University of Debrecen
Faculty of Engineering

# Mechatronics Engineering BSc Program

2024

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# DEAN'S WELCOME

Welcome to UD's Faculty of Engineering!

The Faculty of Engineering of the University of Debrecen has become an outstanding centre of education and research in the Eastern Hungarian region. Following the footsteps of our predecessors, the academic and administrative staff of the Faculty work hand in hand to make our training programmes and researches meet both national and international standards.

The Faculty of Engineering is one of Hungary's most significant institutions of higher-education, and its 3000 students make it a dominant faculty of the University of Debrecen which - having the most international students, offering the most academic programmes among Hungarian universities and having been classified as a research university, the highest of qualifications - is officially listed among the best universities in the country.

We welcome the most outstanding and inquisitive students of the region with an enthusiastic and professional team of academics and researchers, and a set of laboratories unique in the country. We consciously aspire to develop the quality of education and research further, based on a close cooperation between the Faculty and the industry. Our students enter many prestigious competitions and they are becoming increasingly successful and acclaimed, while our instructors are working on a growing number of national and international projects of basic and applied research.

The Faculty bridges the gap between theory and practice and provides a high-quality theoretical background merged into practice-oriented training based on industrial relations. We do our best to maintain the high prestige of the engineering diplomas awarded by the University of Debrecen and to make sure that the knowledge and achievements of students who graduate from our Faculty continue to be recognised in the labour market.

All things considered, you are kindly advised to read this bulletin which hopefully reflects our endeavours appropriately and provides all the information you need to know about your chosen training programme. We are looking forward to supporting the personal and professional growth of our future engineers.

With the best of wishes for the years to come,

Géza Husi

Dean

## HISTORY OF THE UNIVERSITY

The history of Debrecen's higher education dates back to the 16th century. The Calvinist Reformed College, established in 1538, played a central role in education, teaching in the native language and spreading Hungarian culture in the region as well as in the whole country. The College was a sound base for the Hungarian Royal University, founded in 1912. Apart from the three academic faculties (arts, law, theology) a new faculty, the Faculty of Medicine was established, and the University soon became one of the regional citadels of Hungarian higher education. Today, University of Debrecen is classified as "University of National Excellence" and offers the highest number of academic programs in the country, therefore it is considered to be one of the best universities in Hungary. Its reputation is the result of its quality training, research activities and the numerous training programs in different fields of science and engineering in English. With 14 faculties and a student body of almost 30.000, out of which about 3700 are international students, the University of Debrecen is one of the largest higher education institutions in Hungary.

The history of the Faculty of Engineering dates back to 1965, when the Technical College was established. In 1972 it was renamed Ybl Miklós Polytechnic and in 1995 it became part of Kossuth Lajos University. In 2000 the Faculty of Engineering became part of the integrated University of Debrecen.

In 2005 the Bologna System was introduced which supports the competitiveness of qualifications received at the University of Debrecen against universities all over Europe.

The Faculty of Engineering is practice-oriented and develops skills required for the current needs of the national and international labour market. The teaching staff is involved in numerous domestic and international research and design projects. The recently-opened new building wing with its ultra-modern design hosts several lecture halls, seminar rooms and laboratories equipped with the latest technology. Our students are provided with practical knowledge, training and field practice from numerous prestigious domestic and multi-national industry partners. The internship periods are excellent opportunities for students to experience how theory is put into practice at the most renowned industry representatives and become more successful in the labour market of this highly competitive sector. Students learn how to work in the working environment of multi-national companies and adapt to challenges easily. After graduation they will be able to work at a strategic decision-making level, giving priority to efficiency and engineering ethics.

The Faculty of Engineering offers a great variety of BSc, MSc courses and post-graduate training courses tailored to the needs of the rapidly changing world of engineering and focusing on European and international trends. In 2011 the Faculty of Engineering launched engineering trainings in English. In order to optimize the quality of training, the Faculty continuously strives to expand the number of industrial and educational partners at home and abroad.

The Faculty of Engineering has been a pioneer in the introduction of Quality Management System at faculty level to measure and evaluate the efficiency of its education and teaching staff in order to improve the quality of education and training from the feedback received.

The Faculty of Engineering has a vivid student life. There is a film club waiting for movie buffs and the door of the Faculty library is always open. The library is not only the host to the latest technical books, exhibitions and tea afternoons with invited speakers, but students can also purchase theatre and concert tickets from the librarians. The Borsos József Dormitory is also a hub of activities for students.

The increasing number of international students brings cultural and ethnic diversity to the faculty.

Our aim is to aid students to become efficient members of the labour market and enrich the world of engineering in Hungary and abroad with their knowledge and expertise.

## ADMINISTRATION UNITS FOR INTERNATIONAL PROGRAMMES

### COORDINATING CENTER FOR INTERNATIONAL EDUCATION

98, Nagyerdei körút, Debrecen 4032
Telephone: +36-52-512-900/62796
E-mail: info@edu.unideb.hu

| | |
|---|---|
| Program Director (Non-Medical Programmes) | László Kozma PhD |
| Admission Officer (for fee paying students) | Ms. Ibolya Kun<br>Mr. Norbert Tanki |
| Admission Officer (for scholarship students) | Ms. Lilla Almási-Fónai<br>Ms. Annamária Rácz |
| Administrative Assistant<br>(for fee paying students) | Ádám Losonczi<br>Norbert Balogh |
| Administrative Assistant<br>(for scholarship students) | Ms. Nóra Dede-Kiss |

The Coordinating Centre for International Education supports the international degree programmes of the University of Debrecen in giving new students information on admission and entrance exam. It has tasks in promoting and is in charge of tasks like enrolment, study contracts, modifying student status or degree programme, activating student status, modifying students' personal data, requesting and updating student cards, providing certificates for the Immigration Office (for residence permit), issuing student status letters and certificates on credit recognition, concluding health insurance contract and providing Health Insurance Card, helping students with visa process application.

## INTERNATIONAL OFFICE AT THE FACULTY OF ENGINEERING

2-4, Ótemető utca, Debrecen H-4028

Telephone: +36-52-415-155/78709

| | |
|---|---|
| Head of International Office<br>room 122 | Zsolt Tiba PhD habil.<br>tiba@eng.unideb.hu |
| International Relations Officer<br>room 123 | Márton Lévai<br>levai.marton@eng.unideb.hu |
| International Relations Officer<br>room 123 | Ms. Zsuzsa Flóra Péter<br>peter.zsuzsa.flora@eng.unideb.hu |
| International Relations Officer<br>room 124 | Ms. Zita Popovicsné Szilágyi<br>szilagyizita@eng.unideb.hu |


The International Office has been functioning since 2014 in order to ensure the smooth running of the international degree courses. The office is responsible for student administration (full-time students, full-time transfer students, visiting/Erasmus students), providing certificates for students, considering and accepting requests, solving problems related to course registration, giving information about internship, final exam, thesis, etc.

## DEAN'S OFFICE

Faculty of Engineering

2-4, Ótemető utca, Debrecen H-4028

| | |
|---|---|
| Dean: | Géza Husi PhD, habil., Full Professor |
| E-mail: | husigeza@eng.unideb.hu |
| Vice-Dean for Educational Affairs: | Ms. Judit T. Kiss PhD, Associate Professor |
| E-mail: | tkiss@eng.unideb.hu |
| Vice-Dean for Scientific Affairs: | Imre Kocsis PhD habil., Full Professor |
| E-mail: | kocsisi@eng.unideb.hu |
| Head of Directory Office: | Mr. Szabolcs Kovács |
| E-mail: | kovacs.szabolcs@unideb.hu |

## DEPARTMENTS OF FACULTY OF ENGINEERING

Department of Air- and Road Vehicles
Department of Architecture
Department of Basic Technical Studies
Department of Building Services and Building Engineering
Department of Civil Engineering
Department of Engineering Management and Enterprise
Department of Environmental Engineering
Department of Mechanical Engineering
Department of Mechatronics
Off-Site Department of Aviation Engineering

## DEPARTMENT OF ARCHITECTURE

2-4, Ótemető utca, Debrecen, H-4028, room 409, Tel: +36-52-512-900 / 78704

| name, position | e-mail, room number |
|---|---|
| Tamás Szentirmai DLA, Associate Professor, Head of Department | szentirmai@eng.unideb.hu<br>room 409 |
| Mrs. Réka Aradi, Master Instructor | reka0416@gmail.com<br>room 409 |
| Ms. Edit Huszthy DLA, Associate Professor | huszthyedit@gmail.com<br>room 409 |
| Péter Kovács DLA, Associate Professor | kovacspeterdla@gmail.com<br>room 409 |
| Ferenc Keller DLA, Master Instructor | keller.ferenc@eng.unideb.hu<br>room 409 |
| Miklós János Boros DLA, Senior Lecturer | borosmj@gmail.com<br>room 409 |

| | |
|---|---|
| Ferenc Kállay, Master Instructor | kallay.ferenc@eng.unideb.hu<br>room 409 |
| Péter Müllner, Senior Lecturer | mullner.peter@eng.unideb.hu<br>room 409 |
| Zoltán Major, Senior Lecturer | m.zoltan@eng.unideb.hu<br>room 409 |
| Ms Dóra Szuzsik, Senior Lecturer | szuszik.dora@eng.unideb.hu<br>room 409 |
| János Vági, Associate Professor | vagi.janos@eng.unideb.hu<br>room 409 |
| Dénes Nagy, Departmental Engineer | nagy.denes@eng.unideb.hu<br>room 409 |
| Ms. Bettina Lékó, Administrative Assistant | leko.bettina@eng.unideb.hu<br>room 409 |

## DEPARTMENT OF BASIC TECHNICAL STUDIES

2-4 Ótemető utca, Debrecen, H-4028, ground floor 6, Tel: +36-52-512-900 / 77735

| name, position | e-mail address, room number |
|---|---|
| Imre Kocsis PhD habil, Full Professor, Head of Department | kocsisi@eng.unideb.hu<br>ground floor 2 |
| Gusztáv Áron Szíki PhD, College Professor | szikig@eng.unideb.hu<br>ground floor 7 |
| Balázs Kulcsár PhD, Associate Professor | kulcsarb@eng.unideb.hu<br>ground floor 4 |
| Ms. Rita Nagyné Kondor PhD habil, Associate Professor | rita@eng.unideb.hu<br>ground floor 7 |

| | |
|---|---|
| Csaba Gábor Kézi PhD, Associate Professor | kezicsaba@science.unideb.hu<br>ground floor 6 |
| Ms. Adrienn Varga PhD, Associate Professor | vargaa@eng.unideb.hu<br>ground floor 5 |
| Ms. Gyöngyi Bodzásné Szanyi PhD, Senior Lecturer | szanyi.gyongyi@science.unideb.hu<br>ground floor 6 |
| Ms. Boglárka Burján-Mosoni, Senior Lecturer | burjan-mosoni.boglarka@eng.unideb.hu<br>ground floor 3/B |
| Ms. Ildikó Papp PhD, Senior Lecturer | papp.ildiko@inf.unideb.hu<br>ground floor 3/B |
| Ms. Éva Csernusné Ádámkó PhD, Senior Lecturer | adamko.eva@eng.unideb.hu<br>ground floor 7 |
| Ms. Erika Perge PhD, Senior Lecturer | perge@eng.unideb.hu<br>ground floor 6 |

| | |
|---|---|
| Ms. Dóra Sipos, Assistant Lecturer | dorasipos@eng.unideb.hu<br>ground floor 3/B |
| Attila Szántó, Assistant Lecturer | szanto.attila@eng.unideb.hu<br>ground floor 7 |
| Ms. Nóra Tóth, Administrative Assistant | tothnora@eng.unideb.hu<br>Room 121. |

## DEPARTMENT OF BUILDING SERVICES AND BUILDING ENGINEERING

Ótemető utca 2-4., Debrecen, H-4028, room 121, Tel: +36-52-512-900 / 77770

| name, position | e-mail, room number |
|---|---|
| Ákos Lakatos PhD, habil., DSc, Full Professor<br>Head of Department | alakatos@eng.unideb.hu<br>room 302/a |
| Imre Csáky PhD, Associate Professor, Deputy Head of Department | imrecsaky@eng.unideb.hu<br>room 302/c |
| Ferenc Kalmár PhD, habil., DSc, Full Professor | fkalmar@eng.unideb.hu<br>room 121/324.7 |
| Ms. Tünde Klára Kalmár PhD, Associate Professor | kalmar_tk@eng.unideb.hu<br>room 324/5 |
| Zoltán Verbai PhD, Senior Lecturer | verbai@eng.unideb.hu<br>room 324/4 |
| Ferenc Szodrai PhD, Associate Professor | szodrai@eng.unideb.hu<br>room 324/8 |
| Béla Bodó, Master Instructor | bela.bodo@eng.unideb.hu<br>room 324/4 |
| Sándor Hámori, Master Instructor | sandor.hamori@eng.unideb.hu<br>room 324/8 |
| Gábor L. Szabó PhD, Associate Professor | l.szabo.gabor@eng.unideb.hu<br>room 324/2 |

| | |
|---|---|
| Attila Kostyák, Assistant Lecturer | kostyak.attila@eng.unideb.hu<br>room 324/3 |
| Szabolcs Szekeres, Assistant Lecturer | szekeres@eng.unideb.hu<br>room 324/2 |
| Ferenc Kostyák, Master Instructor, part-time | kostyak.ferenc@eng.unideb.hu<br>room 324/3 |
| Máté Csontos, Departmental Engineer | csontos.mate@eng.unideb.hu<br>room 324/3 |
| Ms. Krisztina Bereczki Administrative Assistant | bkriszti@eng.unideb.hu<br>room 302/b |

## DEPARTMENT OF CIVIL ENGINEERING

2-4 Ótemető utca, Debrecen, H-4028, room 209, Tel: +36-52-512-900 / 78701

| name, position | e-mail, room number |
|---|---|
| Imre Kovács PhD, College Professor, Head of Department | dr.kovacs.imre@eng.unideb.hu<br>room 212/e |
| György Csomós PhD, University Professor | csomos@eng.unideb.hu<br>room 209/d |
| Ms. Kinga Nehme PhD, Associate Professor | knehme@eng.unideb.hu<br>room 209/a |
| Ms. Herta Czédli PhD, Associate Professor | herta.czedli@eng.unideb.hu<br>room 209/e |
| Ms. Gabriella Hancz PhD, Associate Professor | hgabi@eng.unideb.hu<br>room 209/a |
| László Radnay PhD, Associate Professor | laszlo.radnay@eng.unideb.hu<br>room 209/c |

| | |
|---|---|
| Zsolt Varga PhD, Associate Professor | vzs@eng.unideb.hu<br>room 119, Lab |
| Ms. Éva Lovra PhD, Senior Lecturer | lovra.eva@eng.unideb.hu<br>room 209/b |
| Zoltán Bereczki PhD, Senior Lecturer | bereczki.zoltan@eng.unideb.hu<br>room 209/b |
| Titusz Igaz, Assistant Lecturer | igaz.titusz@eng.unideb.hu<br>room 212/b |
| Ádám Ungvárai, Assistant Lecturer | ungvarai@eng.unideb.hu<br>room 212/a |
| János Bíró, Master Instructor | biroj@eng.unideb.hu<br>room 119, Lab |
| Miklós Juhász, Master Instructor | juhasz.miklos@eng.unideb.hu<br>room 212/c |
| Péter Lugosi, Master Instructor | lugosi.peter@eng.unideb.hu<br>room 209/e |
| Beáta Szakács, Master Instructor | beaszakacs@eng.unideb.hu<br>room 212/b |
| Attila Vámosi, Master Instructor | vamosi.attila@eng.unideb.hu<br>room 212/a |
| Zsolt Vadai, Master Instructor | vadai@eng.unideb.hu<br>room 209/e |
| József Kovács, Departmental Engineer | j.kovacs@eng.unideb.hu<br>room 209/b |
| Ms. Beáta Pataki, Lecturer | igaz.titusz@gmail.com<br>room 209/e |

| | |
|---|---|
| Ms., Mónika Tóthné Csákó, Administrative Assistant | csmoni@eng.unideb.hu<br>room 212 |

## DEPARTMENT OF ENGINEERING MANAGEMENT AND ENTERPRISE

2-4 Ótemető utca, Debrecen, H-4028, room 206, Tel: +36-52-512-900 / 77766

| name, position | e-mail, room number |
|---|---|
| Ms. Judit T. Kiss PhD, Associate Professor, Head of Department | tkiss@eng.unideb.hu<br>room 205/b |
| Ms. Edit Szűcs PhD habil, Full Professor | edit@eng.unideb.hu<br>room 206 |
| István Budai PhD, Associate Professor | budai.istvan@eng.unideb.hu<br>room 414 |
| Ms Viktória Mannheim PhD, Associate Professor | mannheim.viktoria@eng.unideb.hu<br>room 202/a |
| Ms. Andrea Emese Matkó PhD habil, Associate Professor | andim@eng.unideb.hu<br>room 202/b |
| Domician Máté PhD habil, Associate Professor | mate.domician@eng.unideb.hu<br>room 202/d |
| László Török PhD, Associate Professor | dr.torok.laszlo@eng.unideb.hu<br>room 202/d |
| Ms. Éva Diószeginé Zentay, Master Instructor | zentayevi@eng.unideb.hu<br>room 202/c |
| Ms. Tünde Jenei PhD, Master Instructor | jeneit@eng.unideb.hu<br>room 202/c |
| Ms. Anita Mikó-Kis, Master Instructor | drkisanita@eng.unideb.hu<br>room 202/b |

| | |
|---|---|
| Emil Varga, Master Instructor | emil@eng.unideb.hu<br>room 202/g |
| Zsolt Buri, Assistant Lecturer | Buri.zsolt@eng.unideb.hu<br>room 202/f |
| Lubna Owais, Assistant Lecturer | lubna owais@yahoo.com<br>room 202/g |
| Norbert Mátrai, Assistant Lecturer | matrai.norbert@eng.unideb.hu<br>room 202/e |
| Miklós Fazekas, Lecturer | miklos.fazekas.87@gmail.com<br>room 206 |
| Dániel Gácsi, Lecturer | gacsidaniel@gmail.com<br>room 202/a |
| Szabolcs Kiss PhD, Lecturer | szabolcs.kiss@eng.unideb.hu<br>room 202/a |
| Ms. Judit Bak<br>Administrative Assistant | bakjudit@eng.unideb.hu<br>room 204 |
| Ms. Tímea Török<br>Administrative Assistant | torok.timea@eng.unideb.hu<br>room 204 |

## DEPARTMENT OF ENVIRONMENTAL ENGINEERING

2-4 Ótemető utca, Debrecen, H-4028, room 312, Tel: +36-52-512-900 / 77827

| name, position | e-mail, room number |
|---|---|
| Dénes Kocsis PhD, Associate Professor, Head of Department | kocsis.denes@eng.unideb.hu<br>room 312 |
| Ms. Ildikó Bodnár PhD, College Professor | bodnari@eng.unideb.hu<br>room 309 |
| János Szendrei PhD, Associate Professor | szendrei.janos@eng.unideb.hu<br>room 313 |
| Gábor Bellér, Associate Professor | beller.gabor@eng.unideb.hu<br>room 313 |
| Ms. Alexandra Truzsi PhD, Senior Lecturer | truzsi.alexandra@eng.unideb.hu<br>room 313 |
| Ms. Andrea Izbékiné Szabolcsik, Assistant Lecturer | szabolcsikandi@eng.unideb.hu<br>room 310 |
| Dóra Beáta Buzetzky PhD, Senior Lecturer | dorabeata@eng.unideb.hu<br>room 310 |
| Lajos Gulyás PhD, College Professor, Lecturer | lgulyas@eng.unideb.hu<br>room 310 |
| Ms. Andrea Halászné Ercsei, Administrative Assistant | halaszneandi@eng.unideb.hu<br>room 312 |

## DEPARTMENT OF MECHANICAL ENGINEERING

2-4 Ótemető utca, Debrecen, H-4028, room 304, Tel: +36-52-512-900 / 77776

| name, position | e-mail, room number |
|---|---|
| Tamás Mankovits PhD, Associate Professor, Head of Department | tamas.mankovits@eng.unideb.hu<br>room 304 |
| Sándor Bodzás PhD, Associate Professor, Deputy Head of Department | bodzassandor@eng.unideb.hu<br>room 308 |
| Levente Czégé PhD, Associate Professor | czege.levente@eng.unideb.hu<br>room 307 |
| László Molnár PhD, Associate Professor | molnar.laszlo@eng.unideb.hu<br>room 301 |
| Sándor Pálinkás PhD, Associate College Professor | palinkassandor@eng.unideb.hu<br>room 308 |
| István Árpád PhD, Senior Lecturer | arpad.istvan@eng.unideb.hu<br>room 306 |
| Ms Szilvia Barkóczyné Gyöngyösi PhD, Senior Lecturer | szilvia.gyongyosi@eng.unideb.hu<br>room 308 |
| Krisztián Deák PhD, Senior Lecturer | deak.krisztian@eng.unideb.hu<br>room 305 |
| Sándor Czomba PhD, Senior Lecturer | sandor.czomba@eng.unideb.hu<br>room 307 |
| Dávid Huri PhD, Senior Lecturer | huri.david@eng.unideb.hu<br>room 305 |
| Dániel Nemes, Assistant Lecturer | nemes.daniel@eng.unideb.hu<br>room 324/6. |

| | |
|---|---|
| István Domokos, Assistant Lecturer | istvan.domokos@eng.unideb.hu<br>room 324/6. |
| Rashwan Al Kentar, Assistant Lecturer | rashwan.alkentar@eng.unideb.hu<br>room 301 |
| Gábor Balogh, Master Instructor | balogh.gabor@eng.unideb.hu<br>room 305 |
| Sándor Andráskó, Master Instructor | sandor.andrasko@eng.unideb.hu<br>room U.0.16 |
| Tibor Pálfi, Master Instructor | tibor.palfi@eng.unideb<br>room 301 |
| Márton Lévai, Engineer Instructor | levai@eng.unideb.hu<br>room U.0.16 |
| András Gábora, Department Engineer | andrasgabora@eng.unideb.hu<br>room U.0.16 |
| Zoltán Gergő Géresi, Department Engineer | zoltan.geresi@eng.unideb.hu<br>room U.0.16 |
| Gyula Somogyi, Department Engineer | gyula.somogyi@eng.unideb.hu<br>room 308 |
| Ms. Lilla Csonkáné Dóró, Administrative Assistant | lilla.csonkane@eng.unideb.hu<br>room 304 |

## DEPARTMENT OF MECHATRONICS

2-4 Ótemető utca, Debrecen, H-4028, room 120, Tel: +36-52-512-900 / 77742

| name, position | e-mail, room number |
|---|---|
| Prof. Géza Husi PhD Full professor, Dean, Head of Department | husigeza@eng.unideb.hu |
| Sándor Hajdu PhD, Associate Professor, Deputy Head of Department | hajdusandor@eng.unideb.hu<br>room 105 |
| Kornél Sarvajcz, Assistant Lecturer, PhD student | sarvajcz@eng.unideb.hu |
| Prof. Péter Korondi PhD, Full Professor | korondi.peter@eng.unideb.hu |
| István Balajti PhD, Associate Professor | balajti.istvan@eng.unideb.hu |
| Husam Abdulkareem Neamah Almusawi, PhD, Senior Lecturer | husam@eng.unideb.hu |
| Gyula Attila Darai, Department Engineer | darai@eng.unideb.hu |
| Gyula Korsoveczki, Assistant Lecturer, PhD student | korsoveczki.gyula@eng.unideb.hu<br>Robotics Laboratory |
| Róbert Mikuska, Department Engineer, PhD student | mikuska.robert@eng.unideb.hu |
| Dávid Péter Nusser, Department Engineer | nusser.david@eng.unideb.hu |
| Kornél Katona, Department Engineer, PhD student | katona.kornel@eng.unideb.hu |
| Mayar Abdullah Abdo Taleb, Department Engineer, PhD student | mayart@eng.unideb.hu |
| Károly Árpád Kis, Department Engineer | kis.karoly@eng.unideb.hu |
| Dániel Vígh, Department engineer | vigh.daniel@eng.unideb.hu |

| | |
|---|---|
| Péter Szilágyi, Department Engineer, PhD student | szilagyi.peter@eng.unideb.hu |
| László Keczán, Department Engineer, PhD student | keczan.laszlo@eng.unideb.hu |
| Zenan Guo, PhD student, Lecturer | guozenan@eng.unideb.hu |
| Aminu Babangida, PhD student, Lecturer | aminu.babangida@inf.unideb.hu |
| Gabriella Kövér, Administrative Assistant | kover.gabriella@eng.unideb.hu |

## DEPARTMENT OF VEHICLES ENGINEERING

2-4 Ótemető utca, Debrecen, H-4028, room 106, Tel: +36-52-512-900 / 77805

| name, position | e-mail, room number |
|---|---|
| József Menyhárt PhD, Associate Professor, Head of Department | jozsef.menyhart@eng.unideb.hu<br>room 105 |
| Zsolt Tiba PhD habil., College Professor | tiba@eng.unideb.hu<br>room 122 |
| Péter Tamás Szemes PhD, Associate Professor | szemespeter@eng.unideb.hu<br>room 105 |
| Timotei István Erdei, Assistant Lecturer, PhD student | timoteierdei@eng.unideb.hu<br>Robotics Laboratory |
| József Kertész, Assistant Lecturer, PhD student | kertesz.jozsef@eng.unideb.hu<br>room 105 |
| Sándor Apáti, Assistant Lecturer, PhD student | apati.sandor@eng.unideb.hu<br>room 105 |
| Masuk Abdullah, Department Engineer | masuk@eng.unideb.hu<br>room 105 |
| János Szilágyi, Department Engineer | janos.szilagyi@eng.unideb.hu |

| | |
|---|---|
| Imre Miklós Tóth, administrator | imre.toth@eng.unideb.hu<br>K/6 |
| Ms. Klára Ágnes Törökné Kiss, Administrative Assistant | toroknekissklara@eng.unideb.hu<br>room 106 |

## DEPARTMENT OF AVIATION ENGINEERING

1 Szatke Ferenc utca, Debrecen, H-4030, Tel: +36-52-870-270, www.pharmaflight.hu

| name, position | e-mail, room number |
|---|---|
| Ms. Enikő Földi JD, Chief Executive Director | training@pharmaflight.hu |
| Gyula Győri, Honorary Associate Professor, Head of Department | training@pharmaflight.hu |
| Ms. Krisztina Szabó MD, Head of Aeromedical Department | aeromedical@pharmaflight.hu |

## ACADEMIC CALENDAR

General structure of the academic year:

| | | | |
|---|---|---|---|
| Study period | 1st week | Registration* | 1 week |
| | 2nd – 7th week | Teaching Block 1 | 6 weeks |
| | 8th week | 1st Drawing Week | 1 week |
| | 9th – 14th week | Teaching Block 2 | 6 weeks |
| | 15th week | 2nd Drawing Week | 1 week |
| Exam period | directly after the study period | Exams | 7 weeks |

*Usually, registration is scheduled for the first week of September in the fall semester, and for the first week of February in the spring semester.

