description of the static equilibrium. It introduces the mechanical truss, beam elements and the corresponding pinned structures. It describes internal load of the beam elements and presents methods to determine the stress resultant diagrams and functions. It describes the models of the non-ideal constraints. 3 hours/4 credits.
Strength of Materials  

The course deals with the behavior of solid objects subject to stresses and strains. The course focuses on the mathematical description of state of stresses and state of strains, and the general Hooke’s law is introduced. A fundamental understanding of mechanical models, such as beams, thin walled membranes are given. During the semester, buckling of compressed beam is discussed together with different work theories. 3 hours/4 credits.

Dynamics  

The aim of the course is to provide students with a description of the motion of rigid bodies and the methods of calculating kinetic changes due to forces. Kinematics and dynamics in planar and three dimensional space is addressed. The course provides students with basic knowledge required to understand and design more complex mechanisms, thought in other subjects. A further aim is to develop students’ logical thinking and to deepen their knowledge of science. 4 hours/5 credits.

Vibrations  

The course aims to give a general overview of simple one and multi-DoF mechanical vibratory systems in terms of theoretical understanding of the underlying physical principles. The course focuses on the mathematical modelling utilizing Newtonian free body diagram based and Lagrangian energy based description of dynamical systems. In the course includes basic principles of one DoF free undamped and viscously damped systems, as well as the effect of Coulomb friction. Students learn the resonance phenomenon in connection with harmonic force and road excitation. By using Lagrangian description the modelling of multiple DoF systems is possible, on which the corresponding eigenvalue problem is studied. Undamped natural frequencies, vibration modes are determined, while the corresponding multi-DoF forced mechanical system is determined in the semester. 3 hours/4 credits.

Fundamentals of the finite element method  

The aim of the course is to give a fundamental knowledge in the field of finite elements through the solution of elasticity problems. The subject is related to the following specified matters. Equations of linear elasticity, minimum principle of total potential energy, Ritz method, function approximation. Variational formulation of bar and beam problems. Basic concept of the finite element method for static problems. Finite element equations, shape functions, stiffness matrices. The assembly process, matrix condensation. Bending vibration of elastic beams and members. Eigenfrequency and eigenshape calculation. Torsional and longitudinal vibration of bars. Finite element solution of free vibration problems. Calculation of lumped and consistent mass matrices. Bending vibration of shafts with masses and disks. Plane problems, the linear triangle element. During the laboratory exercises the solution of related problems by commercial and freeware software is also required. 3 hours/3 credits.

Materials Engineering  

The main goal of the subject to give a strong fundamental for the selection of materials (metals, ceramics and composites) and for the proper selection of technologies for structures used in mechanical engineering. Production, groups and designations of metals and ceramics. Possibilities to modify the mechanical properties (heat-treatments). Casting, powder metallurgy plastic forming, heat-treatments and joining technologies. The effect of technologies on the structure and properties of materials. Analysis of loads and stresses in structures and tools. 3 hours/4 credits.

Composites technology  

Getting familiar with the matrices and reinforcing materials of polymer composites. Gaining knowledge about the manufacturing technologies of thermoset matrix composites. A key objective is to give knowledge to the students to be able to choose a manufacturing technology for a given composite product. The students also learn the basics of composite mechanics and composite specific design guidelines. 3 hours/4 credits.

Injection molding  


Polymer processing  

The aims of this subject are at familiarizing the students with the polymer processing technologies in details (materials, machinery, technology, parameters): preliminary techniques, extrusion (e.g. film, profile, sheet, pipe, wire coating), thermoforming, hollow plastic parts production (extrusion blow molding, injection blow molding, rotational molding, twin-sheet thermoforming), polymeric foams and elastomers technology. 2 hours/3 credits.

Polymer Materials Science and Engineering  

The aim of the subject is to familiarize the students with the following subjects: structure of polymers; the dependence of their properties on structure, temperature and environment; the characteristics of their stress – strain relationships; their basic application, processing and recycling possibilities, including mixing & compounding, extrusion technology, extrusion blow molding, blown film extrusion, coextrusion, film calendering, thermoforming of plastic sheets, basics of injection molding technology, and the common processing techniques of thermosets and polymer composites. 5 hours/6 credits.

Fluid Machinery  

The course aims to give a general overview of pumps, compressors, fans and turbines, both in terms of theoretical understanding of the underlying physical principles and...
the end-user applications. The course focuses on the mathematical description of turbomachines (centrifugal pumps, compressors and fans) utilizing the Euler turbine equation and provides an insight into the use of the corresponding dimensionless quantities and affinity laws. Cavitation issues, series and parallel connections and the hydraulic behaviour of simply pipeline systems are covered. Noise level of fans, performance curves of axial, radial and mixed turbomachines are explained. The basic types and use of water and wind turbines are also covered. A fundamental understanding of positive displacement pumps and motors, together with typical applications is given. Multistage piston compressors with the corresponding thermodynamic principles (e.g. optimal stage pressure ratio) are described.

4 hours/4 credits.

Air Pollution Control, Wastewater and Solid Wastes Management

The aim of the course is to provide theoretical background and practical knowledge in air pollution control, wastewater treatment and solid wastes management for mechanical engineers. Theoretical background, measurement principles, application areas, advantages and limitations of various environmental protection techniques applied in industrial practice. Main topics: physical, chemical and biological methods of separation, recovery and deformation of both gaseous, solid and liquid phase pollutants; typical tasks of wastewater treatment methods & technologies, basic processes and engineering equipment of the terminology; characteristics of solid wastes, collection and treatment, theoretical basics of burning solid wastes, solid waste disposal and recycling. Course helps to recognize & evaluate the environmental protection problems and to solve the most typical engineering problems. 3 hours/3 credits.

Fluid Mechanics

Students will acquire the knowledge necessary to understand and describe the flow of gaseous and liquid fluids, which is important from a technical point of view. Building on this knowledge, the laboratory sessions and seminars will show the students how to solve technical problems related to the flow of a medium. An emphasis will be placed on knowledge related to flow measurements, measurement techniques applied in evaluating flow phenomena occurring in fluid machinery, equipment, and ducts. The students will be evaluated on their ability to learn the theory and apply it to practical problems. These evaluations will be in the form of mid-term exams, tests, and laboratory measurements. This subject prepares the students for their engineering careers by teaching them to recognize fluid mechanics related problems, provides them with the knowledge necessary to solve common problems, and gives them a solid foundation on which they can build in taking on complex assignments. 5 hours/6 credits.

Technical Acoustics and Noise Control

The aim of the course is to provide theoretical background and practical knowledge in acoustics for mechanical engineers. Theoretical background, measurement principles, application areas, advantages and limitations of various noise control tools applied in industrial practice. Main topics: basic phenomena, wave acoustics, acoustic resonators, energetic relations of sound, similitude, sound propagation in free space, room acoustics, sound sources, the attenuation of acoustic waves, acoustic measurements, criteria for noise and engineering noise control. Course helps to recognize, evaluate and solve the most typical engineering noise control problems. 3 hours/3 credits.

Computational Fluid Dynamics

The purpose of this course is to introduce the modeling approaches applicable to different flow categories, the theoretical background of turbulence modeling, the finite volume method, as well as the assessment of errors and uncertainties in numerical modeling. On the whole, it develops the analytic thinking and attitude. The course aims to enable the student to simulate mechanical engineering processes related to the curriculum. 3 hours/4 credits.

Renewable energy systems

The course aims to give a general overview of renewable energy systems (e.g. passive solar, solar collectors, photovoltaic panels, heat pumps, biomass boilers) that are related to buildings, about their indicators, operation and their integration to complex HVAC systems. The course focuses on different system schemes as well as on the introduction of systematic integration of different energy utilization devices. 3 hours/3 credits.

Motion Control

The aim of the course is to provide students with the necessary skills in the selection, commissioning and operation of electrical drives for machine tools, robots and other servo systems. The students will become familiar with the basic principles of motion control, the computing, electronic and power electronics tools needed for their implementation, as well as the operation of measuring instruments and sensors for performing measurements. 3 hours/3 credits.

Power Electronics

The course aims to give a general overview about the power electronic devices, converters and applications for mechanical engineering students. The course focuses on those aspects of power electronics, which are indispensable for mechanical engineers. Besides theoretical knowledge, the course provides strong practical skills in the aforementioned fields with the aid of labs and problem solving seminars. 4 hours/4 credits.

Electrotechnics and electromechanics

The course aims to give a general overview of the basics of electrotechnics and electromechanics to the mechanical engineering students. The course focuses on those aspects of basic electrical engineering, which are indispensable for mechanical engineers. Besides theoretical knowledge, the course provides strong practical skills in the aforementioned fields with the aid of labs and problem solving seminars. 4 hours/5 credits.
Description of MSc Subjects

Basic Subjects

**Differential Equations and Numerical Methods**

_BMEETE90MX46_  

**Advanced Fluid Mechanics**

_BMEGÉÁTNW01_  
Overview of the fundaments of fluid mechanics. Vorticity and approximate dynamics, error estimate between exact and approximate solutions. Fourier series as coordinate representation in Hilbert space. The method of finite differences for the heat equation: error estimate and the maximum principle. 6 hours/8 credits.

**Advanced Thermodynamics**

_BMEGÉENNATW_  
Types of thermodynamical modelling regarding time and space dependence. Equations of state [gases, liquids, and solids (with thermoelasticity)]. Thermodynamical potentials, Maxwell and Gibbs-Helmholtz relations. Phases, metastable and supercritical states. Dimensionless quantities. System of body and environment, heat and work interactions; asymptotic stability, entropy as a Lyapunov function; reversible and irreversible dynamical extensions, Onsagerian approach, nonequilibrium variables, Viscoelectricity, rheology. Basics of continuum thermodynamics, thermodynamical derivation of Fourier heat conduction and of the Navier-Stokes equation. 3 hours/4 credits.

**Advanced Mechanics**

_BMEGÉEMNWAM_  
Topics: Review of dynamics; Dynamic effects in strength of materials; Review of vibrations; Theoretical and experimental modal analysis; Approximations of natural frequencies and modes by methods of Rayleigh, Stodola and Dunkerley; Vibration of continuum: longitudinal, torsion and bending vibrations of prismatic beams; Vibration of stretched strings; Stability of elastic compressed beams; bending vibrations of compressed beams; Rotordynamics, Campbell diagram 3 hours/4 credits.

**Laser Physics**

_BMETE12MX00_  

**Electronics**

_BMEVIAUM001_  

**Advanced Control and Informatics**

_BMEGEMINWAC_  
Short overview of the classical design methods of PID controllers, Sensors and actuators of an internet based motion control system. Implementation of discrete time PID controller for an internet based motion control system. Linear Time Invariant systems. Controllability and Observability. Canonical forms, the Kalman decomposition, realization theory, minimal realizations. Sate feedback control: pole placement, Linear Quadratic Regulator (LQR), Linear Quadratic Gaussian (LQG) control designs. Discrete Time Systems. Robust Control, H infinity control, Sliding Mode Control, Implementation of sliding control design for an internet based motion control system. 3 hours/4 credits.

**Special Compulsory Subjects**

**Machine Design and Production Technology**

_BMEGEGINWD_  
The goal of the course is to give a theoretical overview on the fields of machine design and production technology, according to the detailed topics below. Some elements of the methodology are covered on the seminars throughout a semester project. Machine design: Design principles and methods. Requirements. Modern design techniques. Structural behavior and modeling. Design of frame structures. Polymer and composite components. Load transfer between engineering components. Structural optimization (object function, design variables, constrains, shape and size optimization). Production: Machine-tools and equipment, devices and fixtures, kinematics, machining principles, production procedures and processes, production volume, batches and

**Subjects in Economics**

**Management**

BMEGT20MW02

The course is designed for engineering students who would like to have a better conceptual understanding of the role of management. The course introduces the essentials of management functions (planning, organizing, control and leadership) as they are applied within the contemporary work environment. Particular attention is paid to the planning and control function elements within the course. 3 hours/5 credits.