### ACADEMIC CALENDAR OF THE FACULTY OF ENGINEERING 2023/2024

| | |
|---|---|
| **Opening ceremony of the academic year** | 8 September, 2024 (Sunday) |
| Registration week | 2 – 8 September, 2024 |
| Revision week (exams in Exam courses may be scheduled during this week) | 2 – 6 September, 2024 |
| **1st semester study period in MSc and BSc programs** | 9 September - 13 December, 2024 (14 weeks)<br>In case of finalist courses: 9 September - 8 November, 2024 (9 weeks) |
| Reporting period I (Drawing week I) | 21 - 25 October, 2024<br>(4 working days without scheduled lessons, consultation schedule announced previously) |
| **Conferences, Career Days** | |
| "New Trends and Challenges in Management – Management of Global Business Processes" Conference – Event of the Mechanical Engineering Department | 17 – 18 October, 2024 |
| "Problem-based Learning in Engineering Education" Conference - organised by the Department of Basic Technical Studies | 24 October, 2024 |

| | |
|---|---|
| Professional exhibition and ISCAME – International Scientific Conference on Advance in Mechanical Engineering - organized by Department of Mechanical Engineering | 7 – 8 November, 2024 |
| Faculty Conference of Scientific Students' Association | 22 November, 2024 |
| Reporting period II (Drawing week II) | 9-13 December, 2024<br>(5 working days without scheduled lessons, consultation schedule announced previously) |
| **1st semester examination period** | 16 – 20 December, 2024 (1 week)<br>6 January – 14 February, 2025 (6 weeks)<br>In case of finalist courses: 11 November - 13 December, 2024 (5 weeks) |
| Thesis (BSc, MSc) submission deadline | As defined by the departments; max. 14 days of the beginning of the final examination period. |
| Final examination period | As defined by the departments; at least one occasion between 16 December, 2024 and 26 January 2025. |
| Registration week | 10 - 16 February, 2025 |
| **2nd semester study period in MSc and BSc programs** | 17 February - 23 May, 2025 (14 weeks)<br>In case of finalist courses: 17 February - 8 April, 2025 (9 weeks) |
| Reporting period I (Drawing week I) | 31 March - 4 April, 2025<br>(5 working days without scheduled lessons, consultation schedule announced previously) |
| **Conferences, Career Days** | |
| **Career Days – "Industry Days in Debrecen 2024 "** | 26 - 27 March, 2025 |
| National Scientific Students' Associations Conference (OTDK) | 23 – 25 April, 2025 |
| Professional Days and Exhibition in the Field of Building Services, event organized by the | 6 - 7 March, 2025 |

| | |
|---|---|
| Department of Building Services and Building Engineering | |
| Reporting period II (Drawing week II) | 19 - 23 May, 2025<br>(5 working days without scheduled lessons, consultation schedule announced previously). |
| 2nd semester examination period | 26 May – 11 July, 2025 (7 weeks)<br>In case of finalist courses: 21 April - 23 May, 2025 (5 weeks) |
| Thesis (BSc, MSc) submission deadline | As defined by the departments; max. 14 days of the beginning of the final examination period. |
| Final examination period | As defined by the departments; at least one occasion between 26 May and 26 June, 2025. |

# THE MECHATRONICS ENGINEERING UNDERGRADUATE PROGRAM

INFORMATION ABOUT THE PROGRAM

| | |
|---|---|
| Name of undergraduate program: | Mechatronics Engineering Undergraduate Program |
| Specialisation available: | Specialisation in Mechatronic Systems,<br>Audiovisual Specialization |
| Field, branch: | Engineering, mechanical, transportation, mechatronic engineering |
| Level: | BSc |
| Qualification: | Mechatronics Engineer |
| Mode of attendance: | Full-time |
| Faculty: | Faculty of Engineering |
| Program coordinator: | Géza Husi PhD habil. Full Professor |
| Person in charge of the specialisation: | - Specialisation in Mechatronic Systems:<br>Géza Husi PhD habil. Full Professor<br>- Audiovisual Specialization:<br>Géza Husi PhD habil. Full Professor |
| Program length: | 7 semesters |
| Credits total: | 210 credits |

The objective of the programme is to train mechatronics engineers who has competence to integrate engineering with electronics, electrotechnics and computer control in synergetic way. They are able to complete routine design, operation and maintenance of mechatronics equipment and processes furthermore intelligent machinery, to introduce and apply mechatronics technologies, to organize energy-efficient and environmental process and production management, to complete average tasks on engineering development and design considering the needs of the international labour market. They are prepared to complete their studies in graduate programme.

*Professional competences to be acquired*

*a) knowledge*

He/She knows

- the applied materials and their production, characteristics in the field of mechatronics and the conditions of their application.
- the systems, sensors and actuators of mechatronics, electromechanical, information, motion control and their structural units, fundamental operation in engineering, in electrotechnics and in controlling.

- the fundamental design principles, methods in mechatronics including engineering and precision constructions and the fundamentals of designing analogue and digital circuits.
- the fundamental methods of calculation, modelling and simulation of engineering, electrical and control systems.
- the instruments, subassemblies, fundamental design and programming methods of computerized control, measurement data collection, embedded systems, optical detections, image processing
- the fundamental measurement procedures and their tools, equipment, measurement instruments applied in electronics and engineering.
- the domestic and international standards, regulations.
- the security, health and environment protection (SHE), common standards of quality management and controlling (QA/QC) related to his professional field.
- the fundamentals of the professional field, limits and requirements of logistics, management, environmental protection, quality assurance, occupational health, information technology, law, economics.
- the methods of learning, knowledge acquisition, data collection and their ethic limits, problem solving techniques.
- the basics of corporate finances and the methods and tools of cost-benefit analysis on the bases of engineering.

*b) skills*

He/She is able to

- apply basic calculations, modelling principles, methods in the field of engineering, electrotechnics and controlling related to designing products and technologies of mechatronics, electromechanics, movement control.
- understand and describe the structure, the operation of units and elements of mechatronic systems, the configuration and connection of system elements in engineering, electrotechnics and control technique.
- apply technical standards related to operating mechatronic systems and intelligent machines, the principles of adjusting and maintenance mechatronic systems in engineering, electrotechnic, controlling approaches and know their economical correspondences.
- control and check technological manufacturing processes bearing in mind the elements of quality control.
- diagnose errors, select the right error treatment in engineering, electrotechnic, control technique approaches.
- to integrate knowledge from the fields of electronic, engineering and informatics and systemic thinking with experts of different fields, to carry out professional negotiation, introduce his/her thoughts in his/her professional filed clearly both in written and oral forms.
- understand and use the proper online and printed literature in English and with this knowledge he/she keeps his/her professional development continuous.
- complete monotonous practical tasks with steadiness and tolerance.

- work in groups and accept his/her status in a group and identify with it.

*c) attitude*

He/she

- aspires to have an integrating role in connecting engineering, information, electrical engineering and life science.
- aspires to his/her self-learning in the field of mechatronics within that especially in applied engineering, electrical and informatics and other professional fields related to work in order to his/her self-learning will meet continuously with his/her professional goals.
- aspires to complete tasks to make management decisions preferably in cooperation with his/her colleagues opinions.
- is opened and receptive to applying new, modern, innovative procedures, methods especially in the field of organic farming, health consciousness.
- aspires to learn the best practical, new professional knowledge and methods.
- does his/her job under consideration with ethical standards.
- shares his/her experience with his/her colleagues to promote their development.

*d) his/her autonomy and responsibility*

He/she

- selects and applies the relevant problem solving methods individually.
- shall take responsibility for the statements and professional decisions indicated in designs and other documents, and for manufacturing procedures carried out under his/her control.
- shall become involved in projects of research and development related to his/her profession. In project groups he/she mobilizes his/her theoretical and practical knowledge and skills and cooperate with other group members to gain their aim in the project group.
- manages the work of staffing to which he is assigned, monitors the maintaining machines and instruments according to he instructions of his manager.
- evaluates the work effectiveness, efficiency and safety of his/her staff and as a leader he/she takes care of promoting his/her staff professional development and fosters their efforts. Completion of the academic program

## Credit System

Majors in the Hungarian Education System have generally been instituted and ruled by the Act of Parliament under the Higher Education Act. The higher education system meets the qualifications of the Bologna Process that defines the qualifications in terms of learning outcomes, statements of what students know and can do on completing their

degrees. In describing the cycles, the framework uses the European Credit Transfer and Accumulation System (ECTS).

ECTS was developed as an instrument of improving academic recognition throughout the European Universities by means of effective and general mechanisms. ECTS serves as a model of academic recognition, as it provides greater transparency of study programmes and student achievement. ECTS in no way regulates the content, structure and/or equivalence of study programmes.

Regarding each major, the Higher Education Act prescribes which professional fields define a certain training program. It contains the proportion of the subject groups: natural sciences, economics and humanities, subject-related subjects and differentiated field-specific subjects.

The following professional fields define the Mechatronics Engineering BSc training:

Natural Sciences: 40-50 credits;

Economics and Humanities: 14-30 credits;

Field-specific professional skills for mechatronics engineers: 70-105 credits.

The specialisation provided by the training institute comprises at least 40 credits in the complete bachelor program.

Minimum of credit points assigned to optional subjects: 10

Credit points assigned to thesis: 15

Credits total: 210

## Guideline (List of Subjects/Semesters)

The total number of credit points (210) of the training program can be obtained by completing the subjects of the curriculum. There is a certain degree of freedom in the order students can complete the subjects. However, it is recommended that the suggested order be followed because some subjects can only be taken after the completion of the prerequisite subject(s), and/or can be the prerequisites for other subjects.

The list of subjects you have to complete in the semesters according to the model curriculum of Mechatronics Engineering BSc programme, Specialisation in Mechatronic Systems:

| 1st semester | 2nd semester |
|---|---|
| Mathematics I | Mathematics II |
| Engineering Physics | Mathematics Comprehensive Exam |
| Informatics (Programming in C) | Computer-Aided Modelling |
| Electromagnetism | Materials Engineering |
| Law and Ethics | Economics for Engineering |

| | |
|---|---|
| Basics of Mechatronics | Informatics (Labview) |
| | Electrotechnics |
| 3rd semester | 4th semester |
| Mathematics III | Dynamics and Vibration |
| Statics and Strength of Materials | Mechatronic Devices (Sensors, Actuators, Motors) |
| Microeconomics and economical processes of enterprises | Measurement and data acquisition |
| Electronics I | Environment, Health and Safety, Ergonomics (Basics of EHS) |
| Mechanical Machines and Machine Elements | Applied Automatization I |
| Manufacturing Technologies | Pneumatics and Hydraulics |
| 5th semester | 6th semester |
| Quality and Technical Management | Electrical machines and drives |
| Applied Automatization II | Thermodynamic Processes |
| Electropneumatics and Electrohydraulics | Mechatronics Comprehensive Exam |
| Modelling and Simulation Prototype Technologies I | Modelling and Simulation Prototype Technologies II |
| Robots and Robotics Technology | Caxx Techniques |
| | Cyber-Physical Systems |
| 7th semester | |
| Project of Mechatronics | |
| BSc Thesis | |

The list of subjects you have to complete in the semesters according to the model curriculum of Mechatronics Engineering BSc programme, Audiovisual Specialization:

| 1st semester | 2nd semester |
|---|---|
| Mathematics I | Mathematics II |
| Engineering Physics | Mathematics Comprehensive Exam |
| Informatics (Programming in C) | Computer-Aided Modelling |
| Electromagnetism | Materials Engineering |
| Law and Ethics | Economics for Engineering |
| Basics of Mechatronics | Informatics (Labview) |
| | Electrotechnics |
| 3rd semester | 4th semester |
| Mathematics III | Dynamics and Vibration |
| Statics and Strength of Materials | Mechatronic Devices (Sensors, Actuators, Motors) |

| | |
|---|---|
| Microeconomics and economical processes of enterprises | Measurement and data acquisition |
| Electronics I | Environment, Health and Safety, Ergonomics (Basics of EHS) |
| Mechanical Machines and Machine Elements | Applied Automatization I |
| Manufacturing Technologies | Pneumatics and Hydraulics |
| 5th semester | 6th semester |
| Basics of Sound and Light | A/V Systems Technology |
| Basics of A/V Technology | Informatics |
| Signs and Processing | Audiovisual Culture and Production |
| 7th semester | |
| Project of Mechatronics | |
| BSc Thesis | |

About the prerequisites of each subject please read the chapter "Course Descriptions for Mechatronics Engineering BSc"!

## Work and Fire Safety Course

According to the Rules and Regulations of University of Debrecen students have to complete the online course for work and fire safety in the first semester of their studies. Registration for the course and completion are necessary for graduation. For MSc students the course is only necessary only if BSc diploma has been awarded outside of the University of Debrecen.

Registration in the Neptun system by the subject: MUNKAVEDELEM

Students have to read an online material until the end to get the signature on Neptun for the completion of the course. The link of the online course is available on webpage of the Faculty.

## Industrial practice

Students majoring in the Mechatronics Engineering BSc have to carry out a 6-week industrial practice involved in the model curriculum. The industrial practice course must be signed up for previously via the NEPTUN study registration system in the spring semester (4th semester). Its execution is the criteria requirement of getting the pre-degree certificate (absolutorium).

## Physical Education

According to the Rules and Regulations of University of Debrecen a student has to complete Physical Education courses at least in two semesters during his/her Bachelor training. Our University offers a wide range of facilities to complete them. Further information is available from the Sport Centre of the University, its website: http://sportsci.unideb.hu.

## Optional Courses

According to the Rules and Regulations of University of Debrecen a student has to complete elective courses during his/her BSc training. These elective courses are opened by the Departments at the Faculty of Engineering at the beginning of the actual semester. You can find the list of the actual semester under "Current Students" >" Useful Information about your Study" >" Optional subjects".

A student can also select optional courses from other faculties of University of Debrecen to complete.

In the Mechatronics Engineering BSc programme, you have to gain at least 10 credits with completing elective subjects.

## Pre-degree Certification

A pre-degree certificate is issued by the Faculty after completion of the bachelor (BSc) program. The pre-degree certificate can be issued if the student has successfully completed the study and exam requirements as set out in the curriculum, the requirements relating to Physical Education, industrial practice (mandatory) – with the exception of preparing thesis – and gained the necessary credit points (120). The pre-degree certificate verifies (without any mention of assessment or grades) that the student has fulfilled all the necessary study and exam requirements defined in the curriculum and the requirements for Physical Education. Students who obtained the pre-degree certificate can submit the thesis and take the final exam.

## Thesis

A Thesis is the creative elaboration of a professional task (scientific, engineering, design, development, research or research development) in written form. By solving the task, the student relies on his/her studies using national and international literature under the

guidance of an internal and external supervisor (referee). By solving the task, the mechatronics engineering student certifies that he/she is capable to apply the acquired knowledge in practice and to summarize the completed work and its results in professional way, to solve the tasks related to his/her topic creatively and to complete individual professional work. By preparing and defending thesis students who complete the Mechanical Engineering undergraduate program prove that they are capable of the practical applications of the acquired skills, summarizing the work done and its results in a professional way, creatively solving the tasks related to the topic and doing individual professional work. The faculty academic calendar (issued by the Vice-Rector for Education) sets the thesis submission deadline.

A student in bachelor program has to make a thesis as a prerequisite of the final exam. The requirements of the thesis content, the general aspects of evaluation and the number of credits assigned to the thesis are determined by the requirements of the program. In mechatronics engineering program the credits assigned to the thesis is 15.

The latest that thesis topics are announced by the departments for the students is the end of Week 4 of the study period of the last semester. A thesis topic can be suggested by the student as well and the head of department assigned shall decides on its acceptance. . The conditions on the acceptance of thesis as National Conference of Scientific Students' Association (hereinafter NCSSA) topic are specified by the Faculty. The NCSSA work is supposed to meet the requirements in form and content for thesis. Furthermore, it is necessary that the committee of the Pre-NCSSA makes suggestions on the NCSSA work to become a thesis.

Making a thesis is controlled by a supervisor approved by the department who is promoted by a referee also previously approved by the department.

Formal requirements of a thesis are announced in writing by the Department of Electrical Engineering and Mechatronics that are announced with the tasks in written form at the same time.

The faculty academic calendar (issued by the Vice-Rector for Education) sets the thesis submission deadline, for want of this the deadline is the 21. day 12 noon before the first day of the final exam.

Thesis is evaluated by the referee (internal or external), and it is evaluated and qualified individually by the department. The Head of the Department of Electrical Engineering and Mechatronics makes suggestion on its qualification to the Final Exam Board.

If thesis is evaluated with a fail mark by the referee, and the department the student is not allowed to take the final exam and is supposed to prepare a new or modified thesis. The student has to be informed about it. Conditions on resubmitting the thesis are defined by the program coordinator.

## Final exam (Final Exam)

Students having obtained the pre-degree certificate will finish their studies by taking the final exam. Final exam can be taken in active student status in the forthcoming exam period after gaining the pre-degree certificate then after termination of student status in any exam period within two years according to the valid education requirements. After the fifth year of the termination of student status the candidate is not allowed to take the

final exam. Only students who do not have outstanding charges are allowed to take the final exam.

A student having obtained the pre-degree certificate (absolutorium) will finish his/her studies in Mechatronics Engineering BSc training by taking the final exam. A final exam is the evaluation and control of the knowledge and skills acquired in tertiary education during which the candidate has to certify that he/she is able to apply the obtained knowledge in practice.

A final exam can be taken in the forthcoming exam period after obtaining the pre-degree certificate. The Department announces two final exam dates in a year, one at the beginning of January and one at the end of June. A final exam has to be taken in front of the Committee on the fixed date. If a candidate does not pass his/her final exam by the termination of his/her student status, he/she can take his/her final exam after the termination of the student status on any of the final exam days of the relevant academic year according to existing requirements on the rules of the final exam.

The Final exam consists of two parts according to the curriculum.

1) Thesis Defence (a presentation of the thesis, answering questions, comments then answering questions based on the knowledge related to the thesis topic).
2) To answer questions on the knowledge related to the topic of the Thesis without preparation.

A final exam can be started if the candidate can be submitted to the final exam on the basis of definite opinion of the referees. The two parts must be hold on the same day.

The parts of the final exam are evaluated on a five-point scale by members with voting rights in the Final Exam Board. The final grade for the final exam will be decided on by voting in a closed sitting after the final exam, then. In case of equal votes, the committee chair will make the decision. Final exam results will be announced by the committee chair. Results of the final exam and thesis defence will be announced at the end of the given exam day (when all candidates finished final exam and thesis defence on the given day). A note of the final exam will be taken.

*Improving failed final exam*

If a thesis is evaluated with a fail mark by the Final Exam Board a final exam has to be retaken with a new or modified thesis.

If any of part if the final exam is a fail it must be retaken according to the existing rules of the university. Final exam can be retaken twice. The ensuing final exam period is the soonest that the re-sit is allowed.

*Final exam board*

Committee chair and members of the committee are called upon and mandated by the dean with the consent of the Faculty Council. They are selected from the acknowledged

internal and external experts of the professional field. Traditionally, it is the chair and in case of his/her absence or indisposition the vice-chair who will be called upon, as well. The committee consists of – besides the chair – at least one member (a professor, an associate professor or college professor) and at least two questioners (instructors) and the examiner. In controversial cases the chair makes the decision. The mandate of a Final Examination Board lasts for three years. The division of the candidates to the mandatory final exam board is announced by the Registry Office.

## COURSE DESCRIPTIONS FOR MECHATRONICAL ENGINEERING BSC

The order of subject follows the subject list in the model curriculum.

Subject group "Basic Natural Sciences"

### Mathematics I

Code: MK3MAT1A8RX17_EN
ECTS Credit Points: 8
Evaluation: mid-semester grade
Year, Semester: 1st year/1st semester
Its prerequisite(s): -
Further courses are built on it: Yes/No
Number of teaching hours/week (lecture + practice): 4+4

**Topics**:

The basic notions of linear algebra, differentiation and integration for real functions; some applications in physics.

Part A - Linear algebra: real numbers, coordinate systems, sets, sequences of real numbers and their limit, series of real and complex numbers, series of real functions, vector geometry, vector algebra and applications, the set of the complex numbers, complex series, approximation of real functions, matrices, determinants, vector spaces, systems of linear equations, linear functions

Part B - Differential and integral calculus: real functions, elementary functions, limit and continuity of real functions, differentiation, L'Hospital's rule, Taylor polynomial, analysis of differentiable functions, primitive function (antiderivative), indefinite integral, the Riemann integral, the Newton-Leibniz theorem, numerical integration, improper integral, applications of the integral

**Literature:**

Required:

- Adrienn Varga, Mathematical Analysis for Engineers, Debrecen, Hungary: Dupress (2019), 118 p. ISBN: 9789633188156
- Lajos, Hajdu; Adrienn, Varga, Engineering Mathematics: part I. Debrecen, Hungary: Dupress (2021), 154 p. ISBN: 9789633189030

Recommended:

Thomas' Calculus, Addison Wesley (11th edition, 2005), ISBN: 0-321-24335-8

S. Minton, Calculus Concept and Connections, McGraw Hill (2006), ISBN 0-07111200-6

Recommended textbook:

Síki Gusztáv Áron, Nagy Kondor Rita, Kézi Csaba, Differential and integral calculus for Engineering and Economists Debrecen, Magyarország: Dupress (2019), 225 p. ISBN: 9789633187418

## Schedule

| 1st week Registration week | |
|---|---|
| **2nd week:**<br>**Lecture:**<br>Part A1: Sets, Real numbers<br>Part A2: The set of the complex numbers<br>**Practice:**<br>Part A1: Sets, Real numbers<br>Part A2: The set of the complex numbers | **3rd week:**<br>**Lecture:**<br>Part A1: Vectorgeometry, vectoralgebra<br>Part A2: Vectorgeometry, vectoralgebra<br>**Practice:**<br>Part A1: Vectorgeometry, vectoralgebra<br>Part A2: Vectorgeometry, vectoralgebra |
| **4th week:**<br>**Lecture:**<br>Part A1: Matrices<br>Part A2: Vector spaces<br>**Practice:**<br>Part A1: Matrices<br>Part A2: Vector spaces | **5th week:**<br>**Lecture:**<br>Part A1: Systems of linear equations<br>Part A2: Linear functions<br>**Practice:**<br>Part A1: Systems of linear equations<br>Part A2: Linear functions |
| **6th week:**<br>**Lecture:**<br>Part A1: Determinations of eigenvalues, eigenvectors.<br>Part A2: Caculations with mathematical software<br>**Practice:**<br>Part A1: Determinations of eigenvalues, eigenvectors. | **7th week:**<br>**Lecture:**<br>Part A1: Real functions, elementary functions and their inverses<br>Part A2: Polynomials and interpolations<br>**Practice:**<br>Part B1: Real functions, elementary functions and their<br>Part B2: Polynomials and interpolations |

| | |
|---|---|
| Part A2: Caculations with mathematical software | |
| **8th week: 1st drawing week** | |
| **9th week:**<br>**Lecture:**<br>Part B1: Sequences<br>Part B2 : Series<br>**Practice:**<br>Part B1: Sequences<br>Part B2 : Series | **10th week:**<br>**Lecture:**<br>Part B1: Limits of real functions, continuity of real functions<br>Part B2: Differentiation of real functions, linear approximation<br>**Practice:**<br>Part B1: Limits of real functions, continuity of real functions<br>Part B2: Differentiation of real functions, linear approximation |
| **11th week:**<br>**Lecture:**<br>Part B1: Mean value theorems, investigation of differentiable functions<br>Part B2: L'Hospital's rule, Taylor polynomials.<br>**Practice:**<br>Part B1: Mean value theorems, investigation of differentiable functions<br>Part B2: L'Hospital's rule, Taylor polynomials. | **12th week:**<br>**Lecture:**<br>Part B1: Primitive functions, indefinite integral, integration by parts, integral with substitutions<br>Part B2: Definite integral (Riemann integral), Newton-Leibniz theorem<br>**Practice:**<br>Part B1: Primitive functions, indefinite integral, integration by parts, integral with substitutions<br>Part B2: Definite integral (Riemann integral), Newton-Leibniz theorem |
| **13th week:**<br>**Lecture:**<br>Part B1: Improper integrals. Applications of the integration in geometry and physics<br>Part B2: Numerical integration<br>**Practice:**<br>Part B1: Improper integrals. Applications of the integration in geometry and physics<br>Part B2: Numerical integration | **14th week:**<br>**Lecture:**<br>Part B1: Regression<br>Part B2: Mathematical software<br>**Practice:**<br>Part B1: Regression<br>Part B2: Mathematical software |
| **15th week: 2nd drawing week** | |

**Requirements**

A, for a signature and mid-semester grade:

Attending practices is compulsory. Students must attend practice classes and may not miss more than three practice classes during the semester. In case a student does so, the subject will not be signed and the student must repeat the course. Students can't take part in any practice class with another group. Attendance at practice classes will be recorded by the practice leader. Being late is equivalent with an absence. In case of further absences, a medical certification needs to be presented. The final grade can be obtained in the following way:

- students write two tests (Test I part A, Test II part A) from the linear algebra part of the material; maximum 50+50=100 points can be achieved
- students write a two tests (Test I part B, Test II part B) from the differential and integral calculus part of the material; maximum 50+50=100 points can be achieved

Mark ranges after the four tests:

- 175-200 points: excellent (5)
- 150-174 points: good (4)
- 125-149 points: satisfactory (3)
- 100-124 points: sufficient (2)
- 0-99 points: insufficient (1)

Those who fail, or do not accept their marks, can write a Test in any of the first three weeks of the exam period. This Test is a combination of the previous four tests, maximum 50 points can be achieved, and the mark ranges are proportional to the above table. For exam dates see Neptun. If someone does not accept her/his mark, it is possible to get any mark (better, the same, or worse) than the original mark by writing this Test.