**Marketing**

BMEGT20MW01


**Subjects of the Solid Mechanics Specialization Special Subjects / Major or Minor Compulsory Subjects**

**Continuum Mechanics**

BMEGEMMNWCM


**Finite Element Analysis**

BMEGEMMNWFE


**Subjects of the Solid Mechanics Specialization Special Subjects / Major or Minor Elective Subjects**

**Nonlinear Vibrations**

BMEGEMMNWVI


**Elasticity and Plasticity**

BMEGEMMNWEP

Coupled Problems in Mechanics

**BMEGEMMNWCP**


Beam Structures

**BMEGEMMNWBBS**


Experimental Methods in Solid Mechanics

**BMEGEMMNWEM**


Dynamics of Robots

**BMEGEMMNWRO**

The aim of the subject is to give an overview on the basic concept of mechanisms, some application examples of mechanisms, a short historical review of the development of the knowledge and design methods related to mechanisms, the fundamental analysis of planar and spatial mechanisms and a few basic synthesis methods of planar mechanisms. Besides, the kinematic and dynamic modeling of spatial mechanisms and multibody systems are addressed, including the alternatives of the parametrization of the orientation, the pose description with homogeneous transformation, the application of the Denavit-Hartenberg method, the Newton-Euler recursion for open-loop manipulators and the redundant-coordinate-based description of controlled rigid body structures with closed kinematic loops. Effective methods for the equation of motion generation and their numerical solution is detailed. 2 hours/3 credits.

Design and Technology Specialization

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

Product Modelling

**BMEGEGINWPM**


Advanced Manufacturing

**BMEGEGTGNWAM**

In this course the following topics of advanced manufacturing are covered: introduction, summary of conventional machining operations, fundamentals and advanced topics of chip removal processes, fine surface preparation methods, hard cutting processes, gear manufacturing, mold design and manufacturing, key concepts related to Industry 4.0 (big data, cyber-physical systems, digital twins), automation, production management and planning (material requirements planning, advanced models and algorithms), innovative technologies, processes and application of Electro Discharge Machining EDM, micro EDM machining, laser beam machining, laser marking, laser sintering, hybrid machining processes, reverse engineering, rapid prototyping, 3D printing. 4 hours/5 credits.

Design and Technology Specialization

**Special Subjects / Major or Minor Elective Subjects**

CAD Technology

**BMEGEGINWCT**


Materials Science

**BMEGEMTNWMS**

rial characterization. Non-destructive evaluation techniques. Electrical properties of metals, alloys and semiconductors. Superconductivity, Magnetic properties. Soft and hard magnetic materials. 2 hours/3 credits.

**Structural Analysis**

**BMGEGETNWSA**


**Process Planning**

**BMGEGETNWP**

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 (TCP, JIT); statistical process control (SPC); measure and charts of process capability; charts attributes. 2 hours/3 credits.

**NC Machine Tools**

**BMGEGETNWNC**

The lectures include the following topics: Fundamentals of the kinematics of machine tools and the NC technology. Classification of metal-cutting 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. Lathes and turning centres. Milling machines and machining centres. Automatic tool and workpiece changing peripherals. Multifunctional machine tools. Parallel kinematics machine tools. The seminars support the design assignment and help the student in selecting the motion unit components (i.e. rolling guideway, linear motor), spindle, and designing the main structural elements (i.e. frames, moving slides, tool changers) of machine tools. 2 hours/3 credits.

**Fatigue and Fracture**

**BMGEGETNWF**


**Fluid Mechanics Specialization**

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

**Computational Fluid Dynamics**

**BMGEGETNWO2**


**Fluid Mechanics Measurements**

**BMGEGETNW03**

laboratory displays, interactive industrial case studies. 4 hours/5 credits.

Fluid Mechanics Specialization
Special Subjects / Major or Minor Elective Subjects

Open Source Computational Fluid Dynamics

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 postprocessing 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). 3 hours/3 credits.

Multiphase and Reactive Flow Modelling


Aero-Elasticity

The scientist does not study nature because it is useful; he studies it because he delights in it, and he delights in it because it is beautiful. If nature were not beautiful, it would not be worth knowing, and if nature were not worth knowing, life would not be worth living. Henri Poincaré. Aeroelasticity is a multidisciplinary subject dealing with the interaction of flows and structural vibrations. The goal of this course is to give a broad perspective of aero-elastic phenomena in natural sciences and engineering. After learning the physical and mathematical background and understanding the worked examples the student will be able to solve simpler, but practical coupled problems. The trendy FSI (fluid-structure interaction) simulation will be introduced. Beyond the theoretical background for FSI, modelling problems will also be introduced for better understanding of the advanced numerical techniques. 2 hours/3 credits.

Unsteady Flows in Pipe Networks


Building and Environmental Aerodynamics

The aim of the subject is to get acquainted with phenomena and practical problems in building and environmental aerodynamics and with the methods they are investigated. The main focus is laid on the study of wind load effects on buildings and engineering structures using wind tunnel measurement techniques. Besides that, attention is also given to various aspects of urban climate, wind comfort and the dispersion of air pollutants. The subject also reviews the specifics and application rules of Computational Fluid Dynamics (CFD) applied in this field. Students get hands-on experience with one of the above investigation methods within the framework of a group project. 3 hours/3 credits.

Vehicle Aerodynamics

Main aims and objectives, learning outcomes of the subject are to extend the knowledge of students in vehicle aerodynamics as well as to contribute to the development of skills of students in wind tunnel aerodynamic testing. Detailed thematic description of the subject: basics of bluff & streamlined body aerodynamics; theoretical analysis of aerodynamic forces and moments and their coefficients; main periods in the history of vehicle aerodynamics developments; the aerodynamics of passenger cars with detailed analysis of the methods for influencing aerodynamic parameters; racing/competition cars aerodynamics; heavy vehicles (buses and trucks) aerodynamics; basics of wind tunnel testing methods, including methods of moving ground simulation and blockage correction; Computational Fluid Dynamics (CFD) simulation basics for vehicle aerodynamics; invited lecture on vehicle design; wind tunnel laboratory session: vehicle modeling - testing - evaluation - presentation; measurement of aerodynamic parameters (drag & lift) and flow visualization study using the 1:20 scale vehicle models created by the student groups. 3 hours/3 credits.
Advanced Technical Acoustics and Measurement Techniques

**BMEGEÁTNW10**

The goals of the course are the following: Introduce the students to acoustic measurement and simulation techniques, with an emphasis on laying the basic foundations of aeroacoustics, aeroacoustics simulation methods, and state-of-the-art aeroacoustics measurement techniques. The students will be provided with the theoretical background of the simulation and measurement methods, their characteristics, and a basic knowledge regarding the processing of data. The introduced state-of-the-art methods are ones which often appear in research and development, and which can therefore be encountered in the engineering practice. 3 hours/3 credits.

Hemodynamics

**BMEGEVGNX26**


Flow Stability

**BMEGEVGNX27**


Theoretical Acoustics

**BMEGEVGNX28**

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. 2 hours/3 credits.

Thermal Engineering Specialization Special Subjects / Major or Minor Compulsory Subjects

Energy Conversion

**BMEGEENNWEC**

The aim of the course is to acquaint students with the special operating and design knowledge of energy conversion equipment. Accordingly, multistage chillers, heat pumps, and absorption chillers are presented. Using a systems approach, the student learns about fuel cells, solar cells, and ORC cycles. Students will become familiar with the losses, characteristic curves, and 1-D modelling of the combustion process and heat loss in internal combustion engines. The industrial gas engines, steam and gas turbines are presented too. Students will learn about sustainability and methods used to reduce environmental impact. 4 hours/5 credits.

Combustion

**BMEGEENNWCO**

Combustion is unpopular nowadays in the media, however, it is at the edge of dramatic change. The share of fossil fuels will be reduced while the renewable content will increase in the upcoming decades, nevertheless, the chemical and physical properties or renewable fuels show a wide variation. Consequently, it is crucial to understand the governing phenomena of combustion to enable efficient renewable fuel utilization while the emission is kept low. The discussed topics: combustion aerodynamics, physical and chemical properties of fuels, reaction kinetics, atomization, evaporation, pollutant emission, soot and ash formation, combustion acoustics, requirements of ignition, flame stability, and flue gas aftertreatment. 4 hours/5 credits.

Thermal Engineering Specialization Special Subjects / Major or Minor Elective Subjects

Process Control in Energy Engineering

**BMEGEENNWFS**

The role and surroundings of process control in energy engineering. Basics of control theory. Process control tasks and typical solutions. Realization of control loops under the industrial environment. Advanced control methods. Examples of the applications of advanced control methods in the energy industry. 4 hours/5 credits.

Turbines

**BMEGEENNXTU**

The aim of the course is to present the design and operation of steam and gas turbine equipment used in the energy sector. The specifics of the turbines used in different fields and the limitations of their applicability are presented. Through the energy conversion processes of turbines, students learn the interplay of different components, the possible parameter ranges of power and efficiency. The student is introduced to the characteristics of industrial and aeroderative gas turbines, their main characteristic parameters, construction designs. 4 hours/5 credits.
Thermal Physics

The goal of the course is to present the physical and mathematical description of heat conduction problems and its application to engineering problems. The course puts special focus on the determination of the thermophysical properties needed in heat conduction problems. This is addressed in three steps: - detailed discussion of the principles and practical realization of the measurement methods for heat conduction relevant thermophysical properties, including the methods of analytical and numerical extraction of the properties, understanding the direct and inverse heat conduction approach, - application of numerical methods (e.g. finite difference, control volume) for the solution of heat conduction problems connected to the discussed measurement methods, - numerical problem solving of relevant heat conduction problems in a form of computer laboratories using Matlab environment. 2 hours/3 credits.

Simulation of Energy Systems


Thermomechanics


Measurement in EnergyEng.

The course aims to introduce the student to measurement methods in the field of energy systems. Within this, the subject focuses on the methods of measuring the temperature, their fitting to different physical systems and the peculiarities of their power plant use. The aim of the subject is also to get acquainted with the mechanisms, sources, measurement methods, measurement systems and their elements, including solid and gaseous pollutant emissions. Demonstration of measurement techniques and the practical use of equipment is also included within the framework of the subject to deepen practical experience and knowledge. 2 hours/3 credits.
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 referred 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 institutions/ 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. 3.5 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:** 31st May 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) at [http://e-admission.bme.hu/](http://e-admission.bme.hu/) 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 5.5
- 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 fourth 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, the 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**

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**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**
## Curriculum of BSc in Physics

<table>
<thead>
<tr>
<th>Subject</th>
<th>Name</th>
<th>Code</th>
<th>Type</th>
<th>Lecture / Practice / Laboratory / Exam type / Credit</th>
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<td>Multivariate Analysis for Physicists</td>
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<td>Probability Theory for Physicists</td>
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**Elective courses** 9 credits must be completed

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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| Measure Theory        | BMETE92AM42    | KV        |      | 4  | 0  | 0  | v  | 4  |    |
| Individual Research Project 1 | BMETE90AM48  | KV        |      | 0  | 0  | 0  | f  | 2  |    |
| Partial Differential Equations | BMETE92AM45  | KV        |      | 2  | 0  | 0  | v  | 4  |    |
| Convex Geometry       | BMETE94AM22    | KV        |      | 2  | 2  | 0  | v  | 4  |    |
| Combinatorics and Graph Theory 2 | BMETE95AM26  | KV        |      | 2  | 2  | 0  | v  | 4  |    |
| Individual Research Project 2 | BMETE90AM449 | KV        |      | 0  | 0  | 0  | f  | 2  |    |

| **Elective courses** | 9 credits must be completed |           |      |    |    |    |    |    |    |

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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Exam type: v = exam, f = midterm exam, a = signature, s = comprehensive exam
Subject type: K = obligatory, KV = elective, V = optional, KR = criterium

9 credits must be completed
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Other Courses 30 credits

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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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Specialization in Financial Mathematics

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*Exam type: v = exam, f = midterm exam, a = signature
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Curriculum of MSc in Applied Mathematics
Specialization in Stochastics

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**Obligatory courses of specialization (30 ECTS credits)**

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**Elective professional courses (10 ECTS credits must be completed)**

Exam type: v = exam, f = midterm exam, a = signature
Subject type: K = obligatory, KV = elective, V = optional, KR = criterium
# Curriculum of MSc in Computational and Cognitive Neuroscience

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Exam type: v = exam, f = midterm exam, a = signature  
Subject type: K = obligatory, KV = elective, V = optional
Description of BSc Subjects in Physics

MATHEMATICS

Mathematical Methods in Physics 1
BMETE92AF35 – 4/2/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/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/V/6
Dr. Tibor Illéss
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/V/6
Dr. Tibor Illéss

Probability Theory for Physicists
BMETE95AF00 – 2/2/V/4
Dr. Péter Bálint

FUNDAMENTAL PHYSICS

Experimental Physics 1
BMETE13AF02 – 4/4/V/F/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/V/3**

*Dr. Rita Dóczi*

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 neutrinos, epithermal neutrinos, 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
BMET15AF27 – 2/2/0/FV/5
Dr. László Szunyogh

Electrodynamics 1
BMET15AF25 – 2/2/0/FV/5
Dr. Gábor Takács

Statistical Physics 1
BMET15AF29 – 2/2/0/FV/5
Dr. Gergely Zaránd

Introduction to Solid State Physics
BMET11AF05 – 2/2/0/FV/4
Dr. István Kézmári

Applied Solid State Physics
BMET11AF11 – 2/2/0/V/2
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
BMET12AF35 – 2/2/0/V/4
Dr. Gábor Erdei

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 themes 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. Themes: 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 field-effect transistors, small and large signal models of the devices. Active analogue circuits, bipolar and field effect transistor amplifiers, rectifiers. Feedback 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

**BMETE80AF03 – 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
BMETEI1AF33 – 0/0/4/F/5
Dr. Ferenc Fillöp
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; investigation of ionising radiations and radiation detectors; acquirement of modern measurement techniques.