## Mathematics II

Code: MK3MAT2A06GX17_EN, MK3MAT2A06EX17_EN, MK3MAT2A06RX17_EN

ECTS Credit Points: 6

Evaluation: mid-semester grade

Year, Semester: 1st year/2nd semester

Its prerequisite(s): Mathematics I

Further courses are built on it: Yes/No

Number of teaching hours/week (lecture + practice): 2+4

Topics:

Differentiation and integration of multivariable and vector-valued functions, differential equations.

Part A: Differentiation and integration of multivariable vector-valued functions (2 hours of lecture+2 hours of practise/week): Metric, topology, sequences in the space. Linear functions. Parametric curves. Notions of differentiation, linear approximation, curvature, torsion. Parametric surfaces, tangent plane, linear approximation. Surfaces of revolution, ruled surfaces. Scalar field, gradient. Young's theorem. Directional derivative. Local and global extrema. Vector fields. Derivatives. Divergence and curl. Potential function. The notion of double and triple integrals on 2 and 3 dimensional intervals. The extensions of the integrals. Integrals over general regions. The arc length of curves, surface area. Line and surface integrals. The theorems of Gauss and Stokes, Green's formulae. Applications in physics.

Part B: Differential equations (2 hours of practise/week): Notions of differential equations, classification of differential equations, initial value problem. Problems leading to differential equations. First order linear differential equations (homogeneous and inhomogeneous, method of variation). Determination of solutions of inhomogeneous first order linear differential equations. Higher order linear differential equations. Solution of linear homogeneous differential equations of order two having constant coefficients. Method of undetermined coefficients. Special second order differential equations. The Laplace transform and its applications. Slope fields, numerical methods. (Euler, Runge-Kutta).

**Literature:**

Required:

Recommended:

- Thomas' Calculus, Addison Wesley (11th edition, 2005), ISBN: 0-321-24335-8
- S. Minton, Calculus Concept and Connections, McGraw Hill (2006), ISBN 0-07111200-6
- M. D. Greenberg, Fundamentals of engineering analysis, Cambridge University Press, ISBN 978-0-521-80526-1

Recommended textbook:

**Schedule**

| **1st week Registration week** | |
|---|---|
| **2nd week:**<br>**Lecture:**<br>Part A: Metric, topology, sequences in $\mathbb{R}^n$ .<br>**Practice:**<br>Part A: Limits of vector sequences<br>Part B: Notions of differential equations | **3rd week:**<br>**Lecture:**<br>Part A: Parametric curves I.<br>**Practice:**<br>Part A: Differentiation.<br>Part B: Problems leading to differential equations. |

**4th week:**

**Lecture:**

Part A: Parametric curves II.

**Practice:**

Part A: Curvature, torsion

Part B: First order linear differential equations

**5th week:**

**Lecture:**

Part A: Differentiable functions of type $\mathbb{R}^n \to \mathbb{R}^m$.

**Practice:**

Part A: Derivatives of functions of type $\mathbb{R}^n \to \mathbb{R}^m$.

Part B: Higher order linear differential equations.

**6th week:**

**Lecture:**

Part A: Parametric surfaces

**Practice:**

Part A: Surfaces of revolution

Part B: Solution of linear homogeneous differential equations of order two having constant coefficients

**7th week:**

**Lecture:**

Part A: Scalar field, gradient. Young's theorem. Directional derivative.

**Practice:**

Part A: The domains of functions of type $\mathbb{R}^2 \to \mathbb{R}$. Directional derivative and gradient.

Part B: Summary, sample test

**8th week: 1st drawing week**

**9th week:**

**Lecture:**

Part A: Local and global extrema

**Practice:**

Part A: Local extremas of functions of type $\mathbb{R}^2 \to \mathbb{R}$ , $\mathbb{R}^3 \to \mathbb{R}$ .

Part B: Method of undetermined coefficients

**10th week:**

**Lecture:**

Part A: Vector fields

**Practice:**

Part A: Vector fields

Part B: Special second order differential equations.

**11th week:**

**Lecture:**

Part A: Double and triple integrals

**Practice:**

Part A: Integrals on 2 and 3 dimensional intervals

Part B: Laplace transform

**12th week:**

**Lecture:**

Part A: Integrals over general regions

**Practice:**

Part A: Applications

Part B: Slope fields, numerical methods.

**13th week:**

**Lecture:**

**14th week:**

**Lecture:**

| | |
|---|---|
| Part A: Line and surface integrals.<br>**Practice:**<br>Part A: arc length of curves, surface area. Line and surface integrals<br>Part B: Potential functions | Part A: Mathematical software<br>**Practice:**<br>Part A: Summary, sample test<br>Part B: Summary, sample test |
| **15th week: 2nd drawing week** | |

**Requirements**

**A, for a signature and mid-semester grade:**

Attending practices is compulsory. Students must attend practice classes and may not miss more than three practice classes during the semester. In case a student does so, the subject will not be signed and the student must repeat the course. Students can't take part in any practice class with another group. Attendance at practice classes will be recorded by the practice leader. Being late is equivalent with an absence. In case of further absences, a medical certification needs to be presented.

The final grade can be obtained in the following way:

- students write a mid-term test (Test I, B) from differential equation part of the material in the first drawing week; maximum 30 points can be achieved
- students write a mid-term test (Test I, A) from the differential and integral calculus part of the material in the first drawing week; maximum 50 points can be achieved
- students write an end-term test (Test II, B) from the differential equation part of the material in the second drawing week; maximum 30 points can be achieved
- students write an end-term test (Test II, A) from the differential and integral calculus part of the material in the second drawing week; maximum 50 points can be achieved

Mark ranges after the four tests:

144-160 points: excellent (5)

128-143 points: good (4)

104-127 points: satisfactory (3)

80-103 points: sufficient (2)

0-79 points: insufficient (1)

Those who fail, or do not accept their marks, can write a Test in any of the first three weeks of the exam period. This Test is a combination of the previous four tests, maximum 80 points can be achieved, and the mark ranges are proportional to the above table.

For exam dates see Neptun. If someone does not accept her/his mark, it is possible to get any mark (better, the same, or worse) than the original mark by writing this Test.

## Mathematics Comprehensive Exam

Code: MK3MATSA00RX17-EN

ECTS Credit Points: 0

Evaluation: exam

Year, Semester: 1st year, 2nd semester

Its prerequisite(s): Mathematics II at the same time or later

Further courses are built on it: Yes/No

Subjects of the comprehensive exam: Mathematics I and II

## Mathematics III

Code: MK3MAT3A04RX17-EN

ECTS Credit Points: 4

Evaluation: mid-semester grade

Year, Semester: 2nd year, 1st semester

Its prerequisite(s): Mathematics II

Further courses are built on it: Yes/No

Number of teaching hours/week (lecture + practice): 2+2

### Topics:

Probabilty. Variables. Weibull and normal distribution, applications. Numerical characteristics of variables. Non-homogeneous equations, applications.

### Literature:

*Compulsory:*

- Montgomery, D. C., Runger, G. C., Applied Statistics and Probability for Engineers, John Wiley & Sons Inc., 2003
- Soong, T. T., Fundamentals of probability and statistics for engineers, John Wiley & Sons, Inc., 2004
- DeCoursey, W. J., Statistics and Probability for Engineering Applications with Microsoft® Excel, Newnes, 2003
- Burghes, D. N., Modelling with Differential Equations, John Wiley & Sons, 1981.
- Chapra, S. C., Numerical Methods for Engineers, Mc Graw Hill, 2006.

Schedule

| | |
|---|---|
| 1st week Registration week | |
| 2nd week:<br>Lecture: Sample spaces and events. Axioms of probability.<br>Practice: Calculation of probability. | 3rd week:<br>Lecture: Conditional probability. Multiplication and total probability rules. Independence.<br>Practice: Calculation of probability. |
| 4th week:<br>Lecture: Discrete and continuous random variables, probability distribution, density function.<br>Practice: Random variables. | 5th week:<br>Lecture: Binomial, Poisson, uniform, exponential, Weibull and normal distribution, applications.<br>Practice: Random variables. |
| 6th week:<br>Lecture: Numerical characteristics of random variables.<br>Practice: Numerical characteristics of random variables. | 7th week:<br>Lecture: Sampling, descriptive statistics. SPC.<br>Practice: Descriptive statistics. |
| 8th week: 1st drawing week Test 1 | |
| 9th week:<br>Lecture: Point and interval estimation.<br>Practice: Point and interval estimation. | 10th week:<br>Lecture: Modelling with differential equations. Linear systems.<br>Practice: Modelling with differential equations. |
| 11th week:<br>Lecture: Numerical solution methods.<br>Practice: Numerical solution methods. | 12th week:<br>Lecture: Laplace transform and applications.<br>Practice: Laplace transform and applications. |
| 13th week:<br>Lecture: Homogeneous linear differential equations, applications.<br>Practice: Homogeneous linear differential equations. | 14th week:<br>Lecture: Non-homogeneous linear differential equations, applications.<br>Practice: Non-homogeneous linear differential equations. |
| 15th week: 2nd drawing week Test 2 | |

Requirements

A, for a signature:

Participation at practice, according to Rules and Regulations of University of Debrecen. The correct solution of homework and submission before deadline. Solving assorted tasks.

B, for a grade:

All the tests must be written during the semester. Evaluation is according to the Rules and Regulations of University of Debrecen.

## Engineering Physics

Code: MK3MFIZA04RX17-EN

ECTS Credit Points: 4

Evaluation: exam

Year, Semester: 1st year, 1nd semester

Its prerequisite(s): -

Further courses are built on it: Yes/No

Number of teaching hours/week (lecture + practice): 2+2

### Topics:

Geometrical optics, kinematics and dynamics of particles, concept of mechanical work, kinetic and potential energy, electrostatics, electric fields around conductors, transport processes, steady-state transport of electric charge, steady-state heat transfer (conduction, convection and radiation)

### Literature:

*Compulsory:*

- Alvin Halpern: 3,000 Solved Problems in Physics, SCHAUM'S SOLVED PROBLEM SERIES (2011), ISBN-13: 978-0071763462
- Jerry S. Faughn, Raymond A. Serway, Chris Vuille, Charles A. Bennett: Serway's College Physics, Published 2005 by Brooks Cole Print, ISBN 0-534-99723-6

### Schedule

| 1st week Registration week | |
|---|---|
| **2nd week:**<br>**Lecture:** Geometrical (ray) optics.<br>Concept of geometrical optics, law of reflection and refraction (Snell's law), Brewster's angle, Optics of prisms and lenses, imaging properties and magnification, aberrations, compound lenses.<br>**Practice:** Solving problems for the reflection and refraction of light beams and for the imaging of lenses and compound lenses. | **3rd week:**<br>**Lecture:** Kinematics of a particle I.<br>Description of the motion by scalar quantities: Scalar position, velocity and acceleration.<br>Example: uniform and uniformly varying motion<br>**Practice:** Solving problems for uniform and uniformly varying motions. |
| **4th week:** | **5th week:** |

**Lecture:** Kinematics of a particle II. Description of the motion by vector quantities: Position vector, vector velocity and acceleration.

Example: throwing problems, circular motion.

**Practice:** Solving throwing and circular motion problems.

**Lecture:** Kinetics of a particles I. Inertial frame of reference, Newton's Laws, force formulas. Application of Newton's Laws in static and dynamic problems.

**Practice:** Application of Newton's laws in kinetic problems.

**6th week:**

**Lecture:** Kinetics of a particles II. Concept of work and kinetic energy, work-energy theorem. Application of work-energy theorem in dynamic problems.

**Practice:** Application of Newton's laws and the work energy theorem in kinetic problems.

**7th week:**

**Lecture:** Electrostatics I. Electric field strength and flux, Gauss's law for electricity (Maxwell's first equation), potential energy in electric fields.

**Practice:** Calculation of the electric field strength and its flux in the electrostatic fields of different charge arrangements.

**8th week: 1st drawing week Test 1**

**9th week:**

**Lecture:** Electrostatics II. Electric voltage and potential, capacitance, capacitance of planar, cylindrical and spherical capacitors, the energy of capacitors, capacitor circuits.

**Practice:** Calculating the capacitance and stored energy of different types of capacitors and capacitor connections.

**10th week:**

**Lecture:** Transport processes

Concept of physical system, current intensity and source strength, extensive and intensive physical properties, conduction and convection current. Equation of balance and steady-state conduction. Thermal conductivity and conductive resistance. Conductive resistance circuits.

**Practice:** Application of the equation of balance and steady-state conduction in different physical problems.

**11th week:**

**Lecture:** Steady state transport of electric charge (Direct electric current). Electric current intensity, electrical conductivity and resistance, Ohm's law, electric work and power, characteristics of DC sources, Kirchhoff's circuit laws, solution of DC circuits

**Practice:** Solution of DC circuits

**12th week:**

**Lecture:** Steady-state heat transfer I - Thermal conduction. Concept of heat current and thermal conduction, equation of steady-state thermal conduction, thermal conductivity and resistance, steady state temperature distribution in a one dimensional wall of thermal conductivity

**Practice:** Solving thermal conduction problems

**13th week:**

**Lecture:** Steady-state heat transfer II - Thermal convection. Concept of thermal convection and heat transfer, equation of

**14th week:**

**Lecture:** Steady-state heat transfer III - Thermal radiation. Thermal radiation characteristics, concept of black body

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|---|---|
| steady-state heat transfer, heat transfer coefficient and resistance, overall heat transfer coefficient and resistance<br>**Practice:** Calculating the steady state temperature distribution in a one dimensional wall of thermal conductivity. | radiation, fundamental laws of thermal radiation (Planck distribution, Wien displacement law, Stefan-Boltzmann and Kirchhoff's law), gray body radiation<br>**Practice:** Solving thermal radiation problems. |
| 15th week: 2nd drawing week Test 2 | |

Requirements

A, for a signature:

Participation at lectures is compulsory. Students must attend lectures and may not miss more than three of them during the semester. In case a student does so, the subject will not be signed and the student must repeat the course. Attendance at lectures will be recorded by the lecturer. Being late is equivalent with an absence. In case of further absences, a medical certification needs to be presented. Missed lectures must be made up for at a later date, being discussed with the tutor.

Students have to write two midterm tests during the semester. The first (40 points max) in the 8th, the second (40 points max) in the 14th week. At the end of the semester everybody will get a seminar grade as follows (score/grade): 0-39 = fail; 40-50 = pass (2); 51-60 = satisfactory (3); 61-70 = good (4); 71-80 = excellent (5).

If somebody fails, then he has to write both tests in the 1st week of the exam period again. If the result is 40 points (50%) or better, then he can take an exam. If somebody has to repeat his midterm tests, then his seminar grade can't be better than (2).

There will be homework from week to week. Only students who have handed in all their homework at the time of the midterm test will be allowed to write it. The problems in the midterm tests will be selected from the homework assignments.

B, for a grade:

Everybody will get an exam grade for their exam. The final grade will be the average of the seminar and exam grade. If it is for example (3.5) then the lecturer decides if it is (3) or (4).

## Computer Aided Modelling

Code: MK3SZABA04RX17-EN

ECTS Credit Points: 4

Evaluation: mid-semester grade

Year, Semester: 1st year, 2nd semester

Its prerequisite(s): -

Further courses are built on it: Yes/No

Number of teaching hours/week (lecture + practice): 0+4

Topics:

Computer-aided geometric design deals with the description of shape for use in computer graphics. The aim of this course is to develop the spatial ability - which is essential in engineering applications -, the 3D representation and the techniques of graphic communication with use of computer-aided design (CAD) software. Basics of plane geometry. Computer-aided geometric constructions. Representation of solids, sizing, plane transformation, intersections. Plane curves, splines. Basics of spatial geometry. Solid modelling, 3D construction.

Literature:

*Compulsory:*


- Foley, J. D. Computer Graphics. 2nd ed. Addison-Wesley, 1990.
- Finkelstein, E. AutoCAD 2010 and AutoCAD LT 2010 Bible. Wiley, 2009
- Yamaguchi, F. Computer-Aided Geometric Design. Springer Verlag, 2002.
- Hoschek, J., and D. Lasser. Fundamentals of Computer Aided Geometric Design. Wellesley, MA: A. K. Peters Ltd., 1993.


Schedule

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|---|---|
| 1st week Registration week | |
| 2nd week:<br>**Practice:** Basics of plane geometry. Representation of the space elements (point, line, rectangle, arc, circle, polygon) | 3rd week:<br>**Practice:** Moving, copying, trimming space elements in the drawings, creating chamfer between two faces of an object. Rounding of an interior or exterior corner of a part design. |
| 4th week:<br>**Practice:** Creating concentric circles, parallel lines, and parallel curves and creating a mirrored copy of objects. | 5th week:<br>**Practice:** Rotating objects around a base point. Enlarging or reducing selected objects, keeping the proportions of the object the same after scaling. Creating copies of selected objects to be arranged in a pattern |
| 6th week:<br>**Practice:** Sizing. | 7th week:<br>**Practice:** Mid-term test. |
| 8th week: 1st drawing week | |
| 9th week:<br>**Practice:** Spatial geometry. Basic elements in 3D. Box, Cylinder, Cone, Sphere, Pyramid. | 10th week:<br>**Practice:** Solid creating. Dynamically modifying objects by extrusion and offset. Creating a 3D solid from an object that encloses an area, or a 3D surface from an object with open ends. |
| 11th week: | 12th week: |

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| **Practice:** Combining two or more 3D solids, surfaces, or 2D regions into a single, composing 3D solid, surface, or region. Creating a 3D solid, surface, or 2D region from overlapping solids, surfaces, or regions. Creating as a new object by subtracting one overlapping region or 3D solid from another. | **Practice:** Solid editing. Creating a 3D solid or surface by sweeping an object around an axis. Creating a 3D solid or surface in the space between several cross sections. |
| **13th week:** | **14th week:** |
| **Practice:** Creating a temporary 3D solid from the interferences between two sets of selected 3D solids. Creating new 3D solids and surfaces by slicing, or dividing, existing objects. | **Practice:** End-term test |
| **15th week: 2nd drawing week** | |

**Requirements**

**A, for a signature:**

Regular attendance (Minimum 70 %). Successful accomplishment of homework.

**B, for grade:**

Grades will be calculated as the average of mid-term test and end-term test. Minimum requirements to pass the semester: Minimum 50% at both tests.

## Informatics (Programming in C)

Code: MK3INFCA4RX17-EN

ECTS Credit Points: 4

Evaluation: mid-semester grade

Year, Semester: 1st year, 1st semester

Its prerequisite(s): -

Further courses are built on it: Yes/No

Number of teaching hours/week (lecture + practice): 0+4

**Topics**:

The course covers the following topics: algorithmisation, basic structures; basic knowledge of programming (types, operators, expressions); control structures (selection controls, iteration controls); one and two dimensional arrays, strings, the Struct type; macros, functions, pointers; introduction with Arduino; development environment; analog and digital inputs and outputs; LEDs, 7-segment displays, LCD displays, buttons,

keymatrix, PWM signal, servo motor, potentiometer, photoresistor; ultrasonic sensor module, internal EEPROM; communication protocols (serial, IR, SPI, I2C).

### Literature:

*Compulsory: -*

- Brian W. Kernighan, Dennis M. Ritchie – The C programming language, Second Edition, Prentice-Hall, Inc., New Jersey, ISBN: 013 110 362 8
- Clovis L. Tondo, Scott E. Gimpel – The C Answer Book, Second Edition, Prentice-Hall, Inc., New Jersey, ISBN: 013 109 653 2
- Scott Fitzgerald, Michael Shiloh – The Arduino Projects Book (e-book)

### Schedule

| 1st week Registration week | |
|---|---|
| 2nd week:<br>Practice: Algorithmisation, Basic structures: sequence, iteration, selection | 3rd week:<br>Practice: Language hierarchy, structure of the C language program, number representation, binary number system, variables, operators, header files |
| 4th week:<br>Practice: Simple statements, Selection statements: IF statement, SWITCH statement, logical values, logical operators | 5th week:<br>Practice: Iteration statements, FOR loop, pretest loop: WHILE loop, posttest loop: DO-WHILE loop, embedded loops |
| 6th week:<br>Practice: Arrays, one and two dimensional arrays, strings, user defined types, the STRUCT type | 7th week:<br>Practice: Macros, Functions, Pointers, Summary, Consultation, Sample Test |
| 8th week: 1st drawing week, Test | |
| 9th week:<br>Practice: Introduction with Arduino, pin allocation, Development environment, Arduino C, operation of the LED, timing functions, serial monitor | 10th week:<br>Practice: Digital and analog inputs, buttons, keymatrix, digital and analog outputs, 7-segment display, LCD display, RGB LED |
| 11th week: | 12th week: |

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|---|---|
| Practice: Communications: serial communication, infra-red communication, SPI communication, I2C communication | Practice: Analog signals, potentiometer, photoresistor, PWM output, servo motors, ultrasonic sensor module, internal EEPROM |
| 13th week:<br>Practice: Consultation, preparing the project exercises | 14th week:<br>Practice: Consultation, submitting the project exercises |

**15th week: 2nd drawing week, Test 2**

**Requirements**

**A, for a signature:**

Participation at practices, according to Rules and Regulations of University of Debrecen. Writing the test at least at a sufficient level. The correct solution of homework and submission before deadline.

**B, for a grade:**

The final grade of the course is based on the result of the test, the homework and active participation.

## Electromagnetism

Code: MK3EMAGA04RX17-EN

ECTS Credit Points: 4

Evaluation: exam

Year, Semester: 1st year, 1st semester

Its prerequisite(s): -

Further courses are built on it: Yes/No

Number of teaching hours/week (lecture + practice): 2+2

**Topics**:

Electrostatics, electrical potential, electric fields around conductors, electric current, the fields of moving charges, the magnetic field, electric and magnetic fields in matter, electromagnetic induction and Maxwell's equations, alternating-current circuits, electromagnetic waves.

**Literature:**

*Compulsory:*

- Mathew N.O Sadiku: Principles of Electromagnetics (2009) Oxford University Press, ISBN-13: 978-0198062295

- William H. Hayt, John A. Buck: Engineering Electromagnetics (Irwin electronics & Computer Engineering) (2011) McGraw-Hill Education, ISBN-13: 978-0073380667

Schedule

| | |
|---|---|
| 1st week Registration week | |
| 2nd week:<br>**Lecture:** Coulomb's law. Electric field strength and its flux. Gauss's law for electricity (Maxwell's first equation)<br>**Practice:** Calculation of the strength of static electric fields generated by simple charge arrangements. | 3rd week:<br>**Lecture:** Potential energy in static electric field and its calculation in simple cases. Electric potential and voltage. Capacitance. Capacitance of a planar, spherical and cylindrical capacitor.<br>**Practice:** Calculation of potential energy and voltage in static electric fields. |
| 4th week:<br>**Lecture:** Capacitor circuits. Energy stored in a capacitor. Electric field in matter.<br>**Practice:** Calculation of the capacitance and energy of different types of capacitors and capacitor connections | 5th week:<br>**Lecture:** Electric current. Current intensity and density. Ohm's law (differential and integral form). Electrical work and power. Characteristics of voltage sources: electromotive force and internal resistance. Kirchhoff's circuit laws and their application for the solution of DC circuits.<br>**Practice:** Solution of DC circuits |
| 6th week:<br>**Lecture:** The magnetic field: Lorentz force, magnetic induction and its flux. Gauss's law for magnetism. (Maxwell's second equation) Ampere's circuital and Biot-Savart law and their application for the calculation of magnetic induction in simple cases.<br>**Practice:** Calculation of the force acting on a moving charged particle in a magnetic field. Calculation of magnetic induction in a magnetic field generated by current carrying wires. | 7th week: Waste Management<br>**Lecture:** Force acting on a current carrying conductor in a magnetic field. Method for the measurement of current and voltage on the bases of the above force with Deprez device. The magnetic analogy to Ohm's law. Magnetic circuits.<br>**Practice:** Calculation of the force acting on a current carrying wire in a magnetic field. Calculations in magnetic circuits. |
| 8th week: 1st drawing week, Test 1 | |
| 9th week:<br>**Lecture:** Electromagnetic induction: Faraday's law of induction and generalized Ampere's law (Maxwell's third and fourth equations). Self- and mutual-induction.<br>**Practice:** Calculation of the voltage induced in a loop and in different types of coils. | 10th week: Occupational Safety<br>**Lecture:** Working principle of AC generator and transformer. Summary of Maxwell's equations.<br>**Practice:** Solving problems in connection with AC generators and transformers. |

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|---|---|
| Calculation of the self and mutual inductance of coils. | |
| **11th week: Labor and Health**<br>**Lecture:** Concept and characteristics of alternating current and voltage, inductive and capacitive reactance. Power in AC circuits.<br>**Practice:** Calculations in AC circuits. | **12th week:**<br>**Lecture:** Analyzing AC circuits with complex numbers.<br>**Practice:** Analyzing AC circuits with complex numbers. |
| **13th week:**<br>**Lecture:** Characteristics of electromagnetic waves (wave number and length, intrinsic impedance, polarization, propagation constant). Reflection and transmission of plane electromagnetic waves at plane boundaries.<br>**Practice:** Calculation of the characteristics of electromagnetic waves. Solving problems of reflection and transmission of plane electromagnetic waves at plane boundaries. | **14th week:**<br>**Lecture:** Propagation of electromagnetic field along transmission lines<br>**Practice:** Solving electromagnetic wave propagation problems. |
| **15th week: 2nd drawing week, Test 2** | |

**Requirements**

**A, for a signature:**

Participation at lectures is compulsory. Students must attend lectures and may not miss more than three of them during the semester. In case a student does so, the subject will not be signed and the student must repeat the course. Attendance at lectures will be recorded by the lecturer. Being late is equivalent with an absence. In case of further absences, a medical certification needs to be presented. Missed lectures must be made up for at a later date, being discussed with the tutor.