Advanced Laboratory Exercises in Physics 3
BMETEI2AF21 – 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 techniques. Advanced optical measurements. Nuclear measurements. Modern measurement methods.

Computer programming, numerical methods (10 credits)

Programming
BMENVIEA024 – 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: mandatory declaration / definition, syntax / semantics: Syntax diagram, syntax of an integer value, Basic syntax rules; free writing mode (white spaces), a != A, # preproc, /* tax diagram, syntax of an integer value, Basic syntax rules:*/

Numerical Computation for Physicists
BMETE92AF01 – 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 symbolic methods. Matlab: Programming in Matlab, Vectors, matrices, functions, graphics. Maple: Basic commands, LinearAlgebra, Dsolve tools, 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, carboxylic 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 Pesenyák


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


**Functional Analysis for Physicists**

**BMETE92AF02 – 4/2/0/V/6**

Dr. Dénes Petz


**Group Theory for Physicists**

**BMETE11AF35 – 2/2/0/V/4**

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. Calculation: Description of normal modes, crystals, and quantum mechanical wave functions using group theory. Selection rules.

**ADVANCED PHYSICS**

**Mechanics 2**

**BMETE15AF32 – 2/2/0/FV/5**

Dr. Gergely Zaránd


**Quantum Mechanics 2**

**BMETE15AF36 – 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.

**Electrodynamics 2**

**BMETE15AF34 – 2/2/0/FV/5**

Dr. Gábor Takács


**Fluid Mechanics**

**BMGEÁTAF11 – 2/0/0/F/3**

Dr. Gergely Kristóf

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 – 2/0/0/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. Semiclssical quantization, WK method; Gutzwiller-trace formula; Spectral statistics, Loschmidt-echo.

Theory of Relativity

BMETE15AF38 – 2/0/0/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 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.

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
**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 biological 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/V/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 Csírus  

#### 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’s 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


Introduction to Algebra 2

Dr. Alex Küronya

Dual space. Application of vector spaces over finite fields in coding theory, cryptography and combinatorics.

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**

**BMETE92AM38 – 4/1/0/V/7**

Dr. Attila Andai


**Algebra 1**

**BMETE91AM38 – 4/1/0/V/7**

Dr. Álex Károlyna


**Probability Theory 1**

**BMETE95AM29 – 2/2/0/V/6**

Dr. Péter Bálint


**Programming Exercises for Probability Theory**

**BMETE91AM46 – 0/0/0/F/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**

**BMETE93AM15 – 2/2/0/V/6**

Dr. Katalin Nagy

Informatics 3

BMETE91AM44 – 2/0/2/F/4

Dr. Alex Kőrnyea

The aim of the course is to understand the basic elements of C++ language fundamental in effective scientific calculations. Compiling C++ programs, programming environments for C++, Input/Output. Built-in data types: int, double, char, bool, complex. Control commands: if, switch, for, while, do. Exception handling (recall Python). Functions. Extending operators (fractions struct), references (a += b, cout << < fraction, cin >> fractions). Object-oriented programming in C++: object, class, encapsulation, member functions, constructors, destructors (in complex class with re + im or r + i fi data members). 

Mathematical Statistics 1

BMETE95AM31 – 2/0/2/V/5

Dr. Marianna Bolla


Analysis 2

BMETE92AM39 – 2/0/2/V/5

Dr. Attila Andai


Differential Geometry 1

BMETE94AM19 – 2/1/0/F/4

Dr. Krisztián Kódós

Definition of curve, parametrisation, reparametrisation, length and arclength, invariance of length under isometries, tangent vector, curvature, Fox-Milnor’s theorem, normal, vector, signed curvature and turning angle, total curvature and convexity, the four vertex theorem, isoperimetric inequality, Frenet-Serret frame, torsion, fundamental theorem of curves. Definition of a regular embedded surface, Gaussian curvature, principal curvatures, intrinsic geometry, Theorema Egregium, Christoffel symbols, PMC equations, fundamental theorem of surfaces, covariant derivative, Lie bracket, Riemann curvature tensor, geodesic curvature, geodesics, Gauss-Bonnet theorem.

Operations Research

BMETE93AM19 – 2/0/0/F/5

Dr. Marianna Eisenberg-Nagy


Theory of Algorithms

BMETE94AM19 – 2/2/0/V/5

Dr. Katalin Friedl

Pattern matching: naive algorithm, the fingerprinting method of Rabin and Karp, solution by finite automata. Deterministic and non-deterministic finite automata and their equivalence. Regular expressions, regular languages, and their connections to finite automata. Finite automaton as lexical analyser. Context free grammars, Parse tree, left and right derivation. Ambiguous words, grammars, languages. The importance of unambiguous grammars for algorithms. Pushdown automaton. Connection between pushdown automata and context free grammars, how to get a PDA from a CF grammar. The main task of a parser. The general automaton: Turing machine. Church-Turing thesis. The classes P, NP, coNP, their relations. Karp reduction and the notion of NP completeness. Theorem of Cook and Levin. 3SAT, 3COLOR are NP complete languages. Further NP complete languages: MAXSTABLE, HAM-CYCLE, HAM-PATH, TSP, 3DH, SUBSETSUM, PARTITION, KNSACK, SUBGRAPHISO. The problem of GRAPHISO. Linear and integer programming. LP is in P (without proof), IP is in NP. LP and IP as algorithmic tools, translation of combinatorial problems to integer programming. Another tool: branch and bound. Dynamical programming (example: knapsack, longest common substring). The objective in approximation algorithms. Bin packing has fast and good approximations (FF, FFD, theorem of Ibarra and Kim). Fro the TSP even the approximation s hard in general but there is efficient 2-approximation in the euclidean case. Comparison based sorting: bubble sort, insertion sort, merge sort, quick sort.
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/F/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/V/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: \( \varphi(n) \), \( \sigma(n) \). Multiplicativity, convolution, Möbius function, the Möbius inversion formula. Prime number theorem, magnitude of the nth 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/F/4
Dr. Boglárka Gazdag-Tóth

Stochastic Processes

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

Creating Mathematical Models

**BMETE95AM12** – 0/0/2/F/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

**BMETG30A410** – 3/0/0/F/4
Dr. Katalin Petró

Applied Numerical Methods with Matlab

**BMETE92AMXX** – 2/0/2/F/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/V/4**

Dr. Szilárd Szabó


**BSc Thesis Project**

**BMETE90AM47 – 0/0/1/F/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/F/2**

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
the proof of its existence. Convex polytopes and polyhe-
dral sets, their connection, face structure of polytopes,
combinatorial equivalence. The f-vector of polytopes, Euler
characteristic of polytopes, theorem of Euler. Polar of a set,
fundamental properties of polarity, properties of the polar of
a polytope, dual polytope. Moment curve, cyclic polytopes
and their face structure, Gale’s evenness condition. Haus-
dorff distance of convex bodies. Affine transformations,
Banach-Mazur distance. Ellipsoid as an affine ball. Unique
existence of largest volume inscribed, and smallest volume
circumscribed ellipsoid of a convex body. The Löwner-John
ellipsoid, John’s theorem for general, and centrally symmetric
convex bodies.

Combinatorics and Graph Theory 2

Dr. Tamás Fleiner

Geometric and abstract duality, weak isomorphism (2-iso-
morphism) and the Whitney theorems. Vertex and edge col-
oring, Mycielsky’s construction, Brooks’ theorem. 5-colour
theorem, Vizing’s theorem, connection of edge-colouring
to matchings, Petersen’s theorem. List colouring of graphs,
Galvin’s theorem. Perfect graphs, interval graphs and the
perfect graph theorem. Ramsey’s theorem, Erdős-Szekeres
theorem, Erdős’ lower bound and the probabilistic method.
Turán’s theorem, Erdős-Stone theorem, Erdős-Simonovits
theorem. Hypergraphs, Erdős-Ko-Rado theorem, Sperner’s
theorem and the LYM inequality. De Bruijn-Erdős theorem,
infinite planes, construction from finite field, and from differ-
ence sets. Generating functions, Fibonacci numbers, Cata-
lan numbers. Posets, Dilworth’s theorem.
BASIC COURSES

Fundamentals of Photonics

BMETE12MF49 – 2/1/0/V/4

Dr. Attila Barócsi


Nuclear Physics

BMETE80MF00 – 3/0/0/V/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.

Statistical Physics 2

BMETE15MF44 – 2/1/0/V/4

Dr. Gergely Zaránd


Computer Simulation in Physics

BMETE15MF45 – 2/1/0/F/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 (Lánczos 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). 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 – 2/1/0/V/4

Dr. Gábor Takács

Investments

**BMEGT35M004** – 2/0/0/F/2

*Dr. Mihály Örmös*


Applied Numerical Methods with MATLAB

**BMETE92MFXX** – 4/0/2/F/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

**BMETE11AF40** – 2/2/0/V/5

*Dr. Titusz Feher*

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. Calculation: Description of normal modes, crystals, and quantum mechanical wave functions using group theory. Selection rules.

Electrodynamics 2

**BMETE15AF34** – 42 – 2/2/0/FV/5

*Dr. Gábor Takács*


Quantum Mechanics 2

**BMETE15AF36** – 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

**BMETE15AF32** – 44 – 2/2/0/FV/5

*Dr. Gergely Zaránd*


Computer Solution of Technical and Physical Problems

**BMETE11AF41** – 0/0/2/F/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/F/3

Dr. Csaba Tőke

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 Kriza

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 Kriza


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 accommodating 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.

Evolutionary Game Theory
BMETE15MF11 – 2/0/0/V/3
Dr. László Szunyogh
This course gives an introduction to the multi-agent evolutionary games building on statistical physics knowledge gained while earning a BSc degree in Physics. The following topics are discussed: Concepts of traditional game theory (strategy, payoff, matrix game, Nash equilibrium, etc.); Evolutionary games with population dynamics; Evolutionary games on lattices and graphs; Generalization of dynamical pair approximation. Many interesting phenomena are described by considering the repeated multiagent Prisoner’s Dilemma and Rock-Scissors-Paper games for different connectivity structures.

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 identi-
fied in relation to classically integrable and chaotic systems.
The problem of decoherence is studied as well. Then the
universal conductance fluctuations in quasi-one-dimen-
sional 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 fluctua-
tions, etc.

Classical and Quantum Chaos

Dr. Imre Varga
Hamiltonian formalism, integrability in general, examples
in physics for chaotic behavior in case of continuous and
discrete dynamics; Continuous, non-autonomous differ-
ential equations; Anharmonic, dissipative oscillator; Map-
plings, Poincare-mapping; Periodically excited systems; Bil-
liards. 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; Kolm-
ogorov-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

Dr. András Halbritter
The building blocks of nowadays electronic devices have
already reached a few tens on nanometers sizes, and further
miniaturization requires the introduction of novel technolo-
gies. At such small length-scales the coherent behavior and
the interaction of electrons, together with the atomic granu-
larity 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, hetero-
structures, two dimensional electron gas systems, nanoscale fabrication techniques. Diffusive and ballistic
nanowires, quantum wires, Landauer description of meso-
scopic transport, conductance quantization. Interference
phenomena in nanocircuits, decoherence. Integer and frac-
tional 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 applica-
tions, artificial atoms, spin qubits. Carbon nanostructures,
graphene, carbon nanotubes, fullerenes. Superconducting
nanostructures, Andreev reflection, mesoscopic proximity
effects. Spintronics, spin valve, spin torque, spin decoher-
ence, spin injection, nonlocal measurements. Nanoelectro-
mechanical systems.

Material Science Laboratory

Dr. Olga Homókiné Krafczik
The goal of the course is an introduction - in the field of
materials science - to material characterization measure-
ment methods and technologies on theoretical level and in
practice also. On each laboratorie a measurement method,
technical conditions of sample preparation and measure-
ment, evaluation and informations obtained from measure-
ments will be introduced. Practical measurement examples
and technological informations obtained from the measure-
ment 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 technologi-
ical lab by a „miniproject”, in this way students can get an
overview from sample preparation to measurement evalu-
ation in a specialization field of materials science. The cho-
sen 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

Dr. Ferenc Réti
The subject is based on the B.Sc knowledge in physics,
treating selected topics of the modern materials science,
using practical examples. Topics: Role of chemical bonds
in the properties of materials. Single crystals, polycrystals
and non-crystaline materials. Polymorphism and allotropy.
Carbon and silicon in materials science; their modifications
and properties. Mechanical properties of metals, ceramics,
polymers, methods of their characterisation. Stress, elastic
and plastic strain. Failure. Fatigue and the factors influen-
cing it. Planning, risks, security factors. Crystal defects, their
types, their importance in electrical and mechanical prop-
erties. Role of dislocations, Increase of hardness by reduc-
ing dislocation mobility. Driving force of phase transitions,
the thermodynamic criteria. Crystalline and glassy transi-
ition. Modification of the properties of engineering materi-
als by heat treatment. Phase diagrams, alloys, eutectics,
intermetallics. The carbon-iron system, microstructures,
steels. Properties and applications. Driving force of dif-
sion, its kinetics and mechanisms. Surface and intergranular
diffusion, electromigration. The role of diffusion in micro-
electronics and solid phase chemical reactions. Monomers,
oligomers, polymers. Structure of polymers, their molecular
weight, shape of their molecules. Copolymers. Amorphous
and crystalline and polymers. Composites. Corrosion, cor-
rosion types, protection against corrosion.

Physics of Semiconductors 1

Dr. Miklós Csongos
This course describes the behavior of modern semiconduc-
tor physics, – mostly those properties (electrical and opti-
cal), which provides understanding of present day electron-
ics –, 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 ap-
proximation, 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 physical sciences 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.

**Magnetic Flows and Solitons**

**BMETE12MF42 – 3/0/0/V/3**

*Dr. Ildikó Barna*

The aim of the course is to introduce students to the fundamentals of the physics of magnetic materials and solitons. The course content includes: magnetization, magnetic anisotropy, magnetic hysteresis, magnetic moment, magnetic polarization, magnetostatic waves, magnetic solitons, magnetic skyrmions, and magnonic crystals.

**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 Kornis
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 Cziifrus*

**Medical Imaging**

**BMETE80MF91 – 3/1/0/V/4**

*Dr. Dávid Légrády*

The lecture focuses on the mathematics of medical imag-
ing 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. Elements 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)

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
BMETE73MM029 – 3/1/0/V/5
Dr. David Szeszlér
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

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. Zsanett 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 Illés**

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 monopoliy, the design 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

**BMETE91MM03 – 3/1/0/F/5**  
*Dr. Erzsébet Horváth*


Homological Algebra

**BMETE91MM06 – 2/0/0/F/2**  
*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: definition, boundedness, the Lyndon–Hochschild–Serre spectral sequence, application to calculating group cohomology. (2 credits)

Individual Projects 1, 2

**BMETE92MM01, 02 – 0/0/4/F/4**  
*Dr. Mátra 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

**BMETE95MM17 – 2/0/0/F/3**  
*Dr. Béla Barabás*


Introduction to Economic Dynamics

**BMETE93MM08 – 3/1/0/V/5**  
*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

**BMETE92MM08 – 2/0/0/V/3**  
*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

**BMETE95MM10 – 3/1/0/V/5**  
*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*

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/F/2**

*Dr. Marianna Bolla*


**Non-Euclidean Geometry**

**BMETE94MM03 – 3/1/0/F/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 Gyorfi*


**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
Motivation: a little electrostatics, Dirichlet problem and Brownian motion. An extremal problem: logarithmic potential, Chebyshev constant and transfinite diameter. Electrostatics with external fields, weighted energy integral and potential. Equilibrium measure and the modified Robin constant. How to solve the Dirichlet problem, when the boundary conditions are not ”nice”? Modified Poisson kernel with respect to singularities, lower semicontinuity, Perron-Wiener-Brelot solution, harmonic measure. Regularity, balayage, generalized Poisson integral. Brownian motion and harmonic measures. (3 credits)

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

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/N/5
Dr. Károly Simon

Stochastic Differential Equations
BMETE95MM08 – 3/1/0/N/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
<table>
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<th>Theory of Operators</th>
<th>Wavelet Analysis</th>
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<td><strong>BMETE92MM06 – 2/0/0/F/2</strong></td>
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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. Mára 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 also 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/V/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 thich 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, Version 7, 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, front end, 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 logics. 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.
Neurobiology 1 – Foundations and Neurobiology of Perception

BMET47MC22 – 2/0/2/V/5
Dr. Gyula Kovács


Neurobiology 2 – Sensory and Motor Processes

BMET47MC23 – 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

BMET47MC24 – 2/0/0/V/3
Dr. Szabolcs Kéri


Neuropsychology

BMET47MC06 – 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

BMET47MC36 – 2/0/0/V/3
Dr. Ágnes 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

BMET47MC31, 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 specialized in the fields of business, economic and social sciences.

The Faculty has more than 3000 students studying in 6 undergraduate (BA/BSc), 12 graduate (MA/MSc) and one doctoral program (Ph.D.) taught by more than 100 professors in the fields of economic and social sciences.

Our programs are among the best degree programs in Hungary in social sciences. According to the latest Hungarian rankings, our bachelor programs in Engineering Management and in Communication and Media Science are ranked number 1 in the country, while our Bachelor in Business Administration and Management and Bachelor in Finance and Accounting programs occupy the 2nd and 3rd positions in their respective fields. Programs offered by the Faculty provide solid theoretical foundations, along with up-to-date practical skills to their students 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 well established programs in Hungarian, the Faculty launched its English language programs in 2019, which is available to students from all around the world including students of the Stipendium Hungaricum program.

The Faculty is a member of EFMD since 2018. EFMD is a global network of business schools and corporations dedicated to enhance excellence in management education and development globally. In 2020 GTK became the first official Hungarian Academic Partner of the Global Association of Risk Professionals (GARP). GARP is the only globally recognized membership association for risk managers.

Since GTK is very active in providing courses to students of the engineering and natural science faculties of the University in both Hungarian and English, the Faculty can offer ideal conditions for those students, who are interested in a multidisciplinary study environment and are ready to prepare themselves for the contemporary challenges faced by our societies.

Students of GTK can enjoy state-of-the-art facilities, including a modern building with well-equipped lecture halls and widely available internet services, which promote effective learning and a very enjoyable stay at the University.

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 the Centre for Physical Education, which provides modern facilities and a wide range of sport programs to the students.

The following pages introduce three master and a doctoral programme of the Faculty for the academic year 2020/21.
**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

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**Budapest University of Technology and Economics**  
**Faculty of Economic and Social Sciences**  
Faculty Office: Building “Q” wing A, 203.

**Address:**  
2 Magyar Tudósok krt. H-1111 Budapest, Hungary  
E-mail: gtk-dekani@gtdh.bme.hu  
Phone: (+36-1) 463-2152  
Web: https://www.gtk.bme.hu/en/

**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)

**International Students’ Office:**  
Ms. Noémi Girst  
Email: iso@gtdh.bme.hu  
Address: Building “Q” wing A, Mezzanine floor 5., 2 Magyar Tudósok krt., H-1111 Budapest, Hungary
Description of master programmes

Master in Finance

**Length of study:** 4 semesters

**Programme objectives:** The goal of our programme is to educate economic professionals to have a global competitive edge in finance, in particular in financial analysis and risk management. Our graduate students are capable of complex and independent financial thinking, managing and analysing the financial processes of the economy both at the macro and micro levels. The main focus of our programme is to provide a high level of professional standards in investment analysis, portfolio management, corporate and bank treasury and risk management.

For the above-mentioned purposes, we have been striving to cover the requirements of the international Chartered Financial Analyst (CFA) and Financial Risk Manager (FRM) in the development of the course structure and curricula. As a consequence, our students upon graduation will also have the knowledge to successfully pass CFA / FRM exams. This feature of our training is unique in the Hungarian higher education market, and it 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)
- In case of other BA/BSc, completion of a minimum of 60 ECTS (credits or equivalent) should be proven in the following areas of study:
  - 15 ECTS from Quantitative Foundations (mathematics, statistics, informatics)
  - 10 ECTS of Economics (micro and macroeconomics, international economics, environmental economics, economics theory, economics statistics, 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 min 72 or IELTS min 6.0 or bachelor degree was taught entirely in English.
Master in Management and Leadership

Length of study: 4 semesters

Programme objectives: The program equips admitted students with knowledge, skills, and competencies required for a successful managerial career in the age of digital transformation, cultural and global change. Students enrolled in the Management and Leadership Master’s program have solid and integrated professional knowledge in a broad field of management. The basic essentials of the program cover knowledge areas in quantitative decision making, operations management, financial management, marketing, project management, business law and business analytics 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. With their acquired knowledge, students are able to analyse, plan and manage the processes of the competitive and public sector organizations.

We consider our program unique from the following two overarching points of view. The first is the integration of digital transformation and its implications for all of our courses. Secondly, we cannot imagine successful leadership without understanding cultural diversity, the essence of working in projects, and without balancing economic interests with the interest of social responsibility. Our aim is to transfer knowledge and experience through lectures, seminars, case studies and simulation exercises to work on. Invited experts also provide insights into the application of theory in several production, service and public sector institutions.

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 min 72 or IELTS min 6.0 or bachelor degree was taught entirely in English.
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 contributing 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 the field of either Economics and/or Management or Engineering or Natural Sciences (IS-DEC level 6 or higher)
- In case of BA/BSc in Engineering or Natural Sciences, completion of a minimum of 60 ECTS (or equivalent) should be proven in the following areas of study:
  - 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, 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 min 72 or IELTS min 6.0 or bachelor degree was taught entirely in English.

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.

General conditions of admission into the doctoral programme:

- A master degree certificate certifying that the student has successfully completed master level university studies and passed the final examination preferably with a qualification of ‘Merit’ or ‘Distinction’.
- Master degrees in Business management, Management Science, Engineering management and Business Economics are acceptable. Applications from other areas (e.g. mathematics, physics, informatics, and different areas of engineering) can be also considered after the special consideration of the management of the doctoral school.
- Initial scientific/professional achievement.
- B2 level command of English: a TOEFL iBT score of 88 and above, IELTS overall band 6.5 or above.
## Curriculum in MA of Finance

<table>
<thead>
<tr>
<th>Subject</th>
<th>Contact hours / Exam type / Credit</th>
<th>Preliminary requirements</th>
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<tr>
<td>Economics</td>
<td>BMGET30M210 2/t/3</td>
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<td>Quantitative Methods</td>
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<tr>
<td>Accounting</td>
<td>BMGET35M009 4/e/5</td>
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<td>Introduction to Financial Mathematics*</td>
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<td>Intensive Seminar</td>
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<td>Data Analytics</td>
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<td>Management Controlling</td>
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<td>Economic History</td>
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<td>Macro Finance*</td>
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<td>Pricing and Price Forecasting</td>
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<td>Innovation and Green Finance</td>
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<td>Physical Education and Sports (refer to separate documentation)</td>
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<td>Insurance</td>
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<td>Financial and Business Ethics</td>
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**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 Methodology C – 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>
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<tr>
<th>Subject Contact hours / Exam type / Credit</th>
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**Course Unit Type**
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**Example of Notation**
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- Meaning: Compulsory (Core) Unit, 4 contact hours a week, performance assessed by means of examination, totalling 5 ECTS credits.
## Curriculum of MA in Regional and Environmental Economics