Students have to write two midterm tests during the semester. The first (40 points max) in the 8th, the second (40 points max) in the 14th week. At the end of the semester everybody will get a seminar grade as follows (score/grade): 0-39 = fail; 40-50 = pass (2); 51-60 = satisfactory (3); 61-70 = good (4); 71-80 = excellent (5).

If somebody fails then he has to write both tests in the 1st week of the exam period again. If the result is 40 points (50%) or better, then he can take an exam. If somebody has to repeat his midterm tests then his seminar grade can't be better than (2).

There will be homework from week to week. Only students who have handed in all their homework at the time of the midterm test will be allowed to write it. The problems in the midterm tests will be selected from the homework assignments.

**B, for a grade:**

For their exam everybody will get an exam grade. The final grade will be the average of the seminar and exam grade. If it is for example (3.5) then the lecturer decides if it is (3) or (4).

## Statics and Strength of Materials

Code: MK3STSZG04XX17-EN

ECTS Credit Points: 4

Evaluation: mid-semester grade

Year, Semester: 2nd year, 1st semester

Its prerequisite(s): Engineering Physics

Further courses are built on it: Yes/No

Number of teaching hours/week (lecture + practice): 2+2

### Topics:

Introduction to engineering mechanics. Newton's laws of motion. Force, moment, and couples. Statics of a particle. Statics of rigid body. Planar force systems. Statics of planar structures. Internal force systems of rigid bodies. Loading of beams (cantilevers, freely supported beams, fraction lined beams). Determination of stress resultant diagrams (normal force, shear force and bending moment diagrams). Statically determined beam structures (hinged-bar systems, compound beams, truss systems). Fundamentals of Strength of Materials. Physical interpretation of strain terms. State of deformation. State of stresses. Constitutive equation (Hooke's law). Simple loadings (tension, compression, bending, torsion, shear). Sizing methods. Mohr's circle. Combined loadings (tension and bending, inclined bending, excentrical tension, tension and torsion, bending and torsion). An introduction to the finite element method.

### Literature:

*Compulsory:*

- Russel C. Hibbeler (2006): Engineering Mechanics – Statics and Dynamics, Prentice Hall, 2006. ISBN-13 9780132215091
- Ladislav Cerny (1981): Elementary Statics and Strength of Materials, McGraw-Hill, ISBN 0070103399, 9780070103399
- László Kocsis (1988): Brief Account of the Lectures of Mechanics, Strength of Materials, BME
- Ferdinand P. Beer, E. Russel Johnston, Jr., John T. DeWolf (2006): University of Connecticut Mechanics of Materials, 4th Edition, © 2006, ISBN-13 9780073107950

*Recommended:*

- Stephen Timoshenko (1955): Strength of Materials: Elementary Theory and Problems, Van Nostrand
- Jacob Pieter Den Hartog (1961): Strength of Materials, Courier Dover Publications, ISBN 0486607550, 9780486607559

### Schedule

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|---|---|
| 1st week Registration week | |
| 2nd week:<br>**Lecture:** Mathematical preliminaries (vector-, matrixalgebra). Introduction to engineering mechanics. Statics of a particle<br>**Practice:** Calculation the resultant of 2 and 3 dimensional force systems acting on particles. | 3rd week:<br>**Lecture:** Statics of rigid bodies. Moments. Equilibrium state of a rigid body. Planar force systems.<br>**Practice:** Calculation of moments. Examples for equilibrium state of rigid bodies and for planar force systems. |
| 4th week:<br>**Lecture:** Statics of planar structures. Supports and reaction forces.<br>**Practice:** Practical examples for the determination of the reaction forces of statically determined structures. | 5th week:<br>**Lecture:** Internal force systems of rigid bodies. Loading of beams.<br>**Practice:** Practical examples for the determination of the normal force, shear force and bending moment functions of beams. |
| 6th week:<br>**Lecture:** Determination of stress resultant diagrams of beams.<br>**Practice:** Practical examples for the determination of the normal force, shear force and bending moment diagrams of beams. | 7th week:<br>**Lecture:** Statically determined beam structures.<br>**Practice:** Analysis of hinged-bar systems and truss systems. **1st test.** |
| 8th week: 1st drawing week | |
| 9th week:<br>**Lecture:** Fundamentals of Strength of Materials. Displacement-, strain- and stress field. Constitutive equation (Hooke's law).<br>**Practice:** Practical examples for strain and stress calculations. | 10th week:<br>**Lecture:** Simple loadings I: tension, compression and bending of prismatic beams. Fundamentals of sizing and control.<br>**Practice:** Practical examples for tension, compression and bending. |
| 11th week:<br>**Lecture:** Simple loadings II: torsion of prismatic beams with circular and ring cross sections. Mohr's circle. Shear.<br>**Practice:** Practical examples for torsion and shear. | 12th week:<br>**Lecture:** Combined loadings I: tension and bending, inclined bending, excentrical tension.<br>**Practice:** Practical examples for combined loadings. |
| 13th week:<br>**Lecture:** Combined loadings II: tension and torsion, bending and torsion. Sizing methods.<br>**Practice:** Practical examples for combined loadings. | 14th week:<br>**Lecture:** The finite element method.<br>**Practice:** Case studies for numerical calculation of engineering structures. **2nd test.** |
| 15th week: 2nd drawing week | |

Requirements

A, for a signature:

Attendance at **lectures** is recommended, but not compulsory.

Participation at **practice** is compulsory. Students must attend the practice classes and may not miss more than three times during the semester. In case a student does so, the subject will not be signed and the student must repeat the course. Students can't make up a practice class with another group. Attendance at practice classes will be recorded by the practice leader. Being late is counted as an absence. In case of further absences, a medical certificate needs to be presented. Missed practices should be made up for at a later date, being discussed with the tutor. Students are required to bring the drawing tasks and drawing instruments to the course with them to each practice class. Active participation is evaluated by the teacher in every class. If a student's behaviour or conduct doesn't meet the requirements of active participation, the teacher may evaluate his/her participation as an absence because of the lack of active participation in class.

During the semester there are two tests: the 1st test in the 7th week and the 2nd test in the 14th week. Students have to sit for the tests.

B, for a grade:

The course ends in a **mid-semester grade** based on the test results.

The minimum requirement for both mid-term and end-term tests is 50%. Based on the score of the tests separately, the grade for the tests is given as follows: (score/grade): 0-39 = fail; 40-52 = pass (2); 52-63 = satisfactory (3); 64-71 = good (4); 72-80 = excellent (5).

If the score of the sum of the two tests is below 40, the student once can take a retake test of the whole semester material.

## Dynamics and Vibrations

Code: MK3MREZG04XX17-EN

ECTS Credit Points: 4

Evaluation: mid-semester grade

Year, Semester: 2nd year, 2nd semester

Its prerequisite(s): Engineering Physics

Further courses are built on it: Yes/No

Number of teaching hours/week (lecture + practice): 2+2

Topics:

Motion of a particle:

position, velocity and acceleration and the mathematical relations between them, description of the motion of the particle in Cartesian coordinate system and Frenet-frame, Newton's laws and differential equation of the motion of the particle, theorems of kinetics, force fields, kinetic, potential and mechanical energy, constrained motion along a two or three dimensional curve

Motion of a rigid body:

description of the translational, rotational and general plane motion of a rigid body, concept and determination of the instantaneous centre of zero velocity and acceleration, rolling motion without slipping, description of the plane motion of a rigid body in a time interval, centre of mass, momentum and angular momentum, moment of inertia and its calculation, mechanical work, Newton's laws and theorem of kinetics for rigid bodies, rotating and swinging of the body about an axis, rolling without slipping

Vibrations:

Description and classification of vibratory motions and vibrating systems. Basic definitions and properties of vibratory motion. Investigation of the elements of vibrating systems: masses and inertial elements, flexible and damping elements. Investigation of the dynamic models. Two ways for the generation of motion equations: the D'Alembert's principle and the Lagrange equations of motion. Investigation and properties of the free vibrations of single DOF undamped and damped systems. Solution of the homogenous motion equation. Investigation and properties of the forced vibrations of single DOF undamped and damped systems. Basic types of forced vibrating systems. Multiple DOF systems: introduction, basic properties, natural frequencies and modes, modal transform and decoupling.

## Literature:

*Compulsory:*

- Russel C. Hibbeler: Engineering Mechanics – Statics and Dynamics, Prentice Hall, 2006. ISBN-13 9780132215091
- Jerry Ginsberg: Engineering Dynamics, 3rd edition, Cambridge University Press, 2007. ISBN-13: 978-0521883030
- Lakshmana C. Rao, J. Lakshminarasimhan, Raju Sethuraman, Srinivasan M. Sivakumar: Engineering Mechanics: Statics and Dynamics, PHI Learning Pvt. Ltd., 2004. ISBN 8120321898, 9788120321892
- Meirovitch, Leonard: Fundamentals of Vibration, McGraw-Hill Publishing Company, 2000. ISBN 0071181741

*Recommended:*

- Ferdinand P. Beer, E. Russell Johnston, Jr.: University of Connecticut, Mechanics for Engineers: Statics and Dynamics (Package), 4th Edition, ©1987, ISBN-13 9780070045842
- Joseph F. Shelley: 700 solved problems in vector mechanics for engineers, Volume II: Dynamics. (SCHAUM'S SOLVED PROBLEM SERIES), McGraw-Hill, 1990. ISBN 0-07-056687-9

## Schedule

| 1st week Registration week | |
|---|---|
| 2nd week:<br>Lecture: Kinematics of a particle<br>Scalar and vector position, velocity and acceleration and the mathematical relations between them. Description of the | 3rd week:<br>Lecture: Kinetics of a particle I<br>Newton's laws and differential equation of the motion of the particle. Theorems of kinetics (impulse-momentum, work-energy |

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| motion in Cartesian coordinate system and Frenet-frame. Special motion types: Motion with constant acceleration, circular motion.<br>**Practice:** Particle kinematics problems | and angular impulse-angular momentum theorems). Mechanical Power. Force fields (homogeneous, central and conservative). Kinetic, potential and mechanical energy.<br>**Practice:** Particle kinetics problems |
| 4th week:<br>Lecture: Kinetics of a particle II<br>Formulas for work and potential energy in homogeneous and central force fields. Motion of the particle in gravitational and elastic spring force fields. Constrained motion along a two or three dimensional curve.<br>**Practice:** Particle kinetics problems II | 5th week:<br>Lecture: Kinematics of a rigid body I<br>Basic concepts (rigid body and disc, planar, translational, rotational and general plane motion). Connections between the velocity and acceleration of the different points of a rigid body undergoing translational, rotational and general plane motion. Instantaneous centre of zero velocity and acceleration and procedure for the determination of them with calculation and construction.<br>**Practice:** Rigid body kinematics problems |
| 6th week:<br>Lecture: Kinematics of a rigid body II<br>Rolling motion without slipping. Description of the plane motion of a rigid body in a time interval. Pole curves.<br>**Practice:** Rigid body kinematics problems | 7th week:<br>Lecture: Kinetics of a rigid body I<br>Basic concepts: centre of mass, momentum and angular momentum, moment of inertia and its calculation, parallel axis theorem, mechanical work.<br>**Practice:** Rigid body kinetics problems |
| 8th week: 1st drawing week | |
| 9th week:<br>Lecture: Kinetics of a rigid body II<br>Newton's laws and theorem of kinetics for rigid bodies (impulse-momentum, angular impulse-angular momentum and work-energy theorems). Special motion types: Rotating and swinging about an axis, rolling without slipping.<br>**Practice:** Rigid body kinetics problems | 10th week:<br>Lecture:<br>Description and classification of vibratory motions and vibrating systems. Basic definitions and properties of vibratory motion. Investigation of the elements of vibrating systems: masses and inertial elements, flexible and damping elements.<br>**Practice:** Reduction of masses. Replacement of rigid bodies by lumped masses. Reduction of springs and damping elements. |
| 11th week:<br>**Lecture:** Investigation of the dynamic models. Two ways for the generation of motion equations: the D'Alembert's principle and the Lagrange equations of motion. | 12th week:<br>**Lecture:** Investigation and properties of the free vibrations of single DOF undamped and damped systems. Solution of the homogenous motion equation.<br>**Practice:** Calculation problems related to the free vibrations of single DOF undamped and damped systems. |

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| **Practice:** Generating the equations of motion for single- and multiple degrees of freedom (DOF) systems. | |
| **13th week:** | **14th week:** |
| **Lecture:** Investigation and properties of the forced vibrations of single DOF undamped and damped systems. Basic types of forced vibrating systems. | **Lecture:** Multiple DOF systems: introduction, basic properties, natural frequencies and modes, modal transform and decoupling. |
| **Practice:** Calculation examples of several kinds of forced vibrations in case of single DOF undamped and damped systems. | **Practice:** Calculation problems related to the free and forced vibrations of multiple DOF undamped and damped systems. |
| **15th week: 2nd drawing week** | |

**Requirements**

**A, for a signature:**

Attendance at **lectures** is recommended, but not compulsory.

Participation at **practice** is compulsory. Students must attend the practices and may not miss more than three practice classes during the semester. In case a student does so, the subject will not be signed and the student must repeat the course. Student can't make up a practice with another group. Attendance at practice will be recorded by the practice leader. Being late is counted as an absence. In case of further absences, a medical certificate needs to be presented. Missed practices should be made up for at a later date, to be discussed with the tutor.

During the semester there are two tests: the mid-term test is in the 8th week and the end-term test in the 15th week. Students have to sit for the tests.

**B, for a grade:**

The course ends in **mid-semester grade** based on the average grade of the two tests.

The minimum requirement for the mid-term and end-term tests is 60%. Based on the score of the tests separately, the grade for the tests is given according to the following (score/grade): 0-59 % = fail (1); 60-69 % = pass (2); 70-79 % = satisfactory (3); 80-89 % = good (4); 90-100 % = excellent (5).

If the score of any test is below 60, the student once can take a retake test covering the whole semester material.

## Materials Engineering

Code: MK3ANISG06RX17-EN

ECTS Credit Points: 6

Evaluation: mid-term grade

Year, Semester: 1st year, 2nd semester

Its prerequisite(s): Engineering Physics

Further courses are built on it: Yes/No

Number of teaching hours/week (lecture + practice): 3+2

Topics:

The aim of the course is to give the basic, and useful material science knowledge to our students, through the presentation of special materials and its tangible analysis. Additionally, students can get closer to medical materials, which are currently being developed at a remarkable scale.

Literature:

*Compulsory:*

- Chawla, Krishan K. Composite Materials Science and Engineering 3rd ed. Springer 2012
- Nicolais, Luigi; Meo, Michele; Milella, Eva: Composite Materials: A Vision for the Future, 2011 Springer Verlag
- C.P. Poole, F.J. Owens: Introduction to nanotechnology, Wiley Interscience, 2003

Schedule

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|---|---|
| 1st week Registration week | |
| 2nd week:<br>Lecture: Overview of the groups of engineering materials and presentation of the latest material science results<br>Practice: Preparation of a metallographic sample for semester task | 3rd week:<br>Lecture: Metals I - overview and presentation of metallic alloys<br>Practice: Preparation of a metallographic sample for semester task |
| 4th week:<br>Lecture: Metals II - manufacturing technology of metals<br>Practice: Preparation of a metallographic sample for semester task | 5th week:<br>Lecture: Metals III – Material testing and qualification<br>Practice: Preparation of a metallographic sample for semester task |
| 6th week:<br>Lecture: Metals IV – Theoretical background f metal alloys<br>Practice: Microscopic analysis to complete the semester task | 7th week:<br>Lecture: Polymer I - Overview of Industrial Polymers, Production Technology<br>Practice: Microscopic analysis to complete the semester task |
| 8th week: 1st drawing week | |
| 9th week:<br>Lecture: Polymer II - Certification procedures for industrial polymers, case studies | 10th week:<br>Lecture: Ceramics I - Overview<br>Practice: Microscopic analysis to complete the semester task |

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| **Practice:** Microscopic analysis to complete the semester task | |
| **11th week:** | **12th week:** |
| **Lecture:** Ceramics II - Production technology | **Lecture:** Ceramics III - Qualification procedures |
| **Practice:** Measurement of toughness toughness and theoretical strength calculation of the ceramic coating of the neural implant. | **Practice:** Measurement of toughness toughness and theoretical strength calculation of the ceramic coating of the neural implant. |
| **13th week:** | **14th week:** |
| **Lecture:** Composite materials. | **Lecture:** Special and Biocompatible materials. |
| **Practice:** Presentation of semester task | **Practice:** Microscopic analysis of human implants |
| **15th week: 2nd drawing week** | |

Requirements

A, for a signature:

Attending practices is compulsory. Students must attend practice classes and may not miss more than three practice classes during the semester. In case a student does so, the subject will not be signed and the student must repeat the course. Students can't take part in any practice class with another group. Attendance at practice classes will be recorded by the practice leader. Being late is equivalent with an absence. In case of further absences, a medical certification needs to be presented. Missed practice classes must be made up for at a later date, being discussed with the tutor.

During the semester there are two tests: the mid-term test is on the 8th week and the end-term test is on the 15th week. Students must sit for the tests.

B, for a grade:

The course ends in a mid-semester grade based on the average grade of the two tests.

The minimum requirement of the mid-term and the end-term test is 60% separately. The grade for each test is given according to the following (score/grade): 0-59 % = fail (1); 60-69 % = pass (2); 70-79 % = satisfactory (3); 80-89 % = good (4); 90-100 % = excellent (5).

If the score of any test is below 60, the student once can take a retake test of the whole semester material.

## Law and Ethics

Code: MK3JOGEM04XX17-EN

ECTS Credit Points: 4

Evaluation: mid-semester grade

Year, Semester: 1st year, 1st semester

Its prerequisite(s): -

Further courses are built on it: Yes/No

Number of teaching hours/week (lecture + practice): 2+0

### Topics:

This subject helps the students to understand the basics of a legal relationship. The subject also covers the organization of power, duties, and functions of public authorities of all kinds engaged in administration; their relations with one another and with citizens and non-governmental bodies; legal methods of controlling public administration; and the rights and liabilities of officials. The subject also helps the students understand the organization of a national legislature, the structure of the courts, the characteristics of a cabinet, and the role of the head of state, and the government. It introduces sources of law and legal method, business organizations and legal relationships, contracts including the supply of goods and services. Since Hungary is a part of the European Union the subjects also covers the basic knowledge of European Union Law. Students will learn about the concepts and fundamental values of decent human conduct including the universal values and basic human rights.

### Literature:

*Compulsory:*

- The basic Law of Hungary, Lóránt Schink, Balázs Schanda, András Zs. Varga, Clarus Press, 9781905536-45-0

### Schedule

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|---|---|
| **1st week Registration week** | |
| **2nd week**<br>**Lecture:** The introduction of Hungarian legal system, the basics, the Constitution, and the sources of law in Hungary and in the European Union. The fundamental values, Hungary and basic human rights. | **3rd week:**<br>**Lecture:** The basics of state administration, the legislative, executive bodies, the Parliament, the Government, the Head of state. The court system in general. |
| **4th week:** | **5th week:** |

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| **Lecture:** The role of the local governments in Hungary, and the institutes of the local administration. | **Lecture:** Hungary and The European Union, the history, the legal and institutional changes since Hungary joined the EU. The sources of Law in the European Union. |
| 6th week: | 7th week: |
| **Lecture:** The basic legal phrases of the civil law in Hungary and in the law of the European Union, the sources of law, the legal relationships, the law system. | **Lecture:** The most important features and legal rules of the legal person. The founding documents, the common rules of legal persons (entrepreneurships), the organization of legal persons. |
| 8th week: 1st drawing week | |
| 9th week: | 10th week: |
| **Lecture:** The most important features and rules of contracts in Hungarian and EU Law. The rules of the freedom of the contracts. | **Lecture:** Most important individual contracts in Hungarian and EU Law, especially sales contract, entrepreneurship contract, employment contract. |
| 11th week: | 12th week: |
| **Lecture:** The working and development of the law system and sources of law in practice. The basics of Ethics and Universal values. | **Lecture:** The practical introduction of the individual contracts, explaining the common rules and the differences. Also the basics of engineering ethics, and a closer look at the engineering contracts. |
| 13th week: | 14th week: |
| **Lecture:** The Hungarian legal system compared with other legal systems in the European Union, examining the continental legal system, and the common law. | **Lecture:** Questions and answers, comparison of Hungarian legal system with the students home countries'. |
| 15th week: 2nd drawing week | |

Requirements

A, for a signature:

Attendance at **lectures** is recommended, but not compulsory.

B, for a grade:

The course ends in **mid-semester grade** based on the average grade of the two tests.

The minimum requirement for the mid-term and end-term tests is 60%. Based on the score of the tests separately, the grade for the tests is given according to the following (score/grade): 0-59 % = fail (1); 60-69 % = pass (2); 70-79 % = satisfactory (3); 80-89 % = good (4); 90-100 % = excellent (5).

If the score of any test is below 60, the student once can take a retake test of the whole semester material.

## Economics for Engineers

Code: MK3KOZMM04XX17-EN

ECTS Credit Points: 4

Evaluation: exam

Year, Semester: 1st year, 2nd semester

Its prerequisite(s): -

Further courses are built on it: Yes/No

Number of teaching hours/week (lecture + practice): 1+2

Topics:

Measuring Economic Output and National Income. The Keynesian Theory of consumption. The Government and Fiscal policy. Open Economy. Money market. The aggregate demand and aggregate supply. The labour market. Unemployment. Inflation.

Literature:

*Compulsory: -*

- Mankiw, Gregory: Principles of Economics. Fifth Edition. South-Western, Mason, USA, 2009. ISBN: 9780324589979.
- Mankiw, Gregory (2015): Principles of Economics. Study Guide. Seventh Edition. Cengage Learning, ISBN-13:978-1-285-86421-1.
- Judit T. Kiss (2014): Introduction to Macroeconomics for Engineers and Technical Managers. Debrecen University Press. ISBN: 978-963-318-416-5.

*Recommended:*

- K. E. Case – R. C. Fair – S. M. Oster (2012): Principles of Macroeconomics, Tenth Edition. Prentice Hall, ISBN 13: 978-0-13-139140-6.
- Samuelson P.A., Nordhaus W.D.: Economics, 18th edition, Academic Internet Publishers Inc., 2006. ISBN: 0072872055
- Parkin, M., Powell, M. & Matthews, K. (2008) Economics. 7th ed. Harlow: Addison Wesley. ISBN-13: 9780132041225
- Parkin, M (2005) Economics, 7th edn, Addision Wersley: Pearson. ISBN: 0321248449.

Schedule

| 1st week Registration week | |
|---|---|
| 2nd week:<br>**Lecture:** The Scope and Method of Economics<br>Introduction to economics. The method of economics. Microeconomics and Macroeconomics. Models in Economics. Introduction to Macroeconomics. The | 3rd week:<br>**Lecture:** Measuring national output and national income (Gross Output, Gross Domestic Product, calculating GDP, real versus nominal GDP, the components of the GDP, the expenditure approach, the income approach, GDP deflator, Gross National Income, and Gross National |

components of the Macroeconomics. The circular flow Diagram. Market sectors.

**Practice:** Calculation/team problems: The circular flow Diagram. Case study examination.

Disposable income). Measuring the cost of living (GDP and Social Welfare, the Consumer Price Index, GDP deflator versus CPI, real and nominal interest rate).

**Practice:** Calculation/team problems: The expenditure approach. The difference between real GDP and nominal GDP. Macroeconomic indicators.

**4th week:**

**Lecture:** Market demand and supply, equilibrium. The Keynesian Theory of consumption, consumption function, marginal propensity to consume, planned investment, saving function, marginal propensity to saving, aggregate output, determination of equilibrium output, the multiplier, IS curve.

**Practice:** Calculation/team problems: Market demand and supply, equilibrium. Two sector model.

**5th week:**

**Lecture:** The government and fiscal policy. Government purchases, taxes, disposable income, government budget deficit and surpluses, determination of equilibrium output, fiscal policy, the government spending multiplier, the tax multiplier. Average tax rate, tax wedge, and marginal tax rate.

**Practice:** Calculation/team problems: Fiscal policy and the equilibrium. Average tax rate, tax wedge, and marginal tax rate.

**6th week:**

**Lecture:** Demand and supply in an open economy. Equilibrium output in an Open Economy, net exports. Imports and exports and Trade Feedback effect. Measurement of openness. Exchange rates.

**Practice:** Calculation/team problems: Demand and supply in an open economy. Equilibrium output in an Open Economy, net exports.

**7th week:**

**Lecture:** The meaning of money, the functions of money, measuring the supply of money. The creation of money, required reserve ratio. The money multiplier. Open market operations. Fisher effect (nominal and real interest rate). Banking system, Commercial banking.

**Practice:** Calculation/team problems: The money multiplier. Fisher effect (nominal and real interest rate).

**8th week: 1st drawing week**

**9th week:**

**Lecture:** The demand for money. Supply and demand in the money market. The equilibrium interest rate. The LM curve. The equilibrium price-level.

**Practice:** Mid-Term Test I

**10th week:**

**Lecture:** Aggregate demand curve and aggregate supply curve. The effects of a shift in aggregate demand, the Equilibrium. The IS-LM model. Fiscal and monetary policy.