<table>
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<tr>
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<td>Project Management</td>
<td>4/e/5</td>
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<tr>
<td>Environmental Management Systems*</td>
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<tr>
<td>Regional and Municipal Marketing</td>
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<tr>
<td>Local Development and Social Policy</td>
<td>2/t/3</td>
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<tr>
<td>Urban Development and Urbanism</td>
<td>4/e/5</td>
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<tr>
<td>Sectoral Sustainability Studies</td>
<td>4/t/5</td>
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<tr>
<td>Competitiveness Evaluations</td>
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<tr>
<td><strong>Compulsory Elective Unit</strong></td>
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<tr>
<td>Diploma Project</td>
<td>9/t/10</td>
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<td>Thesis Work</td>
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<td><strong>Total</strong></td>
<td>20/2e/28</td>
<td>22/3e/29</td>
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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 Methodology C – 4/e/5  
Meaning: Compulsory (Core) Unit, 4 contact hours a week, performance assessed by means of examination, totalling 5 ECTS credits.
History of Science

BMEGT419709-ER

This course introduces students to the history of economic thought. It does not present the major theoretical traditions as milestones of a single scholarly endeavor, but as an ambiguous cumulation of socially embedded theoreticians and theories. The course does not develop an abstract (internalist) disciplinary history, but offers a glimpse into multiple down-to-earth (externalist) histories. The ideas, engagements, desires, hopes and fears of great thinkers offer a thick social layer which might provide a better understanding of their theories. Being more concerned about how these theoreticians perceived their own theories than how others interpreted them later helps to avoid anachronistic accounts. By emphasizing the historical context and the interpretative flexibility of economic ideas, this course aims to develop social and cultural sensitivity in how one handles economic and social theories. (2 credits)

Environmental Economics (Theory and Practice of Environmental Economics)

BMEGT42MN05

Created for Masters’ students but also recommended for Bachelors’, the subject aims to present the most important principles of environmental economics, environmental policy and sustainability as well as to show some practical applications. The topics included are: systems and relations of economy, the society and the environment, a historical overview of environmental economics, the concept of sustainable development, its levels and different interpretations. Environmental policy from an economic perspective is also discussed: its definition and types, economic and regulatory instruments in environmental protection, their advantages and limitations. Theoretical approaches include the theory of externalities, internalisation of externalities, Pigovian taxation and its limitations, Coase’s theorem and its criticisms, environmental economics in a macroeconomic context, alternative, “green” macro-indicators (NEW, ISEW,GPI), monetary environmental valuation, the concept of total economic value and environmental valuation methods (cost-based methods, hedonic pricing, travel cost method, contingent valuation, benefit transfer). (5 credits / 4 credits)

Sustainable Environmental and Natural Resource Economics

BMEGT42MN03

Created for Masters’ students but also recommended for Bachelors’, 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 in the various areas of our lives. (6 credits)

Regional Economics

BMEGT42MN01 (MSC/MA) BMEGT42N002 (BSC/BA)

Created for Masters’ students but also recommended for Bachelors’, the aim of this subject is to introduce basic, actual regional economics and spatial planning theory as well as the EU and Hungarian practice. The topics of the subject include the roots of spatial planning in economic theory, including the theories of Thünen, Weber and Lösch, the theory of central places, growth poles and growth centres and territorial division of labour (Ricardo, Ohlin). Further topics include the types and history of regions in Western, Central and Eastern Europe, regionalisation, decentralisation and regionalism, rural development, the effect of agricultural policy on rural development and rural development, urban development, historical overview, differences between Western and Eastern Europe. The main characteristics of infrastructure development are also introduced, as well as the types of borders, the significance of borders in regional development and cross-border regional co-operations. Finally, contemporary developments and novel approaches in regional science are also discussed. (3 credits / 2 credits)

EU Environmental and Regional Policy

BMEGT42MN06

Created for Masters’ students but also recommended for Bachelors’, this course unit aims to introduce the evolution of environmental and regional policies, their strategic elements and changing tools, and their contemporary practices and key policy areas in the European Union. The course will introduce the basics of regional policy; its goals and interrelations with environmental policy, and the practical implications on Europe. It will highlight the development stages of regional policy in Europe, focusing on the key milestones and reform efforts in an expanding European Union. During the latter part of the semester, the course will introduce students to the fundamental concepts of environmental policy: its origins, nature and key stages of development. It will also focus on the EU’s Environmental Action Plans, and the Sustainable Development Strategies. (6 credits)

Climate Change – Advanced Level

BMEGT42V100

Created for Masters’ students but also recommended for Bachelors’, this course unit aims to provide knowledge about environmental, social and economic issues regarding climate change through the basics of physical evidences, international policies, impacts and consequences. This course will give an overview of the scientific background of climate change, climate modelling, climate scenarios etc. This subject deals with the main impacts and consequences of climate change. Climate policy and climate economics, carbon footprint methodologies. To conclude, students will learn about impacts, solutions and adaptation opportunities in different sectors (e.g. energy management, water management, transport sector, agriculture, tourism etc.). (3 credits)

Environmental Management of Energy

BMEGT42N003

The aim of the subject is to introduce and expand the scope of sustainable energy and resource management both on a domestic, EU and global scale, primarily from the corporate and policy aspects. The course will give an overview of the energetic status and trends in the EU and the world. It will give an introduction to Energetic Life Cycle Analysis. Business model of energetics and energy enterprises. EU energy policy, environmental and sustainability strategies. Energy strategies and energy-saving programmes. A Sustainability analysis of the environmental effects of the different kinds of
sources of energy. Energetic interrelations in climate protection. Pollutions from energetic sources in Hungary and the EU. State institutions of energy and environmental protection policy. Summary and future perspectives. (3 credits)

**Sectoral Sustainability Studies**

**BMEGT42MN11 (MSC/MA) BMEGT42N004 (BSC/BA)**

Created for Masters’ students but also recommended for Bachelors’, the course unit aims to give an overview of the sectoral aspects and particularities of the transition to sustainable development. Students will be given an insight into the current trends and practices in the various sectors of the economy. Students are introduced to the concept of sustainable development and the basics of environmental evaluation. They are then introduced to the horizontal strategies and policies of sustainable development. To conclude, students will learn about the sustainability strategies in various economic sectors. (4 credits / 5 credits)

**Environmental Management Systems**

**BMEGT42A003**

Tailored for Bachelors’ but also recommended for Masters’ students, the course covers the topics relevant to the protection of environmental compartments, environmental pressures and pollution in a global context. The course introduces the concepts, indicators and tools of environmental protection, and the environmental management systems (EMS) at enterprises and other organizations. EMS topics include the assessment of environmental aspects and impacts, environmental audits, reporting, environmental performance evaluation, life cycle assessment. (3 credits)

**Environmental Evaluation and Risk Management**

**BMEGT42A022**

Tailored for Bachelors’ but also recommended for Masters’ students, the course covers the various questions that arise from the necessity to economically value our environment. Key topics to be covered: Monetary valuation of natural capital and the concept of sustainable development (weak and strong sustainability). The necessity to evaluate natural resources: the problem of public goods and free goods, discounting (social discount rate) and externalities. The areas of application and methodological basics of environmental valuation. The concept and elements of Total Economic Value. A detailed overview of the methods of environmental valuation: cost-based methods, productivity approach, revealed preference methods (hedonic pricing and travel cost method), stated preference or hypothetical methods and benefit transfer. An introduction to risk management: definition and approaches of risk, corporate risk management techniques, corporate social responsibility. Cost-benefit and cost-effectiveness analysis, case studies. (3 credits)

**Philosophy of Art**

**BMEGT43A186**

The course will introduce students into some major issues and problems in aesthetics and the philosophy of art. We will study a number of philosophical questions about the nature, the production, the interpretation and the appreciation of works of art. After studying the basic philosophical categories concerning art and artworks we will concentrate on specific aspects of the creation and appreciation of paintings, drawings, photographs, moving images, digital images, fictions, music etc. For instance, we will consider questions and arguments about “realism” with respect to pictorial works of art, about literature and fictional works, and about the understanding and appreciation of music. Although most of the course will be devoted to the analytic philosophy art, we will also examine issues concerning design practices and products. (5 credits)

**Recorded Music**

**BMEGT43A066**

Technology for recording, processing, storing and distributing information does not only influence access to cultural products (price, circulation, distribution channels). It also fundamentally impacts upon the formation of cultural canons and, on an individual level, the reception, interpretation and social use of cultural products. However, it would be wrong to assume a one-sided determinism, as neither the direction of technological development nor the speed of the spreading of new technology are independent from the cultural needs of a given society, or its economic and political conditions. The history of sound recording, encompassing more than one hundred years, illustrates this dynamics well. The theoretical perspective of the course draws on Cultural Studies, Media Theory, the Sociology of cultural production and consumption, as well as Popular Music Studies. Besides the technological history of sound recording, we will also look at the history and logic of the music industry, primary areas of sound archiving and collecting, and further cultural use relating to recorded music. We pay particular attention to avant-garde/experimental music that makes use of recorded music; digital pop music and DJ culture; as well as copyright debates relating to sampling and remixing. (2 credits)

**Sociology of Culture**

**BMEGT431143**

The course introduces basic theories of the Sociology of Culture relating to identity, subcultures, cultural differences and ethnicity, as well as presenting and discussing their practical relevance. Throughout the semester, we will critically examine the concepts of high, mass and subculture, as well as those of nation, tradition, and community. The aim of this critical inquiry is not the relativisation of the mentioned concepts, but the introduction of those processes of social construction that lead to the emergence, consolidation and at times (re)negotiation of these categories and the related values and emotions. Through such inquiry, we are aiming towards a more nuanced understanding of the social-cultural conflicts of today’s globalised society by the end of the semester. Beyond presenting relevant theories and literature, the goal is to discuss the practical relevance and applicability of the observations through examples taken from across the globe. (2 credits)

**Fashion and the Psychology of Advertising**

**BMEGT52V100**

The course aims to look behind the scenes of the colorful and glamorous world of fashion and advertising. What we see at first glance is a huge industry where millions of professionals are pushing the machinery to play upon our instincts. We shall study the methods, review the role of public relations, sales promotion, the role of the brands, and the templates and stereotypes used in the different media. The vast amount of knowledge piled up by behavioral sciences will help us answer the question why our basic instincts to imitate can be used and abused. Why is it that we are ready to spend billions on shampoo, new clothes, junk food, gadgets etc., hoping to buy identity. We will
also reveal that the very nature of the social animal – the group – plays an even more decisive role in our preferences and purchases – introducing a variety of approaches from the basic theories of fashion (trickle down, cascade, herd behavior) to network theories. (2 credits)

Hungarian Culture (in English)
BMEGT658361

Ungarische Kultur (in German)
BMEGT61ANKT

Cultura húngara (para estudiantes internacionales) (in Spanish)
BMEGT62ASCH

This interdisciplinary course covers a variety of interconnected fields to present a comprehensive survey of Hungarian culture and history. The course is thematically organised and focuses on Hungarian culture as it is expressed through the arts (fine arts, literature, and music). Special emphasis is given to the history of Hungarian thought from early to recent times. The concepts of Hungarian poets, writers, composers, and scientists are considered in their historical and social context. (2 credits)

English and other language subjects offered for Erasmus students

.... (language) for Engineers

ENGLISH (BMEGT63A051)
GERMAN (BMEGT61A061)

The course 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 credits)

Communication Skills – ..... (language)

ENGLISH (BMEGT63A061)
GERMAN (BMEGT61A061)
FRENCH (BMEGT62AF61)
SPANISH (BMEGT62AS61)

The Communication Skills course 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 credits)

Manager Communication – ..... (language)

ENGLISH (BMEGT63A081)
GERMAN (BMEGT61A081)
FRENCH (BMEGT62AF81)
SPANISH (BMEGT62AS81)

This course is designed to prepare students to be successful in exchange programmes and in the business environment. Special emphasis is on job-related activities and topics like public relations, job descriptions, CV-writing, job interviews, managing conflicts and changes. (2 credits)

Crosscultural Communication – ..... (language)

ENGLISH (BMEGT63A091)
GERMAN (BMEGT61A091)
FRENCH (BMEGT62AF91)
ITALIAN (BMEGT62A191)
SPANISH (BMEGT62AS91)

This course is designed at an awareness of cultural differences, develop their intercultural competencies. Special emphasis is on verbal and non-verbal communication, language diversity, and socio-cultural factors. (2 credits)

Deutsch im Unternehmen B2
BMEGT61MNPD

The course is aimed at students who are the active language users of the intermediate (B2) level and have the intention of working for a German company as a trainee or as an employee. The main topics to cover throughout the course are the followings: modern working styles, multicultural differences at work, business communication, handling conflicts, introducing a new product, trade fairs, company profiles (Windhager, Bosch, Ritter Sport, etc.) (2 credits)

Academic English (B2+)
BMEGT63MAPD

The course focuses on developing students’ academic writing skills, namely, they will be provided with the opportunity to practise writing paragraphs, essays and summaries. They will also be introduced to the basics of writing research papers. By the end of the course students will be able to write and evaluate well-argued and well-organised texts. Apart from writing some of the tricks of academic listening, speaking and reading will also be discussed. Students are expected to have a good knowledge of English at around B2+ level to complete the course. (2 credits)

Communication through TED talks
BMEGT63MATD

The aim of the course is to develop students’ listening and speaking skills with the help of a selection of TED talks based upon students’ specific needs. The course develops fields related to occupation and education. (2 credits)

Sport activities

The Budapest University of Technology and Economics offers a wide range of sporting activities that you can choose from, both indoors and outdoors.
Autumn semester only

Corporate Finance
BMEGT35M411
The subject is designed to give the students a broad overview of financial goals and assets of corporations (PLCs), to get them acquainted with project evaluation techniques and methods for supporting decision making. The subject deals with the examination of financing opportunities and decision methods for corporations, investors’ considerations, yield and risk relation. Developing this course syllabus, we have aimed to cover the V module (Corporate finance) of the international CFA (Chartered Financial Analyst) exam. Teaching focuses on enabling students to adapt their theoretical knowledge in practice. (2 credits)

Accounting, Control, Taxation
BMEGT35M014
Teaching the subject will get the students acquainted with the goals and tasks of accounting, controlling and tax. As a result, they learn accounting tools and methods and gain basic knowledge in analysing income and financial state of the company.
Objectives: To get students acquainted with the accounting framework, general accounting principles and accounting regulation; to make students understand what the main accounting elements: assets, liabilities, income, expense; to familiarize them with the annual accounts, the balance sheet and the income statement; to help students develop the capability to perform the basic accounting functions: the recognition, valuation, measurement and recording of the most common business transactions and the preparation of accounting statements. (2 credits)

Investments
BMEGT35M004
The course’s main goal is to familiarize the students with the operating mechanisms of equity markets, stock exchanges, the main market institutions, indices, the basics of equity analysis and the main portfolio-management strategies. During the semester the main emphasis will be on the fundamental analysis of equities. The course covers mainly the content of the modul VI. of the CFA (Chartered Financial Analyst) exam. Another goal of the course is to introduce the students to the world of FINTECH. (2 credits)

Philosophy and Art
BMEGT411099-EN
The course offers an introduction to the most important topics, problems and methods of the philosophical discourses that focus on art, architecture and urban design. We will examine the theoretical issues of essence, function, space, place, aesthetic value, beauty and relations between power and architecture, how social life changes in built environment, and what are the cognitive and psychological effects of living in built environment. (2 credits)

Ethics for Engineers
BMEGT41M004-A0
The purpose of this course is to help students recognise and analyse ethical problems, risks and conflicts (recognition and understanding), make the right decision in morally delicate situations (decision) and become committed to the performance of the right action (action). The objective of this course is to make students able to act in a morally reflective and correct way and to prepare them to understand, evaluate and handle ethical problems apparent on the field of engineering. Main theoretical objectives: acquiring new factual knowledge, new perspectives for evaluation and new behavioural skills. Main practical objectives: becoming able to analyze and solve complex decision problems with particular attention to their ethical dimension. (2 credits)

International communication
BMEGT43A232
Our globalized world today is characterized by a growing number of contacts resulting in communication between people with different linguistic and cultural backgrounds. Working in global teams in international organizations or in multinational corporations, dealing with partners in various fields ranging from business through politics to education and tourism across cultures raises challenges and demands special intercultural knowledge, attitudes and skills. To increase efficiency in international communication, our course will introduce students to the basics of culture, intercultural communication and management, business ethics, corporate and organizational culture, diplomacy, cultural and sport diplomacy, regional and city branding. (5 credits)

Spring semester only

Logic and Argumentation
BMEGT418959-ER
The undergraduate course offers a basic introduction to the everyday issues and scientific use of arguments with an introduction to formal and informal methods of analysing arguments. It examines case studies taken from realistic scenarios and surveys a variety of topics from standard logic, argumentation and critical thinking. The course discusses issues from the point of view of argumentation and formal analysis in various fields as well as from the point of view of rhetoric and critical thinking. The topics covered give an introduction to core concepts and connect recent contributions that explore contemporary approaches to analysing everyday discourses and theoretical works. Apart from familiarizing the student with the established theories and key concepts in logic and argumentation theory, the course also provides practical training that enables students to analyse complex arguments with the help of various tools. (2 credits)

Technology and Society
BMEGT41V101-ER01
The aim of the course is to provide a sophisticated conceptual framework and perspective for understanding technology’s most important sociological and philosophical problems. The course’s main focus is on technology’s development and its risks and possibilities. The relationship between science and technology is also discussed. Presentation of the specifics of technological knowledge, expertise, and tacit knowledge allows students to better understand their own professional body of knowledge that they are in the process of acquiring. These topics are supported with case studies. Cases from the history of natural science illuminate the general questions of underdetermination. Medical case studies illustrate the theoretical and ethical problems of experiment design. Technological case studies provide information about technological evolution, the process of technological closure, and the problems of risk assessment. (2 credits)
Ergonomics
BMEGT52A001
Concept of Ergonomics: Man-machine systems, levels of compatibility, characteristics of the human and the technical subsystems, significance and quality of user interface. Workplace design: Basic ergonomic principles and design guidelines for different working environments: workshops in mechanical industry, traditional and open room offices as well as other working places with VDUs, control rooms in the process industry, client service workplaces (governmental organizations, banks and ICT companies). Human factors of safety. Human-computer interaction: Analytical (cognitive walkthrough, guideline review and heuristic) and empirical methods of assessing usability of software and other smart products. Website quality, web-mining. Industrial case studies with the INTERFACE research and assessment workstation. (2 credits)

Epistemology
BMEGT41M410
Epistemology, especially naturalized epistemology and the neuroscience of epistemology witnessed exceptional measures of development in the last decade. This lecture introduces students to the basic issues of epistemology in order to make them understand the deeper levels of debates on the field. Accordingly the teaching material covers the problem of justification, especially the different sources of knowledge and their cognitive grounds. Further topics, such as the problem of extended minds, the knowledge of mixed systems such as computer-human cooperation, group knowledge and the knowledge attribution to agents in dynamic game-theoretical models are discussed in order to provide an insight to the most recent topics in epistemology. The course teaches students to write a paper in English eligible for later publication and also provides an introduction to the main questions of recent epistemological disputes relevant to the traditional problems of philosophy of mind, cognition and science. (2 credits)

Municipal Management
BMEGT42MN19
Created for Masters' students but also available to Bachelors', this course unit aims to introduce students to how municipalities are managed in modern welfare states. The course introduces the traditions and innovative efforts of governments, and the predominant models of organising state. The course unit introduces the legal framework of territorial and local governance, outlines the budgetary procedures of local administrative units, and discusses the expenditures and revenues of these. To conclude, the course will also focus on the novel approaches in municipal management, and the duties and challenges of territorial governments in light of climate change and sustainable development. (4 credits)

EU Politics
BMEGT43MN20
The aim of the course is to introduce students to the theoretical background and development of European politics and the EU, then a more detailed examination of particular EU policies. In the first part of the course, we clarify the most important theoretical terms, like politics, nation state, democracy, power, international economic order, globalization and regionalization, international governmental and non-governmental organizations, etc., necessary for the understanding of the complex system of international political and economic order developed after WWII, in which the EU is embedded. Then we deal in detail with the historical background, foundation, development of the integration process and institutional set-up of the EU with a special attention to the recent changes, problems and challenges. In the last section students will be given the opportunity to examine the most essential EU policy areas, like finance and budget, agriculture & food, regional and local development, international economic relations, environment and energy, social policy & employment, culture and education. (3 credits)

Social and Visual Communication
BMEGT43MS07
The course aims to discuss and analyze social phenomena by means of exploring their manifestation in the visual sphere. By providing methods with the help of which students learn to understand communicative processes of arts, social campaigns, product design, advertisement, etc. the goal is dual: first, to show how certain social issues are presented in the public visual sphere and second, to deepen students’ theoretical – sociological and philosophical – knowledge on the given topic. Topics: communication, social communication, presentation, media and media literacy, images and photography, the role of visual materials in the socialization process, brands and advertisements, social advertisements and projects using visual elements, campaigns (media, Web 2.0), science communication. (2 credits)

Psychology
BMEGT52A002

Art of Negotiations and Basics of Presentation Techniques
BMEGT41A010-ER
The presentation techniques part of the course is designed to give the students some insights into useful presentation techniques that can be used throughout their academic and non-academic career. In the art of negotiations segment of the curriculum we help students to become self-aware and successful negotiators. The basic theoretical foundations of the art of negotiations are also covered (BATNA, competitive arousal etc.). (2 credits)
English language course offer for Erasmus+ mobility program
BSc/BA courses

Management and Business Economics

**BMEGT20A001**
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: principles of management, marketing management, quality management, production and project management. For problem formulation, both the managerial interpretation and the mathematical techniques are applied. (4 credits)

Micro- and Macroeconomics

**BMEGT30A001**

Industrial Organization

**BMEGT30N002**
Learning outcomes: After completing the course, students will understand the intuition behind different market models and should be able to apply those models in analyzing firm behavior and its social impact. In addition, they will be capable of assessing the benefits and potential shortcomings of the anti-trust policy measures in the US and in Europe. Content: Industrial Organization covers topics that range from production and pricing decisions of the firms in imperfectly competitive markets through collusive behavior, mergers, entry decisions and entry deterrence down to the perfectly competitive markets through collusion. A further consideration, specific to engineering and economics students is that a sociological study of the Great Recession provides valuable insights into the social determinants of innovations, most prominently technological and financial. Learning about these issues will also help them develop a basic understanding of late capitalism. They will find that the major subjects in sociology like power, cultural values, violence, symbolic goods, anomie, collective action, etc. touch upon things that profoundly impact our lives without us being aware of their implications. The craft of sociology is to depart from conventional notions by asking hard questions about these things using the methods of rational inquiry. (2 credits)

Sociology

**BMEGT43A002**
This course will give students an introduction into sociology by discussing a subject that concerns all of us: the global financial crisis and the ensuing Great Recession (or Slump) whose dire consequences continue to affect the world economy to this day. The objective is to equip students with the tools required to make sense of this crisis in its complexity. A further consideration, specific to engineering and economics students is that a sociological study of the Great Recession provides valuable insights into the social determinants of innovations, most prominently technological and financial. Learning about these issues will also help them develop a basic understanding of late capitalism. They will find that the major subjects in sociology like power, cultural values, violence, symbolic goods, anomie, collective action, etc. touch upon things that profoundly impact our lives without us being aware of their implications. The craft of sociology is to depart from conventional notions by asking hard questions about these things using the methods of rational inquiry. (2 credits)

Pedagogy-Digital Pedagogy

**BMEGT51A001**
The aim of the course is to introduce students to the theoretical background and development of pedagogical terms and the structure of teaching and learning processes. During the training period we will present the topics of self-regulated learning and learning motivation, new possibilities for teaching and learning in the information technology age. During this semester we will analyse how the efficient methods of learning, the possibilities of study management and study the concepts of learning from ancient times to our days. Beyond presenting relevant theories of learning we shall turn to new developments in educational technology, modern media as a technological support of effective presentation. Finally, the course introduces basic theories and the tendencies of formal and non-formal education. The aims and objectives of the course are to support understanding directions of digital technologies in current and future learning environments, and presenting how a learning environment can be personalized by means of using ICT. (2 credits)

History of Education and Technologies of Communication

**BMEGT51A017**
This course introduces students to communication technologies and their influence on learning from a historical, theoretical and practical perspective. As the forms of and technologies of communication are constantly changing, their impact on society, on education, on our perception of time and space is too. The lecture will emphasize the theoretical models that are essential to new communication technology as well as the practical applications and implications of new communication technology on education. Starting from the pre-history and non-verbal communication, a number of new communication technology areas such as computer-mediated communication, Web 2.0, mobile society and gamification will be explored. (2 credits)