**Practice:** Calculation/team problems: The demand for money. Supply and demand in the money market. The equilibrium interest rate.

**11th week:**

**Lecture:** The demand for labour, the supply of labour. The labour force, working-age population, active and inactive population,

**12th week:**

**Lecture:** Unemployment, the unemployment rate, the activity rate. Types of unemployment (voluntarily and

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| labour participation rate. Supply curve and demand curve, equilibrium.<br>**Practice:** Calculation/team problems: Examination of the fiscal and monetary policy. | involuntarily unemployment; structural, frictional and cyclical unemployment), Okun law. Social and economic effect.<br>**Practice:** Calculation/team problems: The labour force, working-age population, active and inactive population, labour participation rate. |
| **13th week:**<br>**Lecture:** Inflation; (Price level, inflation rate, definition and measuring of inflation, types and causes of inflation, demand-pull inflation and cost-push inflation, The Philips curve: unemployment rate and inflation rate).<br>**Practice:** Calculation/team problems: Supply curve and demand curve, equilibrium. Disequilibrium in the labour market. | **14th week:**<br>**Lecture:** Growth (sources of economic growth, human capital, education and skills), Economic growth around the World. Sustainable development.<br>**Practice:** Calculation/team problems: demand-pull inflation and cost-push inflation. |
| **15th week: 2nd drawing week** | |

**Requirements**

**A, for a signature:**

Attending practices is compulsory. Students must attend practice classes and may not miss more than three occasions during the semester. In case a student does so, the subject will not be signed and the student must repeat the course. Students can't take part in any practice class with another group. Attendance at practice classes will be recorded by the practice leader. Being late is equivalent with an absence. In case of further absences, a medical certification needs to be presented. Missed practice classes must be made up for at a later date, being discussed with the tutor.

During the semester there are two tests: the mid-term test on the 7th week and the end-term test on the 15th week. Students must sit for the tests.

**B, for a grade:**

The course ends in an **examination.**

The minimum requirement of the mid-term, the end-term test and the teamwork is 50% separately. Based on the score of the tests separately, the grade for the tests and the examination is given according to the following table:

The grade is given according to the following (score/grade): 0-49 % = fail (1); 50-62 % = pass (2); 63-75 % = satisfactory (3); 76-89 % = good (4); 90-100 % = excellent (5).

If the score of any test is below 50%, the student once can take a retake test of the whole semester material.

**An offered grade**: It may be offered for the students if the average of the mid-term test, end-term tests and the teamwork is at least good (4). The offered grade is the average of them.

## Microeconomics and Economical Processes of Enterprises for Engineers

Code: MK3MIKVM04XX17-EN

ECTS Credit Points: 4

Evaluation: exam

Year, Semester: 2nd year, 1st semester

Its prerequisite(s): Economics for Engineering

Further courses are built on it: Yes/No

Number of teaching hours/week (lecture + practice): 1+2

### Topics:

Basic concepts of Economics and Microeconomics. Consumers Preferences and the Concept of Utility. Consumer's demand, types of elasticity of demand. Examination of Firm Behaviour. Production and cost theory. Perfectly competitive markets. Imperfect competition and market structures. Strategic behaviour at the market.

### Literature:

*Compulsory:*

- Besanko, David – Breautigam, Ronald R. (2014): Microeconomics. Fifth Edition (International Student version). John Wiley and Sons, Inc., New York. ISBN: 978-1-118-71638-0
- Besanko, David – Breautigam, Ronald R.: Microeconomics. Study Guide. Third Edition. John Wiley and Sons, Inc., New York, 2008.
- Judit T. Kiss (2015): Introduction to Microeconomics for Engineers and Technical Managers. Debrecen University Press. ISBN: 978-963-318-469-1.

or

- N. Gregory Mankiw – Mark P. Taylor (2011): Microeconomics, 2nd edition. South-Western Cenagage Lerrning.
- Gregory Mankiw (2006): Principles of Microeconomics - Study Guide. South-Western College Pub.
- Nellis, J. G. – Parker, D. (2006): Principles of Business Economics. Pearson Education, 2006. 2nd edition. ISBN: 0273693069, 9780273693062.

*Recommended:*

- Samuelson P.A., Nordhaus W.D.: Economics, 18th edition, Academic Internet Publishers Inc., 2006. ISBN: 0072872055
- Parkin, M., Powell, M. & Matthews, K. (2008) Economics. 7th ed. Harlow: Addison Wesley. ISBN-13: 9780132041225

### Schedule

1st week Registration week

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|---|---|
| **2nd week:** | **3rd week:** |
| **Lecture:** Microeconomics and Macroeconomics, models in Economics. Resources. Key analytical tools. Efficiency. Market mechanism, Demand and supply analysis. Demand curves, Supply curves; shift in demand and supply.<br>**Practice:** Calculation/team problems: equilibrium price and quantity; market demand and individual demand; shifts versus movements along the demand curve (supply curve); market supply and individual supply; shifts versus movements along the supply curve. | **Lecture:** Consumer theory, consumer preferences, Utility theory. Cardinal ranking. Total utility, marginal utility. Principle of diminishing marginal utility. Utility and demand. Individual and market demand functions. Consumer surplus. Condition of optimal choice.<br>**Practice:** Calculation/team problems: Relationship between utility and demand. Individual and market demand functions. Consumer surplus |
| **4th week:** | **5th week:** |
| **Lecture:** Demand and supply together, market equilibrium. The elasticity of demand (price elasticity of demand, cross price elasticity of demand, income elasticity of demand). The elasticity of supply. Total revenue and the price elasticity of demand. Application of elasticity of demand. Energy and price elasticity. Types of goods (substitutes, complements, independents).<br>**Practice:** Calculation/team problems: Calculation of elasticity of demand, relationship between price elasticity of demand and total revenue. | **Lecture:** Business organizational structures. Business objectives. Types of corporation, forms of business. Market environment (domestic, international environment, markets of products, services and labour). Models of the firm's pricing decisions, costs estimation and decision. Sources of Cost efficiency. Business performance, business strategy.<br>**Practice:** Calculation/team problems and case study examination: Firm's pricing decisions, costs estimation and decision. Sources of Cost efficiency. |
| **6th week:** | **7th week:** |
| **Lecture:** Production. Inputs and production function. Total product function. Marginal product of labour and average product of labour.<br>**Practice:** Calculation/team problems: Average product of labour (capital), marginal product of labour (capital), relationship between marginal product and average product. | **Lecture:** Costs of production. (Total, fixed and variable costs, marginal and variable cost). The relationship between marginal and average cost. Total revenue, total profit curves. Calculating problems (types of cost, relationship between cost and profit. opportunity cost).<br>**Practice:** Calculation/team problems: Total, fixed and variable costs; marginal and average costs. The relationship between marginal cost and average cost. |
| **8th week: 1st drawing week** | |
| **9th week:** | **10th week:** |
| **Lecture:** Main characteristics of perfect competition, marginal cost, average costs of production, profit-maximizing output, shut down and breakeven point, the competitive firm's supply curve. Calculating | **Lecture:** Individual and market supply curve, main condition of the profit maximization and cost minimization, Cost-benefit analysis, economical examinations. |

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| problems (marginal average, total revenue, average and marginal profit, profit-maximizing output, marginal cost curve and supply curve).<br>**Practice:** Mid-Term Test I | **Practice:** Calculation/team problems: Profit maximization condition for competitive market. |
| **11th week:**<br>**Lecture:** Why Monopoly arise, Monopoly (the profit-maximization condition; average revenue, marginal revenue, total revenue curves).<br>Problems (calculation of the profit-maximization output and price. Relationship between marginal revenue and linear demand curve).<br>**Practice:** Calculation/team problems: Profit maximization condition for monopoly. | **12th week:**<br>**Lecture:** *Capturing surplus – Price discrimination* First-degree price discrimination, second-degree price discrimination and third- degree price discrimination. Consumer surplus, producer surplus, deadweight loss. The welfare cost of Monopoly.<br>**Practice:** Calculation/team problems: Monopoly versus perfect competition. Producer surplus and deadweight loss. |
| **13th week:**<br>**Lecture:** Main characteristics of oligopoly and monopolistic competition. Markets with a few sellers, product differentiation.<br>**Practice:** Calculation/team problems: Oligopoly market behaviour. | **14th week:**<br>**Lecture:** *The markets for the factors of production*. Taxes and efficiency. Earnings and discrimination. Game theory.<br>**Practice:** Calculation/team problems: Monopoly, Oligopoly and perfect competition. Taxes and efficiency. |
| **15th week: 2nd drawing week** | |

## Requirements

### A, for a signature:

Attending practices is compulsory. Students must attend practice classes and may not miss more than three occasions during the semester. In case a student does so, the subject will not be signed and the student must repeat the course. Students can't take part in any practice class with another group. Attendance at practice classes will be recorded by the practice leader. Being late is equivalent with an absence. In case of further absences, a medical certification needs to be presented. Missed practice classes must be made up for at a later date, being discussed with the tutor.

During the semester there are two tests: the mid-term test on the 7th week and the end-term test on the 15th week. Students must sit for the tests.

### B, for a grade:

The course ends in an **examination.**

The minimum requirement of the mid-term, the end-term test and the teamwork is 50% separately. Based on the score of the tests separately, the grade for the tests and the examination is given according to the following table:

The grade is given according to the following (score/grade): 0-49 % = fail (1); 50-62 % = pass (2); 63-75 % = satisfactory (3); 76-89 % = good (4); 90-100 % = excellent (5).

If the score of any test is below 50%, the student once can take a retake test of the whole semester material.

An offered grade: It may be offered for the students if the average of the mid-term test, end-term tests and the teamwork is at least good (4). The offered grade is the average of them.

## Quality and Technical Management

Code: MK3MINMM04XX17-EN

ECTS Credit Points: 4

Evaluation: exam

Year, Semester: 3rd year, 1st semester

Its prerequisite(s): Microeconomics and Economical Processes of Enterprises for Engineers

Further courses are built on it: Yes/No

Number of teaching hours/week (lecture + practice): 2+2

### Topics:

The aim of the course is to provide students with a comprehensive picture of the organization's operations and the associated management and organizational roles and tasks. The aim of the course is to give students the opportunity to share with the company's quality management techniques, the application of which in the European Union, as well as in Hungary, is an essential element of market competitiveness.

### Literature:

*Compulsory:*

- Nick Milton, Patrick Lambe: The Knowledge Manager's Handbook, Kogen Page, London, 2016
- Ranulfo P. Payos, Ernesto G. Espinosa, Orlando S. Zorilla: Organization and Management, K12, 2016
- Ramani S: Improving Business Performance: A Project Portfolio Management Approach, CRC Press, 2016

### Schedule

| 1st week Registration week | |
|---|---|
| 2nd week:<br>**Lecture:** Basics of Quality management<br>**Practice:** Analyze examples | 3rd week:<br>**Lecture:** The role of quality management in the industry<br>**Practice:** PDCA project |
| 4th week: | 5th week: |

| | |
|---|---|
| **Lecture:** Process Management<br>**Practice:** Create a flowchart | **Lecture:** Quality Planning<br>**Practice:** Developing a Quality Plan |
| **6th week:**<br>**Lecture:** Quality Management Methods I<br>**Practice:** Ishikawa, Pareto Analysis, 5W | **7th week:**<br>**Lecture:** Quality Management Methods II<br>**Practice:** QFD, Kano model, 5s, 8D report |
| **8th week: 1st drawing week** | |
| **9th week:**<br>**Lecture:** Engineering management<br>**Practice:** Case study | **10th week:**<br>**Lecture:** Company and its surroundings<br>**Practice:** SWOT, Pestle analyzes |
| **11th week:**<br>**Lecture:** Management functions, manager roles, tasks<br>**Practice:** Situational tasks | **12th week:**<br>**Lecture:** Organization Theory<br>**Practice:** Process Development, Project Management |
| **13th week:**<br>**Lecture:** Human Resource Management<br>**Practice:** Recruitment, selection, work planning | **14th week:**<br>**Lecture:** Innovation Management<br>**Practice:** Business Plan |
| **15th week: 2nd drawing week** | |

Requirements

A, for a signature:

Participation at lectures is compulsory. Students must attend lectures and may not miss more than three of them during the semester. In case a student does so, the subject will not be signed and the student must repeat the course. Attendance at lectures will be recorded by the lecturer. Being late is equivalent with an absence. In case of further absences, a medical certification needs to be presented. Missed lectures must be made up for at a later date, being discussed with the tutor.

Students have to write two midterm tests during the semester. The first (40 points max) in the 8th, the second (40 points max) in the 14th week. At the end of the semester everybody will get a seminar grade on the basis of the following (score/grade): 0-39 = fail; 40-50 = pass (2); 51-60 = satisfactory (3); 61-70 = good (4); 71-80 = excellent (5).

If somebody fails, then he has to write both tests in the 1st week of the exam period again. If the result is 40 points (50%) or better, then he can take an exam. If somebody has to repeat his midterm tests, then his seminar grade can't be better than (2).

There will be homework from week to week. Only students who have handed in all their homework at the time of the midterm test will be allowed to write it. The problems in the midterm tests will be selected from the homework assignments.

B, for a grade:

Everybody will get an exam grade for their exam. The final grade will be the average of the seminar and exam grade. If it is for example (3.5) then the lecturer decides if it is (3) or (4).

## Basics of Mechatronics

Code: MK3MEALR4RX17-EN

ECTS Credit Points: 4

Evaluation: exam

Year, Semester: 1st year, 1st semester

Its prerequisite(s): -

Further courses are built on it: Yes/No

Number of teaching hours/week (lecture + practice): 2+2

### Topics:

The Basics of Mechatronics module has the goal to found the view after high school of an engineering student, an engineer manager and technical standpoint. The important attribute of mechatronics is the interrogation of the building blocks system, this is why it is especially important to gain a deep insight into the foundation, which during the duration of the studies will make it easier to plan the mechatronics system. We will take a look over the most important ways and actual trends in mechatronics. We will try to shed light, so that the description of the physical appearances during the engineering practice it will be known what mathematical approaches will be needed and later on we will take on other subjects as well. The job of an engineer is a lot of times physical reality mixed with abstract math and making a connection between the two. The module will try to shed light on both of these sides.

### Literature:

*Recommended:*

- Husi Géza: Bond Graph DE MK jegyzet
- Husi Géza: Practical Tasks

### Schedule

| 1st week Registration week | |
|---|---|
| **2nd week:**<br>**Lecture:** Industry 4.0 mechatronics approach, the place of mechatronics if the field of engineering sciences.<br>**Practice:** Examples of four jointed mechanism themes (movement, increasing speed and strength and emphasis description exercises).<br>**4th week:** | **3rd week:**<br>**Lecture:** Description of moving machines and introduction of their problems and on planar four jointed mechanism.<br>**Practice:** Examples of four jointed mechanism themes (movement, increasing speed and strength and emphasis description exercises).<br>**5th week:** |

| | |
|---|---|
| **Lecture:** Physical effects and signs of decomposing components, analytical and numerical models, mechatronics, as point of view, classical mechatronics.<br>**Practice:** Examples of four jointed mechanism themes (movement, increasing speed and strength and emphasis description exercises). | **Lecture:** Bond graphs appliance in mechatronics.<br>**Practice:** Bond graphs appliance. |
| 6th week:<br>**Lecture:** Introduction to Robotics, Robotics trends.<br>**Practice:** Bond graphs appliance. | 7th week:<br>**Lecture:** Opto-mechatronics trends, classical and modern appearance techniques, technics based on illusion, auto stereograms, vehicle mechatronic trends, personal vehicle mechatronics systems.<br>**Practice:** Rated exercise. |
| 8th week: 1st drawing week | |
| 9th week:<br>**Lecture:** Modeling and simulation of mechatronics systems. Creating model – theoretical steps. The role of creating models in mechatronics planning.<br>**Practice:** Modeling four jointed mechanisms. | 10th week:<br>**Lecture:** System technics: foundation concepts, grouping the systems.<br>**Practice:** Modeling of electrical machines. |
| 11th week:<br>**Lecture:** System technics: Finite dimension dynamic system, inscription of equation.<br>**Practice:** Modeling of thermodynamics 2. | 12th week:<br>**Lecture:** System technics: Finite dimension dynamic system, inscription of equation.<br>**Practice:** Modeling of thermodynamics 2. |
| 13th week:<br>**Lecture:** System techniques: mathematical tools SISO LTI investigation of the systems functioning, Laplace operational province, bilinear appearance of frequencies reception.<br>**Practice:** strain gauge stamped acceleration sensor modelling 1. | 14th week:<br>**Lecture:** System techniques: the most important control practice.<br>**Practice:** Strain gauge stamped acceleration sensor modelling 2. |
| 15th week: 2nd drawing week | |

Requirements

A, for a signature:

Participation at practice, according to Rules and Regulations of University of Debrecen. The correct solution of homework and submission before deadline. Solving assorted tasks.

B, for a grade:

Oral exam on theoretical part.

## Informatics (Labview)

Code: MK3LABVA4RX17-EN

ECTS Credit Points: 4

Evaluation: mid-semester grade

Year, Semester: 1st year, 2nd semester

Its prerequisite(s): -

Further courses are built on it: Yes/No

Number of teaching hours/week (lecture + practice): 0+4

### Topics:

The course covers the following topics: introduction to LabVIEW, creating applications, troubleshooting and debugging VIs, using loops, creating and leveraging data structures, using decision-making structures, modularity, acquiring measurements from hardware, accessing files in LabVIEW, using sequential and state machine programming, using variables, communicating data between parallel loops, implementing design patterns, controlling the user interface, file I/O techniques, improving an existing VI, creating and distributing applications.

### Literature:

*Compulsory:*

- National Instruments Corporation – LabVIEW User Manual, 11500 North Mopac Expressway, Austin, Texas, USA, http://www.ni.com/pdf/manuals/320999e.pdf
- National Instruments Corporation – Getting Started with LabVIEW, 11500 North Mopac Expressway, Austin, Texas, USA, http://www.ni.com/pdf/manuals/373427j.pdf
- National Instruments Corporation – LabVIEW Data Acquisition Basics Manual, 11500 North Mopac Expressway, Austin, Texas, USA, http://www.ni.com/pdf/manuals/320997d.pdf

### Schedule

| 1st week Registration week | |
|---|---|
| **2nd week:**<br>**Practice:** What is LabVIEW?, Project Explorer, Parts of a VI, Front Panel, Block Diagram, Searching for Controls, VIs, and Functions, Dataflow, LabVIEW Data Types, Tools for Programming, Cleaning and Organizing Your VI, Building a Basic VI | **3rd week:**<br>**Practice:** Correcting Broken VIs, Debugging Techniques, Error Handling, Loops Review, While Loops, For Loops, Timing a VI, Data Feedback in Loops |

| | |
|---|---|
| **4th week:**<br>**Practice:** Arrays, Common Array Functions, Polymorphism, Auto-Indexing, Clusters | **5th week:**<br>**Practice:** Case Structures, Event-Driven Programming, Understanding Modularity, Icon, Connector Pane, Documentation tools, Using SubVIs |
| **6th week:**<br>**Practice:** Measurement Fundamentals with NI DAQ Hardware, Automating Non-NI Instruments, Usage of myDAQ device | **7th week:**<br>**Practice:** Accessing Files from LabVIEW, High-Level and Low-Level File I/O Functions, Comparing File Formats, Using Sequential Programming, Using State Programming, State Machines |
| **8th week:** 1st drawing week, Test 1 | |
| **9th week:**<br>**Practice:** Local and Global Variables, Using Variables Appropriately, Race Conditions, Communicating Between Parallel Loops, Queues, Notifiers | **10th week:**<br>**Practice:** Usage of Design Patterns, Simple Design Patterns, Multiple Loop Design Patterns, Functional Global Variable, Error handling in Design Patterns, Generating Error Codes and Messages, Timing a Design Pattern |
| **11th week:**<br>**Practice:** VI Server Architecture, Property Nodes, Invoke Nodes, Control References | **12th week:**<br>**Practice:** File Formats, Creating File and Folder Paths, Write and Read Binary Files, Work with Multichannel Text Files with Headers, Access TDMS Files in LabVIEW and Excel |
| **13th week:**<br>**Practice:** Refactoring Inherited Code, Typical Refactoring Issues, Preparing the Files, Build Specifications, Create and Debug an Application, Create an Installer | **14th week:**<br>**Practice:**<br>Summary, Consultation, Sample Test |
| **15th week:** 2nd drawing week, Test 2 | |

Requirements

A, for a signature:

Participation at practices according to Rules and Regulations of University of Debrecen. Writing the two tests at least at a sufficient level.

B, for a grade:

The final grade of the course is based on the result of the tests and active participation.

## Electrotechnics

Code: MK3ELTER06RX17-EN

ECTS Credit Points: 6

Evaluation: exam

Year, Semester: 1st year, 2nd semester

Its prerequisite(s): -

Further courses are built on it: Yes/No

Number of teaching hours/week (lecture + practice): 2+2

**Topics**:

Introduction to DC circuits: voltage, current, basic components. Network analysis: Ohm's Law, Kirchhoff's Law, current and voltage divider, superposition, Thevenin and Norton's Law. Alternating current circuits: sinusoidal wave, calculation on the complex plane, power and effective values. DC and AC power. Transient signals in the AC circuits: series and parallel RLC circuits. 3 phases circuit.

**Literature:**

*Compulsory:*

- Electronic Circuits: Handbook for Design and Application, U. Tietze, Ch. Schenk, 2nd edition, 2008, ISBN-10: 3540004297

**Schedule**

| **1st week Registration week** | |
|---|---|
| **2nd week:**<br>**Lecture:** Electrostatics, DC networks: basic electrical concepts of electric charge, electric current (amperage), electric field, electric field work, electric voltage (potential), electric circuit<br>**Practice:** General description, laboratory regulations, Safety regulations and safety instruction | **3rd week:**<br>**Lecture:** Power source (ideal real), Power Source (ideal for real), Consumer, Ohm's Law, Resistance - design, characteristic data, division, marking according to IEC standard.<br>**Practice:** Introduction to measurements and instrumentation (measuring error, power supply, digital multimeter, signal generator) |
| **4th week:**<br>**Lecture:** Passive resistance of bipolar networks, Star-delta, delta-star conversion, Electrical work, electric power, efficiency<br>**Practice:** 1st measurement: measuring the characteristics of DC voltage (U, I, RB, P) using Ohm's Law. Report writing. | **5th week:**<br>**Lecture:** Network analysis: Kirchhoff's laws, Voltage divider, potentiometer, extending measuring range of a Volt meter current divider, extending measuring range of an Amp meter, Wheatstone bridge<br>**Practice:** 2nd measurement: measuring the values of DC circuit. Using Kirchhoff's laws. Report writing. |
| **6th week:** | **7th week:** |

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|---|---|
| **Lecture:** Network analysis: Nodal analysis, Mesh analysis, superposition theory<br>**Practice:** 3rd measurement: measuring the values of DC circuit. Using voltage and current divider. Report writing. | **Lecture:** Network analysis: Northon and Thevenin theory<br>**Practice:** 4th measurement: Perform a complex DC measurement and calculation task. Report writing. |
| **8th week: 1st drawing week** | |
| **9th week:**<br>**Lecture:** AC circuit, complex number, AC circuit mean value (RMS).<br>**Practice:** 5th measurement introduction to AC measurements and instrumentation (AC type digital multimeter, signal generator, oscilloscope, LRC meter). Report writing. | **10th week:**<br>**Lecture:** Behaviour of a resistance in AC circuit, inductance behavior in AC circuit, capacitance behavior in AC circuit.<br>**Practice:** 6th measurement: Alternating current, voltage characteristics measurement ($U_{eff}$, $I_{eff}$, f, P, waveform) using Ohm's law. Report writing. |
| **11th week:**<br>**Lecture:** AC circuit network analysis, AC Kirchhoff's laws<br>**Practice:** 7th measurement: alternating current analysis of capacitive and inductive elements. Analysis of serial and parallel RLC circuits. Report writing. | **12th week:**<br>**Lecture:** Performance of AC circuits, power factor correction, Three-phase systems<br>**Practice:** 8th measurement: alternating current analysis of wien-bridge. Report writing. |
| **13th week:**<br>**Lecture:** Transient signals in the AC circuits<br>**Practice:** 9th measurement: Measuring of serial RLC circuit. Report writing. | **14th week:**<br>**Lecture:** Advanced alternating current circuits: RL, RC, RLC circuits, parallel RL, RC, RLC circuits.<br>**Practice:** 10th measurement: Measuring of parallel RLC circuit. Report writing. |
| **15th week: 2nd drawing week** | |

Requirements

A, for a signature:

Attendance at lectures is recommended, but not compulsory. Attending practices is compulsory. A student must attend the practice classes and may not miss more than three times during the semester. In case a student does so, the subject will not be signed and the student must repeat the course. A student can't make up a practice class with another group. Attendance at practice classes will be recorded by the practice leader. Being late is equivalent with an absence. Missed practice classes must be made up for at a later date, being discussed with the tutor. Active participation is evaluated by the teacher in every class. If student's behavior or conduct doesn't meet the requirements of active participation, the teacher may evaluate his/her participation as absence because of the lack of active participation in class. During the semester there are one test. Students have to sit for these tests.

Preparing measurement reports until deadline.

B, for a grade:

At the end of the course an exam must be taken. The minimum requirement for end-term test is 41%. Score Grade 0-40 fail (1) 41-55 pass (2) 56-70 satisfactory (3) 71-85 good (4) 86-100 excellent (5)

## Electronics I

Code: MK3ELT1R06RX17-EN

ECTS Credit Points: 6

Evaluation: exam

Year, Semester: 2nd year, 1st semester

Its prerequisite(s): Electromagnetism

Further courses are built on it: Yes/No

Number of teaching hours/week (lecture + practice): 2+4

### Topics:

Introduction to electronics: features of electronic circuits, solid state devices. Transistors, unipolar and bipolar transistors. Operation, characteristics, and basic circuits. Amplifiers: 4 port theory, transfer functions, feedback: positive and negative. Semiconductors, diode, special diode. Common emitter amplifier. Differential amplifier: operational modes, circuit. Class A and AB amplifiers. Power amplifiers. Operational amplifiers: inverting and non-inverting type. Filters: Low and high pass filter, band pass filter.