(Lifelong) Learning and Working Life

**BMEGT51A020**
Emphasizing the development of independent problem-identifying and problem-solving skills by analysing the global labour market challenges. In the framework of optional exercises and self-controlled learning processes and by acquiring the steps of program planning concentrating on the field of technology, training orientation possibilities are granted to participants in their fields of interest. During the training period we will present the practical applica-
The undergraduate course offers a basic introduction to long-term knowledge, wide-range technological examples, case-studies and the analysis of changes. The participants of the course will gain the necessary knowledge and competences for understanding the importance of sustaining the lifelong competitive knowledge. By making individual job and scope of activities analysis based on their own learning competences and methods. They will understand the problems of learning skills as life skills, a new type of human capital, networking, teamwork and working methods in the context of lifelong learning. What does not only surviving but being successful in the dynamically changing professional and global environment today mean? What does it mean: “to be locally engaged while visible globally”, What does the New Deal of Lifelong Learning means for the new generation. What are the key massages and trends after the World Economic Forum 2017? (2 credits)

Business Law

**BMEGT55A001**

The aim of the course: Characteristics of the Anglo-Saxon and continental systems of business law. The development of the system of the Hungarian business law. Basic legal institutions of the state to manage the economics. Organisations and enterprises as the subjects of law: conceptual questions. International models of company law. The development of the Hungarian company law. General rules of the Hungarian Company Act. Internal organisation of companies. The law of company registration, the registration proceedings and the company registry. Companies with a partnership profile. Companies limited by shares. Concept and types of securities. Competition law. EU directives and regulations on companies and competition: their execution in the Hungarian law. (2 credits)

Research Methodology

**BMEGT41A002-ER01**

The undergraduate course offers a basic introduction to long-standing issues concerning scientific knowledge and methodology. It examines case studies taken from realistic scenarios and surveys a variety of topics from the standard philosophy of science. The course discusses issues from the point of view of empirical research in various fields as well as from the point of view of epistemology and philosophy. The topics covered give an introduction to core concepts and connect recent contributions that explore contemporary approaches (e.g. recent advances in the philosophy of measurement and modelling). Apart from familiarizing the student with the established theories and key concepts in philosophy of science and methodology, the course also examines the mechanisms that underlie scientific creativity and discusses the ethical responsibilities of scientists and engineers. (2 credits)

**Autumn semester only**

**Comparative country studies**

**BMEGT43A141 (BSC/BA)**

The main focus of the course is culture, what kind of effect it has on civilizations, societies and economies of past and present. There will be three major topics, such as “food & traditions; water, energy & scarcity of resources; people, environment & cities”, which represent the most challenging areas of development in the 21st century. Under these umbrella topics, we attempt to explore and compare the culture and life of many continents and regions of the world. (5 credits)

**Spring semester only**

**Sociology for Architects**

**BMEGT43A044 (BSC/BA)**

*Important note: for Architects and Civil Engineers only*

The course will be presented for foreign students of the Faculty of Architecture. The aim of the course is to analyse the social context of urban development and the social implications of spatial problems. We will treat the main problems of urban sociology: e.g. architecture of cities, traffic, congestion, experience of urban life, the behaviour of inhabitants, housing, planning of cities, etc., Urban sociology examines the social aspects of urban life: planning improvement of life in cities, urban forms and structures, histories of urban growth, biological or ecological basis of urban behaviour, quality of the urban experience, etc.,

We will analyse the anonymity, unpredictability and uncertainty of events, senses of possibility and danger induced by cities. Some of the main questions are: How is urban life affected by the features of local social structure? How do informal social bonds develop? How can the history of urbanisation be explained? What are the basic features of the spatial structure of cities?

During this semester we will analyse how the interacting mechanisms of capitalism and modernity constitute differential urban experiences. We provide a brief history of urban sociology, mostly focusing on the results of the Chicago Schools, while also exploring other economic and sociological theories of urban development and declination. It is important to study processes which produce inequalities within cities, e.g.: gentrification, suburbanisation, and household division.

We should like to focus directly on the city and modernity. We consider Georg Simmel and Louis Wirth classic works as dealing with a “generic” urban culture. The urban ways of life could be contrasted with the rural ways of life. We state (after Walter Benjamin) that no account of urban culture is adequate unless it takes seriously personal, unique experiences of urban life, in the context of broader cultural forces.

Finally, we analyse urban politics, changing political agendas, local economic policy, urban protest, urban planning, etc. (2 credits)
English language course offer for Erasmus+ mobility program

MSc/MA courses

Marketing

BMEGT20A048

Learning outcomes: After completing the course, the students will be able to understand the role of marketing in an organization. Students will become familiar with marketing tasks, tools and strategies. Through practical work students will be able to elaborate certain marketing topics using the knowledge acquired during lectures.


Autumn semester only

Introduction to Cultural Studies

BMEGT43M410

Cultural research developed at the intersection of a number of different disciplines and theoretical traditions through history. The objective of the course is to introduce these theoretical, conceptual roots and some of the current approaches through the discussion of current cultural phenomena. Following the schedule of the class, first we will discuss the notion of culture and its place in the academic discourse. After the introduction we will look into some of the most prevalent and important contemporary cultural issues, interpreting them with the help of research articles and other readings. (3 credits)

Management

BMEGT20MW02

The course focuses on management theories and principles. It covers a wide range of theories and applications dealing with such topics as decision making theories and methods, motivation, leadership, organizational culture and organizational structures. The goal of this course is to help students develop a conceptual understanding of theories in management, organizational life and to provide a special set of skills for decision making competences. (5 credits)

Quantitative Methods

BMEGT20M011

The main objective of the course is to get students acquainted with the basic mathematical and statistical tools and methods widely applied in business practice. The focus is on the practical applications of them. The primary goal is to familiarize students with the essential tools and to enable them to apply them individually both in their studies and during their later work. The three main chapters of the course are probability theory, descriptive and inductive statistics. During the semester we deal with different probability distributions and with decision theory as well. At the end of the course the basics of decision theory are introduced and discussed. (5 credits)

Production and Operations Management

BMEGT20M013

The aim of the course is to introduce the basic characteristics of production and service processes, as well as the most important methods necessary for the planning and the efficient realization of tasks in production and service systems. Students learn the methods and issues of such important tasks as demand forecasting, capacity analysis, inventory control and aggregate production planning. Besides the theoretical background, the course provides case studies to emphasize the practical issues as well. The objective of the course is to show, that quantitative information related to production and operation systems can help to determine the optimal operation of the system, and the analysis of deviation from optimal operations may provide insight to operation improvements. (5 credits)

Spring semester only

Quality Management

BMEGT20MN03

The primary goal is to acquaint students with the current issues and methods of quality improvement. Students are given an overall picture of quality philosophies applied in both productive and non-productive industries, the basics of quality management related standards, total quality management and of the various soft and hard methods of quality management. (5 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 the creation, operation, analysis and control of transportation-related processes.
- **Vehicle Engineering BSc** – students will acquire knowledge on the construction, manufacturing and handling of transportation vehicles and materials.
- **Logistics Engineering BSc** – the programme offers insights and knowledge in corporate logistics systems and supply chains, building a complex analytical 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
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 Kandó 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

<table>
<thead>
<tr>
<th>Subject</th>
<th>Code</th>
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## Curriculum of MSc in Vehicle Engineering

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<th>Subject</th>
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<td>Programming in C and Matlab</td>
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<td>Railway vehicle system dynamics</td>
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<td>Requirements for superstructure designers</td>
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<td>BMEKOALM332</td>
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<td>Planning of plant logistics systems</td>
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<td>BMEKOALM327</td>
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<td>ALM331 ALM335</td>
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<td>Planning of warehousing systems</td>
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<td>BMEKOALM323</td>
<td>2/2/0/v/5</td>
<td>ALM331 ALM335</td>
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<td>Production planning &amp; scheduling</td>
<td>Production planning &amp; scheduling</td>
<td>BMEKOALM329</td>
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<td>Trade, Financial, Accounting Techniques</td>
<td>Trade, Financial, Accounting Techniques</td>
<td>BMEKOKKM138</td>
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<td>0/3/0/0/30</td>
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</tr>
</tbody>
</table>
Description of M.Sc. Subjects
Master Section in Autonomous Vehicle Control Engineering

Control theory and system dynamics

Dr. József Bokor

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

Dr. Tamás Béczi

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

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 Engineers MSc tematics, the target of the subject is to build up the students, who do not have vehicle engineer BSc. By the end of the subject the students are able to recognize the important parts and systems of road vehicles, they know their function and operation.

Vehicle testing and validation

Dr. Bálint Szabó

Introduction into the modern instrumental vehicle measurements. Acquaintment of the usage of instruments, testing methods, and application of vehicle testing processes. In the Autonomous Vehicle Control Engineers 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

Dr. Gábor Tevesz

Insight is given of the computer system architectures, high performance microcontroller architectures and their building blocks. Conventional architectures are analyzed then special architectures (ARM, DSP, network and graphic processors, GPU) 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

Dr. József Rohács


Programming in C and Matlab

Dr. Tamás Béczi

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

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 vehicle dynamics 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 programming 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

**BMEVIIUAUC07**

*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, 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.

Vehicle operation

**BMEKOGGM174**

*Dr. Tamás Szirányi*


Localization and mapping

**BMEEOFTMKO1**

*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 reconfiguring and fault-tolerating 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 catch up the students, who do not have ve-
Artificial Intelligence

Dr. Béla József Pataki
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; methods and problems of practical implementations.

Design and Integration of Embedded Systems

Dr. István Majzik
This subject first presents the following topics: 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. The subject also covers the specific design methodologies 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. 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.

Software Development Methods and Paradigms

Dr. László Lengyel
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.

Signal Processing Fundamentals

Dr. János Levendovszky
The course is concerned with laying down the foundations of signal processing with special emphasis of the representation of signals in different domains. The adaptive part help

Automotive network and communication systems

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

Dr. Péter Gáspár
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

Dr. Péter Gáspár / Dr. Zsolt Szalay
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.

Dr. Péter Gáspár / Dr. Zsolt Szalay

Traffic modelling, simulation and control

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 Szirányi

Machine vision is one of the most important measures 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

<table>
<thead>
<tr>
<th>Subject</th>
<th>Code</th>
<th>Instructor</th>
<th>Credits</th>
<th>Description</th>
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<tr>
<td><strong>Advanced Driver Assistance Systems</strong></td>
<td>BMEKOGGM657</td>
<td>Dr. Zsolt Szalay</td>
<td>(4 credits)</td>
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<tr>
<td><strong>Advanced materials and technologies</strong></td>
<td>BMEKOGGM601</td>
<td>Dr. Krisztián Bán</td>
<td>(5 credits)</td>
<td></td>
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<tr>
<td><strong>Aircraft design and production I.</strong></td>
<td>BMEKOVRM629</td>
<td>Dr. Dániel Rohács</td>
<td>(4 credits)</td>
<td>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.</td>
</tr>
<tr>
<td><strong>Environment Sensing in the Vehicle Industry</strong></td>
<td>BMEKOKAM656</td>
<td>Dr. Tamás Bécsi</td>
<td>(4 credits)</td>
<td>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.</td>
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<tr>
<td><strong>Instrumental tests for motor vehicles, measurement technology</strong></td>
<td>BMEKOGGM668</td>
<td>Dr. Bálint Szabó</td>
<td>(4 credits)</td>
<td>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 measurements will be carried out during the course. Alongside the development related test, the latest diagnostic measurement methods will be introduced as well.</td>
</tr>
<tr>
<td><strong>Machine Intelligence</strong></td>
<td>BMEKOALM644</td>
<td>Dr. Tamás Szirányi</td>
<td>(4 credits)</td>
<td>This subject teaches the students basics of machine intelligence in order to understand and be capable to apply them.</td>
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<tr>
<td><strong>Measurement techniques and signal processing in vehicles</strong></td>
<td>BMEKOKAM635</td>
<td>Dr. Alexandros Soumelidis</td>
<td>(8 credits)</td>
<td>Provides knowledge about the instrumental measurement and evaluation of the vehicle parameters. Furthermore introducing sensing and measurement principles, signal processing, traffic measurement. Theory of sensor fusion, sensor networks of the vehicle dynamics measurement. State estimation, parameter estimation, Kalman-filter. Applications in vehicle control systems.</td>
</tr>
<tr>
<td><strong>Mechanics of superstructure materials</strong></td>
<td>BMEKOJSM663</td>
<td>Dr. Péter Béda</td>
<td>(4 credits)</td>
<td>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.</td>
</tr>
</tbody>
</table>
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 equipment, 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
BMEKOOGGM648
Dr. Krisztián Bán
(4 credits)