### Literature:

*Compulsory:*

- Electronic Circuits: Handbook for Design and Application, U. Tietze, Ch. Schenk, 2nd edition, 2008, ISBN-10: 3540004297

### Schedule

| 1st week Registration week | |
|---|---|
| 2nd week:<br>**Lecture:** Pure and doped semiconductor characteristics, PN junction behavior at forward and reverse bias conditions.<br>**Practice:** Safety regulations, laboratory order, the use of measuring instruments. | 3rd week:<br>**Lecture:** Characteristics and applications of semiconductor diodes, the rectifier circuit operation, the one-way, two-way rectifier circuits operation.<br>**Practice:** Silicon diode opening and closing characteristics measurements. Analysis of rectifier circuits. Report writing. |
| 4th week: | 5th week: |

| | |
|---|---|
| **Lecture:** Bipolar transistor structure, gain, transistor parameters and characteristics, the FE connection, adjusting the set point. | **Lecture:** Areas of application of bipolar transistor, circuits transistor basic (CB, CC circuits), |
| **Practice:** DC specific analysis of common emitter basic circuit. Report writing. | **Practice:** AC specific analysis of common emitter basic circuit. Report writing. |
| 6th week: | 7th week: |
| **Lecture:** Principles of operation of field-effect transistors. | **Lecture:** Principles of operation of transistor amplifiers. (A, AB class, differential amp.) |
| **Practice:** Analysis of common source basic circuit. Report writing. | **Practice:** Analysis of differential power amplifier basic circuit. Report writing. |
| 8th week: 1st drawing week | |
| 9th week: | 10th week: |
| **Lecture:** Feedbacks concept, types and implementation. Operational Amplifier model structure (differential amplifier, level transmitting amplifiers) and features. | **Lecture:** Operation and characteristics of basic operational amplifier circuits (inverting, non-inverting, follower basic circuit) |
| **Practice:** Analysis of phase inverting operational amplifier basic circuit. Report writing. | **Practice:** Analysis of summing operational amplifier basic circuit. Report writing. |
| 11th week: | 12th week: |
| **Lecture:** Operation and characteristics of basic operational amplifier circuits (summing, differential, differentiator and integrator basic circuit) | **Lecture:** Using of the operation amplifier |
| **Practice:** Analysis of integrator operational amplifier basic circuit. Report writing. | **Practice:** Analysis of differentiator operational amplifier basic circuit. Report writing. |
| 13th week: | 14th week: |
| **Lecture:** Bode and Nyquist diagram | |
| **Practice:** Analysis of differential operational amplifier basic circuit. Report writing. | **Lecture:** Filters: Low and high pass filter, band pass filter. |
| | **Practice:** Analysis of filters basic circuit. Report writing. |
| 15th week: 2nd drawing week | |

Requirements

A, for a signature:

Attendance at lectures is recommended, but not compulsory. Attending practices is compulsory. A student must attend the practice classes and may not miss more than three times during the semester. In case a student does so, the subject will not be signed and the student must repeat the course. A student can't make up a practice class with another group. Attendance at practice classes will be recorded by the practice leader. Being late is equivalent with an absence. Missed practice classes must be made up for at a later date, being discussed with the tutor. Active participation is evaluated by the teacher in every

class. If student's behavior or conduct doesn't meet the requirements of active participation, the teacher may evaluate his/her participation as absence because of the lack of active participation in class. During the semester there are one test. Students have to sit for these tests.

Preparing measurement reports until deadline.

### B, for a grade:

At the end of the course an exam must be taken. The minimum requirement for end-term test is 41%. Score Grade 0-40 fail (1) 41-55 pass (2) 56-70 satisfactory (3) 71-85 good (4) 86-100 excellent (5)

## Mechatronic Devices (Sensors, Actuators, Motors)

Code: MK3ERZBR04RX17-EN

ECTS Credit Points: 4

Evaluation: mid-semester grade

Year, Semester: 2nd year, 2nd semester

Its prerequisite(s): Electrotechnics

Further courses are built on it: Yes/No

Number of teaching hours/week (lecture + practice): 2+2

### Topics:

Types of sensors, categories of measurable quantities, static characteristics of the sensors. Typical applications of sensor systems. Sensors for high temperature measurement (infrared radiometers, pyrometers). Different level sensors (capacitance, thermal, floating, microwave, rotary paddle, etc.). Different flow sensors (induction, calorimetry, ultrasonic, thermal conductance, electromagnetic, rotameters, etc.). Measurement of kinematic quantities based on different principles: distance, speed, acceleration, vibration. The role of actuators. Types of actuators. Pneumatic actuators, valves, latches and actuators. Piezoelectric actuators. Contactors and electrical contactors. Midget motors.

### Literature:

*Compulsory:*

- Robert H Bishop, The Mechatronics Handbook, CRC Press, 2007, ISBN 9780849392573 - CAT# 9257

*Recommended:*

- Sabrie Soloman, Sensors Handbook, Mac-Grow Hill Company, 2010, ISBN : 978-0-07-160571-7, Available on-line at: http://ailab.ijs.si/~blazf/kro/SL/Soloman%20-%20Sensors%20Handbook%202nd%20Edition%20-%202010.pdf

Schedule

| | |
|---|---|
| 1st week Registration week | |
| 2nd week:<br>Lecture: Definition, types of sensors, main error sources of transducers.<br>Practice: Application of ultrasonic distance sensor. | 3rd week:<br>Lecture: Static and dynamic sensor characteristics, environmental impacts on characteristics.<br>Practice: Application of pressure sensor. |
| 4th week:<br>Lecture: Position sensors.<br>Practice: Application of color sensors. | 5th week:<br>Lecture: Level sensors.<br>Practice: Application of level sensors. |
| 6th week:<br>Lecture: Flowmeters.<br>Practice: Application of temperature and humidity sensors. | 7th week:<br>Lecture: High temperature measurement.<br>Practice: Application of gas sensor. |
| 8th week: 1st drawing week | |
| 9th week:<br>Lecture: Chemical sensors: humidity, gas sensor, etc.<br>Practice: Application of light sensors. | 10th week:<br>Lecture: Measurement of kinematic quantities.<br>Practice: Application of acceleration sensor. |
| 11th week:<br>Lecture: Force and torque measurement.<br>Practice: Application of vibration sensor. | 12th week:<br>Lecture: Role of actuators, types of actuators.<br>Practice: QNET Mechatronics sensor trainer. |
| 13th week:<br>Lecture: Electromechanical Actuators: DC Motors, AC Motors, Linear Motors, Stepper Motors, Midget Motors.<br>Practice: QNET HVAC trainer. | 14th week:<br>Lecture: Piezoelectric actuators, magnetostriction actuators, magneto hydrodynamic activators, memory metal actuators.<br>Practice: QNET motors trainer. |
| 15th week: 2nd drawing week | |

Requirements

A, for a signature:

Attendance at lectures is recommended, but not compulsory. Attending practices is compulsory. A student must attend the practice classes and may not miss more than three times during the semester. In case a student does so, the subject will not be signed and the student must repeat the course. A student can't make up a practice class with another group. Attendance at practice classes will be recorded by the practice leader. Being late is equivalent with an absence. Missed practice classes must be made up for at a later date, being discussed with the tutor. Active participation is evaluated by the teacher in every

class. The student has to prepare measurement report on every practise and has to submit the reports until deadline.

B, for a grade:

For the mid-semester grade the student has to write two tests. The mid-semester grade is received in scoring system (total 100) by the following:

- 1st test with 40 points
- 2nd test with 40 points
- quality of the measurement reports with 20 points

The mid-semester grade is given according to the following table:

| *Score* | 0-59 | 60-69 | 70-79 | 80-89 | 90-100 |
|---|---|---|---|---|---|
| *Grade* | fail (1) | pass (2) | satisfactory (3) | good (4) | excellent (5) |

## Mechanical Machines and Machine Elements

Code: MK3MGEPG04RX17-EN

ECTS Credit Points: 6

Evaluation: exam

Year, Semester: 2nd year, 1st semester

Its prerequisite(s): Engineering Physics

Further courses are built on it: Yes/No

Number of teaching hours/week (lecture + practice): 2+2

Topics:

The series of lectures are based on the topics of mechanics. It reviews the standardised presentation of machine elements and tolerance and fit systems; the set-up of a machine group, the connection of its elements and their operation. In the course students acquire the features of prime mowers, machines; the different types of clutches and couplings; the bearing support of shafts and the most widely applied rolling bearings; different types of frictional and positive connection drives; types of brakes and application fields. In practice the different machines and machine elements are introduced and the selection of them from brand catalogues: rolling bearings, couplings, belt and pulley, chain and sprocket.

Literature:

*Compulsory:*

- Ansel Ugural, NEW JERSEY INSTITUTE TECH: Mechanical Design: An Integrated Approach, 1st Edition Hardcover with access card, ©2004, ISBN-13 9780072921854
- Tiba Zsolt: Machine Drawing, Debrecen University Press 2010. ISBN 978-963-318-066-2,

- Tiba Zsolt: Drivetrain Optimization, Lambert Academic Publishing, 2016. (ISBN: 9783659859274)
- Tiba Zsolt: Basic constructions of machine design, Lambert Academic Publishing, 2017. (ISBN: 978-3-330-34649-9)

*Recommended:*

- Optibelt: Technical Manual V-belt drives
- http://www.optibelt.com/fileadmin/content/pdf/Produkte/EN/Optibelt-TH-v-belt-drives.pdf
- Rexnord: Roller Chains
- http://www.rexnord.com/ContentItems/TechLibrary/Documents/7010_Rexnord-and-Link-Belt-Rollerchains_Catalog-p.aspx
- SKF General Catalogue
- http://www.skf.com/group/knowledgecentre/subscriptions/displayfactbox.html?itemid=tcm:12-121486

Schedule

| | |
|---|---|
| 1st week Registration week | |
| 2nd week:<br>Lecture: Tolerance and fit systems<br>Practice: Calculation of tolerance types and fits | 3rd week:<br>Lecture: Set-up of a machine group, operation and operation requirements<br>Practice: Characteristics and operation features of prime mowers, machines and precondition of stabile running |
| 4th week:<br>Lecture: Linkage mechanisms, types of constraints. Statically determinate, indeterminate and unstable constructions<br>Practice: Analyzing linkage mechanisms: suspension systems of vehicles and airplanes. | 5th week:<br>Lecture: Construction details of shafts and its parts, functions. Keyed and splined joints of shafts transmitting the peripheral force.<br>Practice: Construction of keyed and splined joints, sizing. |
| 6th week:<br>Lecture: Shaft bearing systems. Most widely applied rolling bearings and their features.<br>Practice: Introduction of different types of rolling bearings and choosing them from brand catalogue. | 7th week:<br>Lecture: Bearing arrangements. Locating, non-locating bearing arrangement. Cross located bearing arrangements with adjusted or floating bearings. Selection of ball and roller bearings for service life.<br>Practice:<br>Explanation of shaft bearing constructions. |
| 8th week: 1st drawing week | |
| 9th week:<br>Lecture: | 10th week:<br>Lecture: Clutches and couplings. Types, operation features, application fields. |

| | |
|---|---|
| Seals, operation principles. Contacting and non -contacting seals and their application fields.<br>**Practice:** Showing the different types of seals, choosing them from brand catalogues. | **Practice:** Stiff, flexible and universal joints. Introduction in lab and choosing from catalogues. |
| **11th week:**<br>**Lecture:** Heat balance of braking. Types of brakes, actuation of them, operation method.<br>**Practice:** Showing brakes. Analyzing the operation of them. | **12th week:**<br>**Lecture:** Types of belt drives, operation features, application fields.<br>**Practice:** Pulley constructions, belt sections, design of belt drive, applying design charts. |
| **13th week:**<br>**Lecture:** Types of chain drives, operation features, application fields.<br>**Practice:** Sprocket and chain constructions. Design of chain drive, applying design charts. | **14th week:**<br>**Lecture:**<br>Types of gear drives. Operation and their application fields.<br>**Practice:**<br>Explanation of gear drive constructions. Ratio calculation. |
| **15th week: 2nd drawing week** | |

**Requirements**

**A, for a signature:**

Attendance at **lectures** is recommended, but not compulsory.

Attending practices is compulsory. A student must attend the practice classes and may not miss more than three times during the semester. In case a student does so, the subject will not be signed and the student must repeat the course. A student can't make up any practice with another group. Attendance at practice classes will be recorded by the practice leader. Being late is equivalent with an absence. In case of further absences, a medical certificate needs to be presented. Missed practice classes should be made up for at a later date, to be discussed with the tutor. Students are required to bring the drawing tasks and drawing instruments of the course to each practice class. Active participation is evaluated by the teacher in every class. If a student's behavior or conduct doesn't meet the requirements of active participation, the teacher may evaluate his/her participation as an absence because of the lack of active participation in class.

Students have to **submit all the designing tasks** as scheduled minimum at a sufficient level.

During the semester there are two tests: the mid-term test in the 8th week and the end-term test in the 15th week. Students have to sit for the tests.

**B, for a grade:**

The course ends in an **examination**. Based on the average of the grades of the designing tasks and the examination, the exam grade is calculated as an average of them:

- the average grade of the two designing tasks
- the result of the examination

The minimum requirement for the mid-term and end-term tests and the examination respectively is 60%. Based on the score of the tests separately, the grade for the tests and the examination is given according to the following (score/grade): 0-59 % = fail (1); 60-69 % = pass (2); 70-79 % = satisfactory (3); 80-89 % = good (4); 90-100 % = excellent (5).

If the score of any test is below 60, students can take a retake test in conformity with the EDUCATION AND EXAMINATION RULES AND REGULATIONS.

An offered grade: it may be offered for students if the average grade of the designing tasks is at least good (3) and the average of the mid-term and end-term tests is at least good (3). The offered grade is the average of them.

## Manufacturing Technologies

Code: MK3GYARG04RX17-EN

ECTS Credit Points: 4

Evaluation: mid-semester grade

Year, Semester: 2nd year, 1st semester

Its prerequisite(s): Engineering Physics

Further courses are built on it: Yes/No

Number of teaching hours/week (lecture + practice): 2+2

### Topics:

During this semester the students learn the types of cutting machines, devices and tools. The students will know the types of basic cutting technologies (turning, drilling, milling, planning, grinding, etc.) and their characteristics. Introduction of the basic industrial design- and operation documentation procedure in manufacturing. Primary forming processes (casting, powder metallurgy, metallurgical, hot forming processes). After that the students will learn designing basic manufacturing tasks and calculating the necessary technological parameters for a given workpiece.

### Literature:

*Compulsory:*

- Fritz Klocke: *Manufacturing Processes I, Cutting,* RWTH Edition, RWTH Aachen University, p. 524, ISBN 978-3-642-11978-1
- John A. Schey: *Introduction to Manufacturing Processes,* McGraw – Hill Book Company, 1977., p. 392., ISBN 0-07-055274-6
- Prakash M. Dixit, Uday S. Dixit: *Modelling of Metal Forming and Machining Processes,* Springer-Verlag, 2008, ISBN 978-1-84996-749-5
- Heinz Tschaetsch: *Metal Forming Practise: Processes - Machines – Tools,* Springer-Verlag Berlin Heidelberg, 2006., ISBN 978-3-642-06977-2

*Recommended:*

- James G. Bralla: *Handbook of Manufacturing Processes,* First Edition, Industrial Press Inc., New York, 2007, ISBN 0-831 1-3179-9
- Helmi A. Youssef, Hassan El – Hofy: *Machining Technology, Machine tools and operations,* CRC Press, United States of Amerika, p. 672, ISBN 978-1-4200-4339-6
- J. Beddoes, M. J. Bibby: *Principles of Metal Manufacturing Processes,* 1999, p. 337, ISBN 0 340 73162 1

Schedule

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|---|---|
| 1st week Registration week | |
| 2nd week:<br>**Lecture:** The basic definitions of manufacturing processes, the types of machine tools<br>**Practice:** Introducing of the cutting laboratory and machine tools *(cutting laboratory)* | 3rd week:<br>**Lecture:** Process of chip formation, tool wear and tool life<br>**Practice:** Calculation tasks for tool wear and tool life |
| 4th week:<br>**Lecture:** The process and tools of turning technologies<br>**Practice:** Designing of turning technology | 5th week:<br>**Lecture:** The process and tools of drilling and counterbore technologies<br>**Practice:** Designing of drilling and counterbore technologies |
| 6th week:<br>**Lecture:** The process and tools of milling technologies<br>**Practice:** Designing of milling technologies | 7th week:<br>**Lecture:** The process and tools of grinding technologies<br>**Practice:** Designing of grinding technology |
| 8th week: 1st drawing week : Test I on cutting technologies | |
| 9th week:<br>**Lecture:** History of metal forming. Definitions, advantages of metal forming. Bulk deformation processes. Sheet metal forming processes.<br>**Practice:** The basic studies of technological planning on CNC machines, cutting tool selection. | 10th week:<br>**Lecture:** Properties of materials. Industrial materials. The uniaxial tensile test. Upsetting test.<br>**Practice:** Basic studies of Computer Aided Manufacturing (CAM). The types of manufacturing systems |
| 11th week:<br>**Lecture:** Classification of manufacturing processes (casting, forming, material removal, joining). Advantages of casting. Casting terminology. Sand casting.<br>**Practice:** Planning and finite element simulation of cold rolling technology (SolidWorks and Simufact Forming). | 12th week:<br>**Lecture:** Classification of different forming processes. Types of rolling. Rolling operations. Equipment of rolling, rolling mills. Thread rolling, ring rolling.<br>**Practice:** Planning and finite element simulation of cold rolling technology (SolidWorks and Simufact Forming). |
| 13th week: | 14th week: |

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|---|---|
| **Lecture:** Classification of forging operations. Types of forging dies. Overview of metal forming of sheet metals. Bending and deep drawing. | **Lecture:** Manufacturing of polymers. Major processes (extrusion, injection molding, blow molding, thermoforming, rotomolding). |
| **Practice:** Planning and finite element simulation of die forging technology (SolidWorks and Simufact Forming). | **Practice:** Planning and finite element simulation of die forging technology (SolidWorks and Simufact Forming). |
| 15th week: 2nd drawing week: Test II on metal forming technologies | |

Requirements

A, for a signature:

Students have to visit the lectures and seminars. Three absences are acceptable during the seminar.

Students have to write two tests from the two parts of the lectures and seminars (cutting technologies and metal forming technologies). They have to write them for minimum at a sufficient level. Based on these result they will get the final practice mark.

B, for a grade:

The course ends in **mid-semester grade**. Based on the average of the marks of the planning task and the average of the test results, the mid-semester grade is calculated as an average of them:

- grade of the planning task
- average grade of the two tests

The minimum requirement for the mid-term and end-term tests is 60%. Based on the score of the tests separately, the grade for the tests is given according to the following (score/grade): 0-59 % = fail (1); 60-69 % = pass (2); 70-79 % = satisfactory (3); 80-89 % = good (4); 90-100 % = excellent (5).

If the score of any test is below 60, a student once can take a retake test covering the whole semester material.

## Measurement and Data Acquisition

Code: MK3MERAR06RX17-EN

ECTS Credit Points: 6

Evaluation: Mid-Semester Grade, measurement report

Year, Semester: 2nd year, 2nd semester

Its prerequisite(s): Electronics I

Further courses are built on it: Yes/No

Number of teaching hours/week (lecture + practice): 2+2

Topics:

Detectors (sensors) and transducers. Grouping the sensors. The measuring device structure and characteristics. Unit of measurement systems. Measurement errors.

Measurement methods. Electro-mechanical - and electronic instruments. Digital instruments. Microelectronic sensors. Elastic deformation measuring devices. Temperature, light and radiation detectors. Thermocouples, thermometers metal, semiconductor thermometers-; Optical gates-; Capacitive proximity switches-; Ultrasonic sensors-; structure, operating principles and properties. Foil Version strain gauges, semiconductor strain gauges, strain sensor wire, one, two and four-sensor bridge circuit. Fiber optic sensors. Signal processing systems. Pressure, temperature, strain and measurement of rotary motion using National Instruments LabVIEW software.

Literature:

*Compulsory:*

- Aciatore, David G.: Introduction to mechatronics and measurement systems, Boston, 2007, ISBN:007 125407 2
- Ed. Robert H. Bishop: The Mechatronics Handbook, Section III: Sensors and actuators

*Recommended:*

- David G. Alciatore, Michael B. Histand: Introduction to mechatronics and measurement systems 1st. McGraw-Hill, 2013. ISBN: 978-0073380230
- U. A. Bakshi – V.U. Bakshi: Electronic Measurement and Instrumentation 1st. Technical Publications Pune, 2009. ISBN: 9788184315295

Schedule

| 1st week Registration week | |
|---|---|
| 2nd week:<br>**Lecture:** Basic concepts of measurement. Sensors (sensors) and transducers. The sensors are grouped. The structure and characteristics of the measuring apparatus. Measurement Systems. Measurement errors. Measurement methods.<br>**Practice:** General description about laboratory regulations. Accident prevention and safety education. | 3rd week:<br>**Lecture:** Theoretical basis of Light electric effect sensors. The photodiode and photovoltaic structure, modes of operation and application. Multi-color LEDs. The structure and characteristics of optical interfaces. The scanner structure and characteristics of CCD sensors.<br>**Practice:** Examination of solar cell. |
| 4th week:<br>**Lecture:** Types of photo resist and application. The structure and features of a phototransistor. The structure and use of a light pencil. The structure, characterization and application of a liquid crystal display.<br>**Practice:** Measurement of LED characteristics. | 5th week:<br>**Lecture:** Measuring elastic deformation instruments. Piezoelectric and piezoresistive sensors. Elastic deformation measuring instruments. Bellows. Microelectronic capacitive pressure sensors. PN-gradient sensors and the MOSFET structure.<br>**Practice:** Measurement of elastic deformation |
| 6th week: | 7th week: |

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| **Lecture:** Thermoelectric sensors. The operating principles, construction and characteristics of an infrared motion sensor. Thermoelectric transducer coupling, the PVDF film. Thermocouples, semiconductor structure, function and features of metal thermometers and other thermometers.<br>**Practice:** Measurement of temperature. | **Lecture:** An optical gate. Its structure, working principle and characteristics and application areas.<br>**Practice:** Measurement of an optical gate. |
| **8th week: 1st drawing week** | |
| **9th week:**<br>**Lecture:** A capacitive proximity switch. Its structure, working principle, characteristics and application areas.<br>**Practice:** Measuring of capacitive proximity switch. | **10th week:**<br>**Lecture:** Ultrasonic sensors. Their structures, working principles, characteristics, and application areas.<br>**Practice:** Measuring of an ultrasonic distance sensor. |
| **11th week:**<br>**Lecture:** Strain gages. Foil strain gauges, semiconductor strain gauge, strain sensor wires, one, two and four-sensing bridge circuits.<br>**Practice:** Measuring of strain gages. | **12th week:**<br>**Lecture:** The Reed switch and magneto inductive sensors. Their structures, working principles, characteristics and Application areas.<br>**Practice:** Measuring of reed switch. |
| **13th week:**<br>**Lecture:** Description of the main features of the NI LabVIEW software.<br>**Practice:** National Instrumnets with hardware and software. Edit VI. Measuring system construction, Troubleshooting practice | **14th week:**<br>**Lecture:** Structure of the NI data acquisition systems. DAQ connecting to your computer. **Practice:** Recording and evaluation of data measured by National Instruments Hardware |
| **15th week 2nd drawing week, End-term test** | |

**Requirements**

**A, for a signature:**

Attendance at lectures is recommended, but not compulsory. Attending practices is compulsory. A student must attend the practice classes and may not miss more than three times during the semester. In case a student does so, the subject will not be signed and the student must repeat the course. A student can't make up a practice class with another group. Attendance at practice classes will be recorded by the practice leader. Being late is equivalent with absence. Missed practices should be made up for at a later date, being discussed with the tutor. Active participation is evaluated by the teacher in every class. If a student's behaviour or conduct doesn't meet the requirements of active participation, the teacher may evaluate his or her participation as an absence because of the lack of active participation in the class. Students have to submit all the twelve reports as scheduled minimum at a sufficient level. During the semester there are two tests: the mid-term test is in the 8th week and the end-term test in the 15th week.

B, for a grade:

Based on the average of the grades of the reports and the test results, the mid-semester grade is calculated as an average of them: - the average grade of the twelve reports (50 %) - the grade of the tests (50 %). The minimum requirement for end-term test is 60%. Based on the score of the test separately, the grade for the test is given according to the following (score/grade): 0-59 = fail (1); 60-69 = pass (2); 70-79 = satisfactory (3); 80-89 = good (4); 90-100 = excellent (5).

## Environmental, Health, Safety and Ergonomy

Code: MK3EHSAK04RX17-EN

ECTS Credit Points: 4

Evaluation: exam

Year, Semester: 2nd year, 2nd semester

Its prerequisite(s): -

Further courses are built on it: Yes/No

Number of teaching hours/week (lecture + practice): 2+2

Topics:

The subject covers three main topics:

Environment (E): In connection with environment protection the most important topics are introduced to the students. The subject includes air quality, noise protection, water protection, soil protection, and waste management side topics.

Health (H): Basics of labor and health are discussed. The impact of work on health and the health impact on working ability is also a side topic. The fundamentals of occupational health and work hygiene are also involved.

Safety (S): It involves the basics of labor safety and fire protection. The lectures discuss the personal, material and organizational requirements for safe work, ergonomic fundamentals, personal protective equipment, work safety reviews, employer checks, and workplace risk assessment. Industrial safety and security is also a side topic.

The lectures introduce the most important aspects and the practices focus on examples and plant visits.

Literature:

*Recommended:*

- Gilbert M. Masters, Wendell P. Ela: Introduction to Environmental Engineering and Science, Pearson New International Edition, 3/E, Pearson, 2013, ISBN: 9781292025759
- David L. Goetsch, Occupational Safety and Health for Technologists, Engineers, and Managers, 8th Edition, Pearson, 2015, ISBN: 9780133484175
- Richard T. Wright, Environmental Science, Pearson, 2017, ISBN: 9780134011271

Schedule

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|---|---|
| 1st week Registration week | |
| 2nd week: Basics of Environmental Protection and Environmental Management<br>Lecture: Introduction to environmental protection<br>Practice: Global issues on environmental protection | 3rd week: Air Quality Control<br>Lecture: Basics of air pollution control, processes in the atmosphere, greenhouse gases, ozone layer, smog, acid rain<br>Practice: Exercises in connection with air pollution |
| 4th week: Environmental Noise<br>Lecture: The basics of environmental noise<br>Practice: Noise measuring devices and techniques | 5th week: Water Protection<br>Lecture: Water protection and quality, pollutants<br>Practice: Practice in connection with water protection (plant visit: wastewater treatment plant) |
| 6th week: Soil Protection<br>Lecture: Protection of soil quality<br>Practice: Practice in connection with soil protection | 7th week: Waste Management<br>Lecture: Waste management, possibilities, disposal, techniques and hazardous waste<br>Practice: Practice in connection with waste management (plant visit) |
| 8th week: 1st drawing week | |
| 9th week: Basics of labor safety and fire protection<br>Lecture: Personal, material and organizational requirements for safe work, ergonomic fundamentals<br>Practice: Practice in connection with labor safety I. (plant visit) | 10th week: Occupational Safety<br>Lecture: Personal protective equipment, work safety reviews, employer checks, workplace risk assessment<br>Practice: Practice in connection with labor safety II. (plant visit) |
| 11th week: Labor and Health<br>Lecture: The impact of work on health and the health impact on working ability<br>Practice: Practice in connection with occupational health I. | 12th week: Occupational Health and Work Hygiene<br>Lecture: Fundamentals of occupational health and work hygiene<br>Practice: Practice in connection with occupational health II. |
| 13th week: Industrial Safety and Security<br>Lecture: Main goals of industrial safety and security<br>Practice: Practice in connection with industrial safety and security | 14th week:<br>Lecture: Mid-semester TEST<br>Practice: Mid-semester TEST |
| 15th week: 2nd drawing week | |

Requirements

A, for a signature:

Attendance at practice classes (absence up to the permissible level)

B, for a grade:

Test grade (2: from 50%)

## Applied Automatization I

Code: MK3AAUT1R06RX17-EN

ECTS Credit Points: 6

Evaluation: Exam, measurement report

Year, Semester: 2nd year, 2nd semester

Its prerequisite(s): Electronics I

Further courses are built on it: Yes/No

Number of teaching hours/week (lecture + practice): 2+4

Topics:

Control engineering of funds and core control technology, feedback (closed-loop) control knowledge acquisition. Theoretical Foundations Control Technology. Control (open-loop) and application control functions. Programmable Logic Controllers. Timers, counters, sequential controls. Tags of the control loop. Examination of the tags of the control loop steady state. linear transition state regulations. a description of the transitional state of the linear members. Examination of the closed-loop control. Stability and quality features. Selection and setting regulators. Control and feedback systems practical exercises using the PLC programming.

Literature:

*Compulsory:*

- Ed. Robert H. Bishop: The Mechatronics Handbook, Section IV: Systems and Controls, CRC Press; 2nd edition 2007, ISBN: 978-0849392573
- Uday A.Bakshi, S.C.Goyal: Feedback Control Systems,Technical Publications Pune, 2nd edition 2008, ISBN: 978-8189411077

*Recommended:*

- Uday.A.Bakshi,Varsha.U.Bakshi: Control System Engineering, Technical Publications Pune, 1th edition 2008, ISBN: 978-8184314632

Schedule

| 1st week Registration week | |
|---|---|
| 2nd week:<br>Lecture: The theoretical bases of control technology. Basic concepts, symbols and allocation. Comparison of control and | 3rd week:<br>Lecture: Feedback control. Signs and characteristics of a control loop. Loop tags (a sensor, a signal generator, subtraction, |

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| feedback control. Subdivision of control and feedback control. | signal processing, an amplifier, an actuator). |
| **Practice:** Realization of logic functions "AND, OR, NAND, NOR, XOR, XNOR" with relays. | **Practice:** Realization of logic functions "AND, OR, NAND, NOR, XOR, XNOR" with digital circuits. |
| **4th week:** | **5th week:** |
| **Lecture:** Control systems. Boolean algebra, basic operations (And, Or, Not). Basic identity of Boolean algebra. | **Lecture:** De Morgan's theorems. Two-variable logic functions (Nor, Inhibition, Antivalency, Equivalency, Implication). |
| **Practice:** Digital circuits realization of Flip-Flop circuits, RS-JK storage, MUX-DEMUX. | **Practice:** Digital circuits realization of flip-flop circuits, RS-JK storage, MUX-DEMUX. |
| **6th week:** | **7th week:** |
| **Lecture:** Functions to simplify algebraic and graphical way. Operation and programming of freely programmable logic controllers (PLCs). | **Lecture:** Linear Control Systems. Test methods (time domain, frequency domain, and transfer functions method). |
| **Practice:** Operation of programmable logic controllers. Basic programming tasks with PLC. | **Practice:** Operation of programmable logic controllers. Basic programming tasks with PLC. Measuring internal timers and counters. |
| **8th week: 1st drawing week, Self-control test** | |
| **9th week:** | **10th week:** |
| **Lecture:** Linear control steady-state operation. Linear terms (P, I, D) and transmission coefficient. Linear coupling of tags (serial, parallel, feedback). | **Lecture:** A proportional tag, negative feedback through a proportional tag. Examination of feedback. |
| **Practice:** Application of different programming languages for programmable logic controllers Medium programming tasks with PLC. | **Practice:** Medium level programming exercises with PLC. |
| **11th week:** | **12th week:** |
| **Lecture:** Analysis of proportional (type 0) control. Examination of integral (type 1) control. Gaining and measuring a concept loop. | **Lecture:** Linear feedback control transition state. Typical testing functions. Linear tags differential equations. Transfer function preparation about transmission function. |
| **Practice:** Determine and analysis the transfer function of one-two variable proportional tag. | **Practice:** Conditions and analysis of a variable storage differentiator tag and its transfer function. |
| Analyze the transition function of two storage proportional tags with MULTISIM software. | Proportional Integral (PI) tags transfer function analysis of the function using MULTISIM software. |
| **13th week:** | **14th week:** |

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| **Lecture:** Transition, transfer function and differential equations of a proportional and integral tag. Transition, transfer function and differential equations of a derivate and dead time tag.<br>**Practice:** Proportional Differential (PD) tags transfer function analysis of the function using MULTISIM software. | **Lecture:** Continuous (P, PI, PD, PID) controllers. Non-electrical quantities electrical measuring. Control loops stability criterion with Routh-Hurwitz and high-quality specifics.<br>**Practice:** The Proportional-Integral-Derivative<br>(PID) tag recording its transfer function and function analyzing. Optimization of measurement of different types of controllers. |
| 15th week: 2nd drawing week, End-term test | |

Requirements

A, for a signature:

Attendance at lectures is recommended, but not compulsory. Attending practices is compulsory. A student must attend the practice classes and may not miss more than three times during the semester. In case a student does so, the subject will not be signed and the student must repeat the course. A student can't make up a practice class with another group. Attendance at practice classes will be recorded by the practice leader. Being late is equivalent with an absence. Missed practice classes must be made up for at a later date, being discussed with the tutor. Active participation is evaluated by the teacher in every class. If a student's behaviour or conduct doesn't meet the requirements of active participation, the teacher may evaluate his/her participation as absence because of the lack of active participation in class. Students have to submit all the twelve reports as scheduled minimum at a sufficient level. During the semester there are one test: the end-term test in the 15th week. Students have to sit for these tests.

B, for a grade:

At the end of the course an oral exam must be taken. Based on the average of the grades of the reports and the test results, the mid-semester grade is calculated as an average of them: - the average grade of the twelve reports (30 %) - the grade of the tests (20 %) - the oral exam (50 %) The minimum requirement for end-term test is 60%. Based on the score of the test separately, the grade for the test is given according to the following (score/grade): 0-59 = fail (1); 60-69 = pass (2); 70-79 = satisfactory (3); 80-89 = good (4); 90-100 = excellent (5).

## Applied Automatization II

Code: MK3AAUT2R06RX17-EN

ECTS Credit Points: 6

Evaluation: Mid-Semester Grade

Year, Semester: 3rd year, 1st semester

Its prerequisite(s): Applied Automatization I

Further courses are built on it: Yes/No

Number of teaching hours/week (lecture + practice): 0+6

Topics:

The most important industrial communication protocols are presented. Theoretical and practical relations PLC Modbus, CAN-bus, EtherCAT, PROFINET, TCP / IP protocol. The basic realization of the network connections of different communication architectures. Configure the listed industrial communication protocols. Getting to know a single programming environment, programming languages and typical features (Ladder Diagram (LD), structured text (ST), Function Block Diagram (FBD), Instruction List (IL) and Sequential function chart (SFC). Are different types of presentations resolution PLC (Phoenix Contact, FESTO, BECHOFF) and internal structures of the main lines of programming. Practical programming in which logic functions, timer devices, counting devices, analog control problems must be implemented both in theory and practice. Modeling of real industrial processes.

Literature:

*Compulsory:*

- Ed. Robert H. Bishop: The Mechatronics Handbook, Section IV: Systems and Controls, CRC Press; 2nd edition 2007, ISBN: 978-0849392573
- Uday A.Bakshi, S.C.Goyal: Feedback Control Systems,Technical Publications Pune, 2nd edition 2008, ISBN: 978-8189411077

*Recommended:*

- Uday.A.Bakshi,Varsha.U.Bakshi: Control System Engineering, Technical Publications Pune, 1th edition 2008, ISBN: 978-8184314632

Schedule

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|---|---|
| 1st week Registration week | |
| 2nd week:<br>Practice: Introduction, Software, Hardware, Installation. | 3rd week:<br>Practice: Configure industrial communication protocols. |
| 4th week:<br>Practice: Getting to know a single programming environment, programming language features and characteristics. | 5th week:<br>Practice: Implement basic network connections on different communication architectures. |
| 6th week:<br>Practice: Theoretical and practical relationships Modbus programming practice. | 7th week:<br>Practice: Theoretical and practical connections CANbus programming practice. |
| 8th week 1st drawing week, 1st Mid-term test | |
| 9th week: | 10th week: |

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| **Practice:** Theoretical and practical connections EtherCAT, programming practice. | **Practice:** Theoretical and practical connections PROFINET programming practice. |
| **11th week:** | **12th week:** |
| **Practice:** Theoretical and practical connections TCP / IP programming practice. | **Practice:** Modeling industrial processes. |
| **13th week:** | **14th week:** |
| **Practice:** Managing Real Industrial Processes. | **Practice:** Complex management of industrial processes. |
| **15th week 2nd drawing week, 2nd Mid-term test** | |

Requirements

A, for a signature:

Attending practices is compulsory. A student must attend the practice classes and may not miss more than three times during the semester. In case a student does so, the subject will not be signed and the student must repeat the course. A student can't make up a practice class with another group. Attendance at practice classes will be recorded by the practice leader. Being late is equivalent with an absence. Missed practice classes must be made up for at a later date, being discussed with the tutor. Active participation is evaluated by the teacher in every class. If student's behavior or conduct doesn't meet the requirements of active participation, the teacher may evaluate his/her participation as absence because of the lack of active participation in class.

B, for a grade:

Students have to fulfill a mid-term exercise at least for 50% to take part on the next practice classes. All students, who failed the mid-term exercise will not get a mid-semester grade. At the end of the semester, all students have to solve a real life problem in programming. Also a task, to make a complete documentation of the project file, using all the methods, mentioned during the semester. The course ends in a mid-semester grade. Based on the average of the grades of the tasks. The grade for the test is given according to the following table (score/grade): 0-50 = fail (1); 51-65 = pass (2); 66-75 = satisfactory (3); 76-85 = good (4); 86-100 = excellent (5).

## Pneumatics and Hydraulics

Code: MK3PNEUR04G117-EN

ECTS Credit Points: 4

Evaluation: mid-semester grade

Year, Semester: 2nd year, 2nd semester

Its prerequisite(s): Basics of Mechatronics

Further courses are built on it: Yes/No

Number of teaching hours/week (lecture + practice): 0+4

Topics:

Preparation of compressed air. Application of pneumatic working and control elements. Use of way valves, closing and flow control elements. Pneumatic implementation of logical basic functions, counters and timers. Application and implementation of the standard symbol system of pneumatic elements and switches. FluidSIM-P program use. Hydraulic power generation, hydraulic energy converters and their operation. Physical concepts and hydraulic calculations, power and efficiency. Use of hydraulic working and control elements. Directional valves, closing and flow control elements, pressure regulators, sliding and seat elements. Instrumentation measurements and measuring circuits. Use of piping sections, hoses, oil filters. Application and implementation of a standard symbol system for hydraulic elements. FluidSIM-H program use. Energy saving applications.

Literature:

*Compulsory:*

- D. Merkle, B.Schrader, M. Thomes: Hydraulics Basic Level Festo Didactic GmbH and Co., 2003.
- Peter Croser, Frank Ebel: Pneumatics Basic Level Festo Didactic GmbH and Co., 2002.

*Recommended:*

- De Silva, Clarence W.: Mechatronics: an integrated approach CRC Press, 2005.

Schedule

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|---|---|
| 1st week Registration week | |
| 2nd week: | 3rd week: |
| Practice: Development of pneumatics. Compressed air properties. Pneumatic equipment economy. State equation of gases. | Practice: Compressed air production. Compressed air supply. Compressed air preparation. |
| 4th week: | 5th week: |
| Practice: Pneumatic actuators (structurecylinder, rotary actuators, sizing cylinders). | Practice: Generally about valves (way-, closing-, pressure managing-, stop-, time-). |
| 6th week: | 7th week: |
| Practice: Basic circuit (single- and double acting cylinder controlling, control with And- Or elements, increase speed) | Practice: Functions of hydraulic equipment. Symbols and drawing techniques. |
| 8th week 1st drawing week, 1st Mid-term test | |
| 9th week: | 10th week: |
| Practice: Structure and circuit diagrams (control, power supply) of hydraulic systems. | Practice: Physical basics of hydraulics (pressure transmission, force transmission, way transmission, pressure ratio). Kind of flows. |
| 11th week: | 12th week: |

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| **Practice:** Equipment representation (layout drawings, wiring diagrams, operating charts). Power supply system components (gear motor, pump, filter, tank). | **Practice:** Valves (method of construction, the nominal value, slide). Pressure control valves. Way valves (2/2, 3/2, 4/2, 4/3). |
| 13th week: | 14th week: |
| **Practice:** Shut-off valves (check valve, controlled check valve). Flow control valves (one way control valves, 2 way flow control valve). | **Practice:** Hydraulic cylinders (single, doubleacting, sealing, venting, buckling). Hydraulic motors. |
| 15th week 2nd drawing week, 2nd Mid-term test | |

Requirements

A, for a signature:

Attending practices is compulsory. A student must attend the practice classes and may not miss more than three times during the semester. In case a student does so, the subject will not be signed and the student must repeat the course. A student can't make up a practice class with another group. Attendance at practice classes will be recorded by the practice leader. Being late is equivalent with an absence. Missed practice classes must be made up for at a later date, being discussed with the tutor. Active participation is evaluated by the teacher in every class. If student's behavior or conduct doesn't meet the requirements of active participation, the teacher may evaluate his/her participation as absence because of the lack of active participation in class.

B, for a grade:

Students have to fulfill a mid-term exercise at least for 50% to take part on the next practice classes. All students, who failed the mid-term exercise will not get a mid-semester grade. At the end of the semester, all students have to solve a real life problem in programming. Also a task, to make a complete documentation of the project file, using all the methods, mentioned during the semester. The course ends in a mid-semester grade. Based on the average of the grades of the tasks. The grade for the test is given according to the following (score/grade): 0-50 = fail (1); 51-65 = pass (2); 66-75 = satisfactory (3); 76-85 = good (4); 86-100 = excellent (5).

## Electropneumatics and Electrohydraulics

Code: MK3EPNER4RX17-EN

ECTS Credit Points: 6

Evaluation: mid-semester grade

Year, Semester: 3rd year, 1st semester

Its prerequisite(s): Pneumatics and Hydraulics

Further courses are built on it: Yes/No

Number of teaching hours/week (lecture + practice): 0+4

Topics:

Basic electropneumatic circuits. General operation of electric valves. Pneumatic electrical transducers. Pneumatic and electropneumatic controls. Electric converters, signal processors. Relays and protection relays. Connections of electric actuated valves. Direct and indirect management. Logic circuits. Time Tracking Control. Checking workflows. Electric drive. Proportional pneumatics. Proportional switching valves. Applications of FluidSIM-P program. Flow control valves. Basic electrohydraulic circuits. Electrohydraulic control. Hydraulic cylinders. Electrohydraulic circuits. Applications of the FluidSIM-H program. The signal storage path depends on the sequence control. Control of pneumatic and hydraulic processes using a PLC controller.

Literature:

*Compulsory:*

- G. Prede, D. Scholz: Electropneumatics Basic Level Festo Didactic GmbH & Co., 2002.
- Dieter Scholtz: Fundamental of Electrohydraulics Festo Didactic GmbH & Co., 2001.
- Renate Aheimer, Eberhad Bauer, Frank Ebel, Christine Löffler, Dieter Merkle, Helmut Werner: Electrohydraulics Basic Level Festo Didactic GmbH & Co. 2011.

*Recommended:*

- De Silva, Clarence W.: Mechatronics: an integrated approach CRC Press, 2005.

Schedule

| | |
|---|---|
| 1st week Registration week | |
| 2nd week:<br>Practice: Development of electropneumatics. Pneumatic-electric transducers, relays. | 3rd week:<br>Practice: The basic concepts of a control technology. Pneumatic and electro-pneumatic controls. Basics of electricity. |
| 4th week:<br>Practice: Basics of electricity. The electrical power supply. Electric transducers, signal processors. Buttons, switches. | 5th week:<br>Practice: Sensors. Relays and contactors. Freely programmable controllers (PLC). |
| 6th week:<br>Practice: Electrically operated valves. Usage of solenoid valves and structures. Construction methods. | 7th week:<br>Practice: Relay controls. Relay controls applications. Direct and indirect control. Logic controls. Signal storage with relay. |
| 8th week 1st drawing week, 1st Mid-term test | |
| 9th week:<br>Practice: Time tracking controls. Workflow controls. Pneumatic drives. Sensors. Signal processing. | 10th week:<br>Practice: Electric drive proportional pneumatics. Proportional pressure control valves. Proportional valves. |
| 11th week: | 12th week: |

| | |
|---|---|
| **Practice:** Electrical symbols. Electro-hydraulic controls. (hydraulic, electrical diagram, function graphs) | **Practice:** Electro-hydraulic structure of equipment. Electrical basic concepts. |
| **13th week:** | **14th week:** |
| **Practice:** Electro-hydraulic circuits (signal storage way control). | **Practice:** Electro-hydraulic circuits (falling edge automatic mode). |
| **15th week 2nd drawing week, Test 2** | |

**Requirements**

**A, for a signature:**

Attending practices is compulsory. A student must attend the practice classes and may not miss more than three times during the semester. In case a student does so, the subject will not be signed and the student must repeat the course. A student can't make up a practice class with another group. Attendance at practice classes will be recorded by the practice leader. Being late is equivalent with an absence. Missed practice classes must be made up for at a later date, being discussed with the tutor. Active participation is evaluated by the teacher in every class. If a student's behaviour or conduct doesn't meet the requirements of active participation, the teacher may evaluate his/her participation as absence because of the lack of active participation in class.

**B, for a grade:**

Students have to fulfil a mid-term exercise at least for 50% to take part on the next practice classes. All students, who failed the mid-term exercise will not get a mid-semester grade. At the end of the semester, all students have to solve a real life problem in programming. Also a task, to make a complete documentation of the project file, using all the methods, mentioned during the semester. The course ends in a mid-semester grade. Based on the average of the grades of the tasks. The grade for the test is given according to the followings (score/grade): 0-50 = fail (1); 51-65 = pass (2); 66-75 = satisfactory (3); 76-85 = good (4); 86-100 = excellent (5).

## Electrical Machines and Drives

Code: MK3VHAJR06RX17-EN

ECTS Credit Points: 6

Evaluation: mid-semester grade

Year, Semester: 3rd year, 2nd semester

Its prerequisite(s): Mechatronic Devices (Sensors, Actuators, Motors)

Further courses are built on it: Yes/No

Number of teaching hours/week (lecture + practice): 2+4

**Topics**:

Fundamentals and classification of electrical machines. Direct current machines: structure, theory of operation, mechanical and electrical commutation, theory of operation modes. Fundamentals of transformers: theory, operation under different load conditions: open and short circuit, resistive and inductive loads. Tri-phase transformers. Theory and operation of a rotating magnetic field. Synchronous machines: theory and operation of a helical synchronous machine. Stepper motors and drives. Special electrical machines and its applications. Rectifier bridge circuits. Summary of drive circuits for AC machines. VSD: variable speed drives.

Literature:

*Compulsory:*

- Austin Hughes "Electric Motors and Drives", Elsevier, 3rd ed. 2006, ISBN-13: 978-0-7506-4718-2
- Muhammad H. Rashid, "Power Electronics Handbook", Elsevier, 3rd ed. 2011, ISBN 978-0-12-382036-5

Schedule

| | |
|---|---|
| 1st week Registration week | |
| 2nd week:<br>**Lecture:** Classification of electrical energy converters.<br>**Practice:** Laboratory introduction and safety issues. | 3rd week:<br>**Lecture:** Direct Current electrical machines: structure, electrical and mechanical commutator.<br>**Practice:** DC motor start circuits. |
| 4th week:<br>**Lecture:** DC Machines: operating conditions.<br>**Practice:** DC motor start conditions. | 5th week:<br>**Lecture:** Transformers: Theory of operation, induced voltage, open, short cut, and load conditions.<br>**Practice:** Measurement of DC machines: mechanical and electrical variables and power. |
| 6th week:<br>**Lecture:** Tri-phase transformers.<br>**Practice:** Measurement of transformers: open and short cut conditions. | 7th week:<br>**Lecture:** Theory and application of rotating fields.<br>**Practice:** Transformers: calculation of iron core and copper losses. |
| 8th week: 1st drawing week | |
| 9th week:<br>**Lecture:** Synchronous machines: theory and operation of tri-phase, with cylindrical rotor.<br>**Practice:** Synchronous motor starter circuits. | 10th week:<br>**Lecture:** Tri-phase induction motors: theory and operational conditions.<br>**Practice:** Induction motor starter circuits. |
| 11th week: | 12th week: |

| | |
|---|---|
| **Lecture:** Tri-phase induction motors: load conditions and operations. | **Lecture:** Stepping motors: theory and operational conditions. |
| **Practice:** Smooth starter circuit commissioning. | **Practice:** VSD: Variable speed drive practice. Commissioning. |
| **13th week:** | **14th week:** |
| **Lecture:** Special motors: EC and BLDC. Theory and operation. | **Lecture:** Rectifier circuits. One and tri-phase. |
| **Practice:** VSD: Variable speed drive practice. Control. | **Practice:** VSD: Variable speed drive practice. Monitoring. |
| **15th week: 2nd drawing week** | |

**Requirements**

**A, for a signature:**

Participation at practice, according to RR of UD. The correct solution of the project and submission before deadline.

**B, for a grade:**

The practical grade is the evaluation of the project.

## Thermodynamic Processes

**Code:** MK3TERFR04RX17-EN

Code: MK3MOD1R06R117-EN

ECTS Credit Points: 4

Evaluation: exam

Year, Semester: 3rd year, 2nd semester

Its prerequisite(s): Basics of Mechatronics

Further courses are built on it: Yes/No

Number of teaching hours/week (lecture + practice): 2+2

**Topics**:

Fundamental concepts of thermodynamics. First and Second Law of Thermodynamics: definition and application. Extensive property balances: mass energy and entropy balance, control volumes at steady state. Relations and table property of steady state variables. P-v-T surfaces, table look up of thermodynamics properties, phase diagrams. Analytical derivations of state equations with ideal gas model. Vapor and gas power and cooling cycles. Description of thermodynamic models with Bond Graph. T-s diagrams. Energy cycles. Modes of heat transfer. Heat Flux, thermal conductivity. The general differential equation of heat conduction. Steady state and transient conduction. Thermal resistance. Conduction rectangular and cylindrical coordinates. Convection: concepts and basic relationships, boundary layers, the similarity concept. Heat transfer through gases, fluids

and solids. Mechanical construction of thermodynamic systems, and electronic sensors and actuators.

Literature:

*Recommended:*


- Tarik Al-Shemmeri: Engineering Thermodynamics, 2010, ISBN 978-87-7681-670-4
- Robert H. Bishop: Mechatronics Handbook: Engineering thermodynamics (Chapter 12)
- P K Nag: Basic and applied thermodynamics, ISBN 0-07-047338-2
- Lakatos Á. Basics of heat transfer and fluid mechanics. 2014, Terc Kft.
- Robert Balmer (2006) Thermo-dynamics, Jaico Publishing House, ISBN: 817224262X, 868 pages
- James R. Ogden (1998) Thermodynamics Problem Solver, Research and Education Association, ISBN: 0878915559, 1104 pages.
- Warren M. Rohsenow, James P. Hartnett, Young I. Cho (1998), Handbook of Heat Transfer, McGraw-Hill New York, ISBN: 0070535558 / 9780070535558, 1344 pages.