Programming in C and Matlab
BMEKOAKAM603
Dr. Tamás Bécsi
The course aims the introduction to programming in C and Matlab languages. (4 credits)

Railway vehicle system dynamics
BMEKOVRM608
Dr. Zoltán Záboori

Requirements for superstructure designers
BMEKOSJM662
Dr. Péter Béda

Road safety, legislative environment, human factors
BMEKOOGGM653
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
BMEKOOGGM647
Dr. Tamás Markovits

Suspension design
BMEKOOGJM613
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 part 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 part. 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 to the students. Topics are: deterministic and probabilistic damaged stability methods, grounding, docking, stability of floating cranes, split barges. (3 credits)
<table>
<thead>
<tr>
<th>Course Title</th>
<th>Code</th>
<th>Instructor</th>
<th>Description</th>
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</thead>
<tbody>
<tr>
<td>Accident analysis I., forensic processes</td>
<td>BMEKOGGM654</td>
<td>Dr. Gábor Melegh</td>
<td>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, ascertaining 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)</td>
</tr>
<tr>
<td>Aircraft analysis I.</td>
<td>BMEKOVRM631</td>
<td>Dr. Károly Beneda</td>
<td>The aim of the course is to introduce the analysis techniques of aircraft and powerplants. (4 credits)</td>
</tr>
<tr>
<td>Aircraft design and production II.</td>
<td>BMEKOVRM630</td>
<td>Dr. Balázs Gáti</td>
<td>Aircraft Design II. (4 credits)</td>
</tr>
<tr>
<td>Computational fluid- and thermodynamics</td>
<td>BMEKOVRM606</td>
<td>Dr. Árpád Veress</td>
<td>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)</td>
</tr>
<tr>
<td>Construction of vehicle manufacturing systems I.</td>
<td>BMEKOGGM649</td>
<td>Dr. Tamás Markovits</td>
<td>(4 credits)</td>
</tr>
<tr>
<td>Design methods of drive systems</td>
<td>BMEKOALM646</td>
<td>Dr. Gábor Bohács</td>
<td>Design and norming of material handling machines. Capacity and power requirement calculation for machine of bulk materials. Design of material handling machines for unit loads, especially forklifts and cranes. (5 credits)</td>
</tr>
<tr>
<td>Design of material handling machine design</td>
<td>BMEKOKAM627</td>
<td>Dr. Gábor Bohács</td>
<td>The course aims at introduction of the specialities pleasure craft design. (4 credits)</td>
</tr>
<tr>
<td>Diesel and electric traction</td>
<td>BMEKOVRM610</td>
<td>Dr. András Szabó</td>
<td>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, electromechanical, 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)</td>
</tr>
<tr>
<td>Discrete Control Design</td>
<td>BMEKOKAM658</td>
<td>Dr. Péter Gáspár</td>
<td>The course aims the presentation of discrete control theory. Besides the theoretical and mathematical design aspects, implementation issues are also discussed. (4 credits)</td>
</tr>
</tbody>
</table>
| Dynamics of vehicle, active- and passive safety                            | BMEKOGJM641   | 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 mechanical 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 transverse vehicle dynamics, methods for controlling vehicle dynamics. 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 reconstruction of an accident. (4 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)

Engine design I.

**BMEKOOGGM670**

*Dr. Huba Németh*


Fixing and sealing

**BMEKOOGGM650**

*Dr. Krisztiján Bán*

(4 credits)

Machines of construction material production

**BMEKOALM672**

*Dr. Gábor Bohács*

Computer aided construction of crushing machines. Motion 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 operating principles of robots. Numeral systems CPU arithmetics, operations and algorithms with binary numbers. CPU architectures, tasks and operation. Computer networks: protocols, devices for wired and wireless communication. (4 credits)

Ship motions

**BMEKOVRM624**

*Dr. Gyöző Simongáti*

The course aims to introduce students to the dynamics and transient phenomena of ship motions, and their dynamics of equipments which may effect on ship motions. (4 credits)

Structural vibrations

**BMEKOJSM665**

*Dr. Péter Béda*


Structure analysis

**BMEKOJSM609**

*Dr. Péter Béda*

Theory and practice of the finite element method. Linear, elastic and plastic material modeling. Mechanical and thermal analysis. Eigenfrequencies and vibrations. Topological structure optimisation. Study and verification of the optimized 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

**BMEKOVRM129**

*Dr. István Zobory*

Traction mechanics  
**BMEKOVRM619**  
Dr. István Zobory  
Factors of train motion. Ttractive effort, braking force, track force. The ttractive 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. Determining 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 reconfigurating and fault-tolerant 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; confinement the circle of questions answerable by available parameters and data in a concrete case. Interpretation of probabilistic ascertainment. 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 Szabó  
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 systems. 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 Bécső

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

BMEKOGGM652

Dr. Pál Bánlaki

Basic concepts of measurement methods, measurement errors, random errors, measuring tools and measurement systems. Typical measurement tasks and assets: shape measurement error, position error measurements, surface-based characteristics, coordinate measurements. Automatic size control. Surface digitization. Process measurement technology. Measuring instruments calibration, validation. Statistical process control (SPC). Measuring device management. (5 credits)

Mechatronic design of vehicle systems

BMEKOGGM622

Dr. Zsolt Szalay


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**

**BMEKOJGJM640**

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 coast. 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**

**BMEKOVJM638**

Dr. Vilmos Zoller


**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

### Description of M.Sc. Subjects

#### Master Section in Transportation Engineering

<table>
<thead>
<tr>
<th>Subject</th>
<th>Code</th>
<th>Instructor</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control theory</td>
<td>BMEKOKAM142</td>
<td>Dr. József Bokor</td>
<td>The course provides deepening of knowledge in control theory. Provides theoretical knowledge, and discusses modern tools, which are necessary for later engineering practice. This is introduced through different examples, taken from vehicle and transportation systems. (3 credits)</td>
</tr>
<tr>
<td>Decision making methods</td>
<td>BMKOKKM221</td>
<td>Dr. Zoltán Békefi</td>
<td>Introduction of the most important methods of operations research and their applications in the transport sector. (5 credits)</td>
</tr>
<tr>
<td>Intelligent transport systems</td>
<td>BMEKOKUM205</td>
<td>Dr. János Tóth</td>
<td>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)</td>
</tr>
<tr>
<td>Mathematics MK</td>
<td>BMETE90MX59</td>
<td>Dr. Sági Gábor</td>
<td>(4 credits)</td>
</tr>
<tr>
<td>Road Safety</td>
<td>BMKOKKM222</td>
<td>Dr. János Juhász</td>
<td>Indicators of Traffic Safety. Evaluation of PIN in EU and in Hungary. Attributes of the traffic elements (human, infrastructure, vehicles), their influences to traffic safety. Pedestrians and cyclists behaviours. Driver’s training. Self explaining roads. Passive and active vehicle safety systems. (3 credits)</td>
</tr>
<tr>
<td>Transport automation</td>
<td>BMEKOKAM202</td>
<td>Dr. Balázs Sághi</td>
<td>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)</td>
</tr>
<tr>
<td>Transport Economics</td>
<td>BMEKOKGM201</td>
<td>Dr. Ferenc Mészáros</td>
<td>Analysis of EU transport strategies in different modes. Monetarising and internalising of transport externalities. (4 credits)</td>
</tr>
<tr>
<td>Air Traffic Management (ATM)</td>
<td>BMKOVRM224</td>
<td>Dr. Dániel Rohács</td>
<td>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)</td>
</tr>
<tr>
<td>Communications, Navigation and Surveillance (CNS) I.</td>
<td>BMKOKAM226</td>
<td>Dr. Dóra Meyer</td>
<td>The aim of the subject is to prove deeper knowlegde 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)</td>
</tr>
<tr>
<td>Controlling systems in transportation</td>
<td>BMEKOKGM215</td>
<td>Dr. Ferenc Mészáros</td>
<td>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)</td>
</tr>
<tr>
<td>Electronics – electronic measurement systems</td>
<td>BMEKOKAM103</td>
<td>Dr. Géza Szabó</td>
<td>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)</td>
</tr>
<tr>
<td>Forwarding Management 1</td>
<td>BMEKOKKM132</td>
<td>Dr. Ferenc Mészáros</td>
<td>History and attitudes 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)</td>
</tr>
</tbody>
</table>
### I+C technologies

**BMEKOKAM104**  
**Dr. Tamás Bécsi**  
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

**BMEKOKAM232**  
**Dr. Géza Szabó**  
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 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 phenomena 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

**BMEKOKKM227**  
**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

**BMEKOKKM223**  
**Dr. Csaba Csicsár**  
The subject is based on Transport information systems I. and II. Main topics: modelling of con-concepts, relations and regularities in information systems and applying of these models in trans-portation. 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

**BMEKOKKM228**  
**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

**BMEKOKKM229**  
**Dr. János Tóth**  

### Transport operation

**BMEKOKUM206**  
**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
BMKOVRM237
Dr. Dániel Rohács
The students have to participate in one of the R+D projects of the faculty. (3 credits)

City logistics
BMEOALM244
Dr. Bóna Krisztíán
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.
BMOKKM239
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
BMOKAM234
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
BMOKKM230
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 charges. 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
BMOKKM236
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
BMOKKM133
Dr. Ferenc Mészáros
Mode specific knowledge of freight forwarding management (road, rail, aviation, inland waterway and maritime, combined and LTL transport). (5 credits)

Forwarding marketing
BMOKKM135
Dr. Botond Kővári
Marketing concepts, overview of resources. Market analysis methods. Product mix reviews. Advertising strategies. (4 credits)

Human resource management in transportation
BMOKKM238
Dr. Botond Kővári
Applied human resource challenges, especially in transportation. Motivation, teamwork, carrier planning. (3 credits)

Management of transport and logistic services
BMOKGM217
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
BMOKUM208
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
BMOKAM242
Dr. Balázs Sághi
Project work (3 credits)
Projectmanagement in transportation
BMEKOKKM241
Zoltán Nagy
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)

Safety in air traffic control
BMEKOKAM243
Dr. Dóra Meyer
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)

Signal processing in transport
BMEKOKAM211
Dr. József Bokor
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)

Supply and distribution processes
BMEKOALM240
Dr. Gábor Kovács
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)

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)

Traffic flow
BMEKOKUM204
Miklós Kózel
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)
### Description of M.Sc. Subjects

#### Master Section in Logistic Engineering

**Control theory**

- **BMEEKAM122**  
  *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**

- **BMEOALM322**  
  *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**

- **BMEEKKM330**  
  *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 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**

- **BMEOALM321**  
  *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, webservices, interfaces, Enterprise Service Bus, Orchestration, ERP webservices, workbench, dictionary, business warehouse, reporting, BI systems. Transactional database. (5 credits)

**Mathematics ML**

- **BMET90MX60**  
  *Dr. Gábor Sági*  
  (5 credits)

**Planning of extra-logistics networks**

- **BMEOALM337**  
  *Dr. Krisztián Bóna*  

**Algorithm Design**

- **BMEOALM326**  
  *Dr. Tamás Bécsi*  
  The course aims the introduction of algorithm theory and numerical complexity. (5 credits)

**Automation of logistics systems**

- **BMEOALM325**  
  *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**

- **BMEOALM328**  
  *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.**

- **BMEOALM339**  
  *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 students. 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**

- **BMEEKKM132**  
  *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 (IEPC, 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 Bóna
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 optimization models. Analytical queueing theory and simulation 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 Bóna
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 Bóna
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 role 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 CESAER (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)

Introductory 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)

Introductory 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 duality; 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
Excursions - Hortobágy
Excursions - Sopron
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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We offer undergraduate & PhD courses in:

- Architecture Engineering
- Architecture (DLA program)
- Business and Management
- Chemistry
- Chemical- Bio- and Environmental Engineering
- Civil Engineering Sciences and Earth Sciences
- Computer Engineer
- Electrical Engineering
- Mathematics and Computer Science
- Physical Sciences
- Mechanical Engineering Science
- Autonomous Vehicle Control Engineering
- Transportation Engineering
- Vehicle Engineering
- Logistics Engineering

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