Schedule

| | |
|---|---|
| 1st week Registration week | |
| 2nd week:<br>Lecture: Thermodynamics concepts and definitions, Principles.<br>Practice: Thermodynamics principles practice. | 3rd week:<br>Lecture: Extensive state variable balance: mass, energy, entropy balance.<br>Practice: Application examples practice. |
| 4th week:<br>Lecture: Volume change in steady state.<br>Practice: Application examples practice. | 5th week:<br>Lecture: State variables: relation and table properties. P-V-T surfaces, thermodynamics table lookup, phase diagrams.<br>Practice: State variable lookup practice. |
| 6th week:<br>Lecture: Analytical derivation of state equations, ideal gas model.<br>Practice: State equation practice. | 7th week:<br>Lecture: Steam and gas processes.<br>Practice: Application examples practice. |
| 8th week: 1st drawing week | |
| 9th week:<br>Lecture: Thermodynamics models with Bond Graphs.<br>Practice: Application examples practice. | 10th week:<br>Lecture: Mechanical structures of thermodynamics systems. Energy cycles.<br>Practice: Application examples practice. |
| 11th week: | 12th week: |

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|---|---|
| **Lecture:** Thermal conduction.<br>**Practice:** Application examples practice.<br>**13th week:**<br>**Lecture:** Digital control of thermodynamics system.<br>**Practice:** Application examples practice. | **Lecture:** Heat transfer in systems.<br>**Practice:** Application examples practice.<br>**14th week:**<br>**Lecture:** Heat convection in thermodynamics systems.<br>**Practice:** Application examples practice. |
| **15th week: 2nd drawing week** | |

**Requirements**

**A, for a signature:**

Participation at practice, according to Rules and Regulations of University of Debrecen. Two practical tests.

**B, for a grade:**

The practical grade is the evaluation of the project.

**The course ends with exam grade. Based on the average of the test results x 0.3 + the exam grade from the theory x 0.7 exam grade is calculated as an average of them.**

**The minimum requirement for the mid-term, end-term tests and for the exam is 50%.**

## Mechatronics Comprehensive Exam

Code: MK3MSZIR00RX17-EN

ECTS Credit Points: 0

Year, Semester: 3rd year, 2nd semester

Subjects of Comprehensive exam: Basics of Mechatronics, Electrotechnics, Electronics I, Applied Automatization I, II, Electropneumatics and Electrohydraulics

Subject group "Differentiated Professional Subjects" –
Mechatronics Systems Specialization

## Modelling and Simulation Prototype Technologies I

Code: MK3MOD1R06R117-EN

ECTS Credit Points: 6

Evaluation: mid-semester grade

Year, Semester: 3rd year, 1st semester

Its prerequisite(s): Applied Automatization I

Further courses are built on it: Yes/No

Number of teaching hours/week (lecture + practice): 2+4

Topics:

Multidomain simulation with Bond Graphs. Simulation of mechanical, electrical, thermal and flow processes. Derivation of differential equations from Bond Graphs. Linearization of differential equation at operational points. Numerical solution of differential equations with integration.

Sizing with simulation: derivation of parameters based on time and energy optimum. Performance measurement of simulated system using cost functions. Development of stability regions, using parameter disturbances (tolerances) and disturbance distribution.

Application of domain-specific simulation environments, solution of real-life challenges.

1. Application of building physics simulation software to model renewable energy utilization systems, and building management systems (BMS). (EnergyPlus form US DOE, NREL)

2. Complex, analogue and digital electronics simulation system: static and transient analysis, parameter disturbance analysis, and effect of temperature change. (Multisim from National Instruments)

3. General purpose, multidomain, object oriented simulation environment. (Modelica and OpenModelica)

Literature:

*Compulsory:*

- Peter Fritzson "Object-Oriented Modeling and Simulation with Modelica 3.3", IEEE-Wiley, 2014, ISBN-13: 978-1118859124
- EnergyPlus, "Engineering Reference", ed. 8.7. US DOE, NREL
- "NI Multisim User Manual", National Instruments, 2009 January

Schedule

| 1st week Registration week | |
|---|---|
| 2nd week:<br>**Lecture:** Multi-domain simulation with Bond Graphs: Mechanical, Electrical, Thermal and Flow process simulation.<br>**Practice:** Multi domain computer simulation practice. | 3rd week:<br>**Lecture:** Derivation of differential equation from BondGraph. Linearization of differential equations around operational point.<br>**Practice:** System linearization practice. |
| 4th week:<br>**Lecture:** Numerical solution of differential equations.<br>**Practice:** Numerical solution practice. | 5th week:<br>**Lecture:** Sizing with simulation: derivation of system parameters along time and energy constraints.<br>**Practice:** Sizing with simulation practice. |
| 6th week:<br>**Lecture:** Simulated system performance measure with cost functions.<br>**Practice:** System performance measure practice. | 7th week:<br>**Lecture:** Derivation of operational stability range, against disturbance signals.<br>**Practice:** Operational stability practice. |

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|---|---|
| 8th week: 1st drawing week | |
| 9th week: | 10th week: |
| Lecture: Building physics simulation software introduction. | Lecture: Building simulation with renewable energy utilisation. |
| Practice: Building physics simulation practice. | Practice: Renewable energy utilisation practice. |
| 11th week: | 12th week: |
| Lecture: Mixed, analogue and digital electrical signal simulation introduction. | Lecture: Steady state and transient analysis, parameter variable analysis, heat generation and cooling. |
| Practice: Mixed electrical circuit simulation practice. | Practice: Multi analysis practice. |
| 13th week: | 14th week: |
| Lecture: General purpose multi-domain system theory. | Lecture: General purpose multi-domain system applications. |
| Practice: Multi-domain simulation practice. | Practice: Multi-domain simulation practice. |
| 15th week: 2nd drawing week | |

Requirements

A, for a signature:

Attendance at **lectures** is recommended, but not compulsory.

Participation at **practice** is compulsory. Students must attend the practice classes and may not miss more than three times during the semester. In case a student does so, the subject will not be signed and the student must repeat the course. Students can't make up a practice class with another group. Attendance at practice classes will be recorded by the practice leader. Being late is counted as an absence. In case of further absences, a medical certificate needs to be presented. Missed practices should be made up for at a later date, being discussed with the tutor. Students are required to bring the drawing tasks and drawing instruments to the course with them to each practice class. Active participation is evaluated by the teacher in every class. If a student's behaviour or conduct doesn't meet the requirements of active participation, the teacher may evaluate his/her participation as an absence because of the lack of active participation in class.

During the semester there are two tests, students have to sit for the tests.

B, for grade:

The course ends in a **mid-semester grade** based on the test results.

The minimum requirement for both mid-term and end-term tests is 50%. Based on the score of the tests separately, the grade for the tests is given according to the following (score/grade): 0-39 = fail; 40-52 = pass (2); 53-63 = satisfactory (3); 64-71 = good (4); 72-80 = excellent (5).

If the score of the sum of the two tests is below 40, the student once can take a retake test of the whole semester material.

## Modelling and Simulation Prototype Technologies II

Code: MK3MOD2R06R117-EN

ECTS Credit Points: 6

Evaluation: exam

Year, Semester: 3rd year, 2nd semester

Its prerequisite(s): Modelling and Simulation Prototype Technologies I

Further courses are built on it: Yes/No

Number of teaching hours/week (lecture + practice): 2+4

Topics:

Mechatronics, multi domain, prototype development, using simulation results. Theory and application of mechanical and electrical prototype development. Manufacturing of mechanical parts with additive and subtractive methods. Additional coating. Attachment of commercial mechanical parts: nuts and bolts, drive types, electrotechnical parts.

Printed Circuit Board (PCB) manufacturing with rapid prototyping technologies. Surface Mounted Technology (SMD) and Trough Hole Technology (THT). Heat transfer and cooling of electrical components. Matching and attachment of commercial electrical components: analogue matching or digital bus connection.

Validation of electrical circuits with measurement: analysis with periodic and non-periodic excitation signals, measurement of harmonic distortion and transfer function.

CPU and FPGA based digital control and signal processing, using model-driven software development tools, such as LabView from National Instruments.

Realization of simulation results, achieved previous subject, with rapid prototyping technologies.

Literature:

*Compulsory:*

- Chee Kai Chua, Kah Fai Leong, "3D Printing and Additive Manufacturing, Principles and Applications" 4th ed. 2014, World Scientific Press, ISBN: 978-981-4571-41-8
- Matisoff Bernie "Handbook of Electronics Manufacturing Engineering", 1997, Springer, ISBN-13: 978-0412086113

Schedule

| 1st week Registration week | |
|---|---|
| 2nd week:<br>**Lecture:** Multi-domain simulation development theory.<br>**Practice:** Prototype development practice. | 3rd week:<br>**Lecture:** Electrical and mechanical prototype development theory.<br>**Practice:** Electrical and mechanical prototype manufacturing practice. |
| 4th week: | 5th week: |

| | |
|---|---|
| **Lecture:** Production of mechanical parts with subtractive and additive methods. Surface treatment methods.<br>**Practice:** Mechanical part manufacturing practice. | **Lecture:** Design with commercial mechanical components: nuts and bolts, gears, and electromechanical components.<br>**Practice:** Design practice with commercial components. |
| 6th week:<br>**Lecture:** Rapid prototyping of printed circuit boards. Modules and components.<br>**Practice:** Printed circuit design practice. | 7th week:<br>**Lecture:** Through hole (THT) and surface mounted technologies for electrical circuits and boards. Heat dissipation and cooling.<br>**Practice:** THT and SMD soldering and testing practice. |
| 8th week: 1st drawing week | |
| 9th week:<br>**Lecture:** Electrical interfacing to commercial components. Analogue and digital interfacing. Connection to digital bus.<br>**Practice:** Electrical interfacing design and manufacturing practice. | 10th week:<br>**Lecture:** Testing of electrical components and modules with periodic and non-periodic excitation signals.<br>**Practice:** Electrical modules testing practice. |
| 11th week:<br>**Lecture:** Testing of electrical components and modules: distortion and transfer characteristics.<br>**Practice:** Electrical components testing practice. | 12th week:<br>**Lecture:** Model driven software development tools, theory.<br>**Practice:** Model driven software development practice. |
| 13th week:<br>**Lecture:** Digital control and signal processing with CPU.<br>**Practice:** Control and signal processing with CPU practice. | 14th week:<br>**Lecture:** Digital control and signal processing with FPGA.<br>**Practice:** Control and signal processing with FPGA practice. |
| 15th week: 2nd drawing week | |

Requirements

A, for a signature:

Attending practices is compulsory. Students must attend practice classes and may not miss more than three occasions during the semester. In case a student does so, the subject will not be signed and the student must repeat the course. Students can't take part in any practice class with another group. Attendance at practice classes will be recorded by the practice leader. Being late is equivalent with an absence. In case of further absences, a medical certification needs to be presented. Missed practice classes must be made up for at a later date, being discussed with the tutor.

During the semester there are two tests: the mid-term test on the 8th week and the end-term test on the 15th week. Students must sit for the tests.

B, for a grade:

The course ends in an examination.

The minimum requirement of the mid-term, the end-term test and the teamwork is 50% separately. Based on the score of the tests separately, the grade for the tests and the examination is given according to the following table:

The grade is given according to the following (score/grade): 0-49 % = fail (1); 50-62 % = pass (2); 63-75 % = satisfactory (3); 76-89 % = good (4); 90-100 % = excellent (5).

If the score of any test is below 50, the student once can take a retake test of the whole semester material.

An offered grade: It may be offered for the students if the average of the mid-term test, end-term tests and the teamwork is at least good (4). The offered grade is the average of them.

## Robots and Robotics Technology

Code: MK3ROBR6R117-EN

ECTS Credit Points: 6

Evaluation: 6 exam

Year, Semester: 2nd year, 1st semester

Its prerequisite(s): Mechatronic Devices (Sensors, Actuators, Motors), Applied Automatization I

Further courses are built on it: Yes/No

Number of teaching hours/week (lecture + practice): 2+4

### Topics:

General introduction to the history of robotics, background of robotics. Concept and classification of robots. Architecture of robots, coordinate systems, workspaces of robots, restrictions/constraints on workspaces. Structure of robots, installing robots. Mechanical structure of robots, characteristics of the mechanical structure of robots, kinetic chains, constraint equations. Manual control of robots, introducing fundamental robot movements. Robotic grippers, relationships between the safety of grippers and the kinetic characteristics of robots. Robot programming and information technology, principles of robot programming, basic concepts in programming. Fundamentals of robot programming.

Describing robot movements in programming language. General principles of generating paths, linear and non-linear paths, linear interpolation, circle interpolation. Defining robot position and orientation, position movements and orientation movements. Robot application and the design of robot application.

Material handling, combined application of technological and material handling systems, synchronizing tasks. Introducing the concept of „Intelligent Space": robots in human spaces. Robot simulation.

### Schedule

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|---|---|
| 1st week Registration week | |
| 2nd week:<br>**Lecture:** Geometric and kinematic characteristics of robots. Denavit-Hartemberg parameters. Jacobi matrix.<br>**Practice:** Accident prevention. Solving tasks using Denavit-Hartemberg parameters, Jacobi matrix. | 3rd week:<br>**Lecture:** Industry 4.0, role of robots, industrial manipulators in production processes. Concept of robots, structure of robots.<br>**Practice:** Solving tasks using Denavit-Hartemberg parameters, Jacobi matrix. |
| 4th week:<br>**Lecture:** 6DOF robots: structural elements, drives.<br>**Practice:** Robot control (6DOF or 4 DOF) – operator level. | 5th week:<br>**Lecture:** 6DOF robots: coordinate systems, installing coordinate systems.<br>**Practice:** Robot control (6DOF or 4 DOF) – operator level. |
| 6th week:<br>**Lecture:** 6DOF robots: Point-to-point and continuous path control of robots. Point-to-point control.<br>**Practice:** Robot control (6DOF or 4 DOF) – operator level. | 7th week:<br>**Lecture:** 6DOF robots: Singularity of robots.<br>**Practice:** Robot control (6DOF or 4 DOF) – operator level. |
| 8th week: 1st drawing week | |
| 9th week:<br>**Lecture:** 4DOF (Scara) robots: structural elements, coordinate control, point-to-point control, continuous path control.<br>**Practice:** Robot control (6DOF or 4 DOF) – operator level. | 10th week:<br>**Lecture:** Offline robot programming.<br>**Practice:** Mid-term test (theoretical), Robot control – classified. |
| 11th week:<br>**Lecture:** Offline robot programming.<br>**Practice:** Offline robot programming. | 12th week:<br>**Lecture:** "Intelligent Space": robots in human spaces.<br>**Practice:** Offline robot programming. |
| 13th week:<br>**Lecture:** Autonomous robots and their simulation.<br>**Practice:** Robot simulation. | 14th week:<br>**Lecture:** Robot simulation.<br>**Practice:** Robot simulation. |
| 15th week: 2nd drawing week | |

Requirements

A, for a signature:

Attendance at practical classes (see Rules and Regulations). Submitting homework assignments until the deadline. Passing the mid-term test.

B, for a grade:

Oral exam on the theoretical part.

## Caxx Techniques

Code: MK3CAXXR06R117-EN

ECTS Credit Points: 6

Evaluation: mid-semester grade

Year, Semester: 3rd year, 2nd semester

Its prerequisite(s): Modelling and Simulation Prototype Technologies I

Further courses are built on it: Yes/No

Number of teaching hours/week (lecture + practice): 2+4

### Topics:

CAXX technology theory summary: CAD, CAPP, CAM. Computer aided principles and technologies of machine production. Productivity and troubleshooting measurement with computer aided tools. Teamwork and cooperation with CAXX technologies.

CAXX technologies for Mechanical engineering practice: geometry design: creation of simple and complex surfaces and volumes. Modell extension with material, load and manufacturing properties. Connection of CAXX and CNC technologies. Practical examples: design and modelling of mechanism and drives.

CAXX technologies for Electrical engineering practice. Cabling and control cabinet design: cable size, cross section, labelling, colour code. Considering assembly best practices during design. Printed circuit design with CAXX technologies: selection of active and passive components' packages, wiring design along geometrical and electrical design rules.

Final element method (FEM) design in mechanical and electrical engineering practices.

Manufacturing with Rapid prototyping: material removal (cutting) and additive technologies. Rapid prototype manufacturing for mechanical and electrical engineering products.

### Literature:

*Compulsory:*


- Chee Kai Chua, Kah Fai Leong, Chu Sing Lim "Rapid Prototyping: principles and Applications", 2010, World Scientific
- A. K. Theraja, "Textbook of Electrical Technology", 2016, S Chand & Company Limited
- R. S. Khandpu, "Printed Circuit Boards: Design, Fabrication, Assembly and Testing", McGraw-Hill Publishing Ltd, 2005


### Schedule

| 1st week Registration week | |
|---|---|
| 2nd week: | 3rd week: |
| **Lecture:** Introduction to CAXX technologies theory | **Lecture:** CAXX technology: effectiveness and productivity |

| | |
|---|---|
| **Practice:** CAXX technology practice | **Practice:** Practice on CAXX technology: effectiveness and productivity |
| **4th week:** | **5th week:** |
| **Lecture:** CAXX technology: cooperation and teamwork. | **Lecture:** CAXX technologies for Mechanical engineering practices: geometrical model. |
| **Practice:** Practice on CAXX technology: productivity and teamwork. | **Practice:** CAXX technologies for Mechanical engineering practices: geometrical model design |
| **6th week:** | **7th week:** |
| **Lecture:** CAXX technologies for Mechanical engineering practices: material and load properties. | **Lecture:** CAXX technologies for Electrical engineering practice: cable design. |
| **Practice:** CAXX technologies for Mechanical engineering practices: material and load properties practice. | **Practice:** CAXX technologies for Electrical engineering practice: cable design practice. |
| **8th week: 1st drawing week** | |
| **9th week:** | **10th week:** |
| **Lecture:** CAXX technologies for Electrical engineering practice: control cabinet design. | **Lecture:** CAXX technologies for Electrical engineering practice: component packages and modules. |
| **Practice:** CAXX technologies for Electrical engineering practice: control cabinet design practice. | **Practice:** CAXX technologies for Electrical engineering practice: packages and modules design practice. |
| **11th week:** | **12th week:** |
| **Lecture:** CAXX technologies for Electrical engineering practice: printed circuit design. | **Lecture:** Rapid prototyping: manufacturing technology theory. |
| **Practice:** CAXX technologies for Electrical engineering practice: printed circuit design practice. | **Practice:** Rapid prototyping: practice. |
| **13th week:** | **14th week:** |
| **Lecture:** Rapid prototyping: manufacturing with cutting technology. | **Lecture:** Rapid prototyping: manufacturing with additive technology. |
| **Practice:** Rapid prototyping: cutting manufacturing practice. | **Practice:** Rapid prototyping: additive manufacturing practice. |
| **15th week: 2nd drawing week** | |

**Requirements**

**A, for a signature:**

Attendance at **lectures** is recommended, but not compulsory.

Participation at **practice** is compulsory. Students must attend the practice classes and may not miss more than three times during the semester. In case a student does so, the subject will not be signed and the student must repeat the course. Students can't make up a practice class with another group. Attendance at practice classes will be recorded by the practice leader. Being late is counted as an absence. In case of further absences, a medical

certificate needs to be presented. Missed practices should be made up for at a later date, being discussed with the tutor. Students are required to bring the drawing tasks and drawing instruments to the course with them to each practice class. Active participation is evaluated by the teacher in every class. If a student's behaviour or conduct doesn't meet the requirements of active participation, the teacher may evaluate his/her participation as an absence because of the lack of active participation in class.

During the semester there are two tests, students have to sit for the tests.

B, for grade:

The course ends in a **mid-semester grade** based on the test results.

The minimum requirement for both mid-term and end-term tests is 50%. Based on the score of the tests separately, the grade for the tests is given according to the following (score/grade): 0-39 = fail; 40-52 = pass (2); 53-63 = satisfactory (3); 64-71 = good (4); 72-80 = excellent (5).

If the score of the sum of the two tests is below 40, the student once can take a retake test of the whole semester material.

## Cyber-physical Systems

Code: MK3KIBRR6R117-EN

ECTS Credit Points: 6

Evaluation: mid-semester grade

Year, Semester: 3rd year, 2nd semester

Its prerequisite(s): Modelling and Simulation Prototype Technologies I

Further courses are built on it: Yes/No

Number of teaching hours/week (lecture + practice): 0+4

Topics:

The industry's 4.0 manufacturing technology trends, its upgrades are inseparable from the total transformation of industrial proceedings. The new approach to manufacturing and some aspects of it worldwide is a paradigm with different names (industrial internet, industry 4.0, cyber physical manufacturing system) one of its building blocks contains the practical teaching of the module. One of the logical explanations can be found in the BMBF (Bundesministerium fur Bildung und Forschung – German alliance educational and research minister) obtaining finance section: The flexibility of the cyber physical systems increases the usage of manufacturing systems (CPPS). This makes it possible for machines and sites to optimize themselves and reconfigure, their behaviour changes in regards to the changing orders and manufacturing conditions. The interrelationship between the real and the digital world, in the modern manufacturing sites it creates the foundation for the internet of things". In the centre of the systems there is a capability, to feel all incoming information, and conduct recognition out of this, and according to this they change their behaviour, and store the knowledge gained by experience. The intelligent manufacturing systems and processes, and the goal oriented engineering plans, methods and tools will become the most important factors of the shared and connected manufacturing winery,

for the successful creation in the future, intelligent manufacturing sites. The intelligent manufacturing sites original conception, the internet of things. This phrase was created in 1999 to put everyday items in a web and the web operation RFID and sensory technology together. The expression 'cyber physical systems' (CPS) was first written down in 2006 as unified actualization of minimal requirements.

Literature:

*Recommended:*


- Lee, Edward A. and Seshia, Sanjit A.: Introduction to Embedded Systems, A Cyber-Physical Systems Approach, http://LeeSeshia.org, ISBN 978-0-557-70857-4, 2011.
- Lee, Edward A. "CPS foundations." Proceedings of the 47th Design Automation Conference.ACM, 2010.
- Shi, Jianhua, et al. "A survey of cyber-physical systems." Wireless Communications and Signal Processing (WCSP), 2011 International Conference on. IEEE, 2011.
- https://www.beckhoff.hu/
- http://graphit.hu/tecnomatix/


Schedule

| | |
|---|---|
| 1st week Registration week | |
| 2nd week:<br>**Practice:** Creation of virtual production with discrete event-driven production & logistics. (with the most up to date software, 2017. TECNOMATIX/PLANT SIMULATION. | 3rd week:<br>**Practice:** Creation of virtual production with discrete event-driven production & logistics. (with the most up to date software, 2017. TECNOMATIX/PLANT SIMULATION. |
| 4th week:<br>**Practice:** Creation of virtual production with discrete event-driven production & logistics. (with the most up to date software, 2017. TECNOMATIX/PLANT SIMULATION. | 5th week:<br>**Practice:** Creation of virtual production with discrete event-driven production & logistics. (with the most up to date software, 2017. TECNOMATIX/PLANT SIMULATION. |
| 6th week:<br>**Practice:** Creation of virtual production with discrete event-driven production & logistics. (with the most up to date software, 2017. TECNOMATIX/PLANT SIMULATION. | 7th week:<br>**Practice:** Creation of virtual production with discrete event-driven production & logistics. (with the most up to date software, 2017. TECNOMATIX/PLANT SIMULATION. |
| 8th week: 1st drawing week | |
| 9th week:<br>**Practice:** Project selection& individual consultation. | 10th week:<br>**Practice:** Individual Consultation. |
| 11th week: | 12th week: |

| | |
|---|---|
| **Practice:** Individual Consultation.<br>**13th week:**<br>**Practice:** Individual Consultation. | **Practice:** Individual Consultation.<br>**14th week:**<br>**Practice:** Project submission & presentation. |

**15th week: 2nd drawing week**

**Requirements**

**A, for a signature:**

Participation on practice, according to Rules and Regulations of University of Debrecen. The correct solution of the project and submission before deadline.

**B, for a grade:**

The practical grade is the evaluation of the project.

Subject group "Differentiated Professional Subjects" –
Audiovisual Specialization

## Basics of Sound and Light

Type of subject: compulsory

ECTS Credit Points: 4

Evaluation: exam

Year, Semester: 3rd year, 5th semester

Its prerequisite: Applied Automatization I

Further courses are built on it: Yes/No

Number of teaching hours/week (lecture + practice): 2+2

**Topics:**

*Lecture:*

- Basic concepts: dimensions, measurements, description of motion and oscillations, systems with one degree of freedom
- Wave theory: propagation of waves (quantities, group speed, polarization, effects of media), wave sources, (basic sources and properties), reflection, refraction, impedance, interference, standing wave, Doppler effect, oscillations, coupled oscillations
- Optics: light sources, light transport, reflection, refraction, interference, color theory (black-body radiation), properties of surfaces and materials, basic of optics

*Practice:*

- Calculation with complex numbers (MatLab, Nyquist, Bode)

- Refraction, prism effect, reflection, lens
- Optics laboratory

## Literature

Ballou, G. (2008). Handbook for Sound Engineers, 4th Edition, Focal Press. ISBN-13: 978-0240809694

Gibson, D. (2005). The Art of Mixing: A Visual Guide to Recording, Engineering, and Production (2nd ed.). Artistpro. ISBN-13: 978-1931140454

## Professional competences to be acquired

a) knowledge

He/She knows

- the systems, sensors and actuators of mechatronics, electromechanical, information, motion control and their structural units, fundamental operation in engineering, in electrotechnics and in controlling.
- the fundamental measurement procedures and their tools, equipment, measurement instruments applied in electronics and engineering.
- the domestic and international standards, regulations.
- the security, health and environment protection (SHE), common standards of quality management and controlling (QA/QC) related to his professional field.
- the fundamentals of the professional field, limits and requirements of logistics, management, environmental protection, quality assurance, occupational health, information technology, law, economics.

b) skills

He/She is able to

- apply basic calculations, modelling principles, methods in the field of engineering, electrotechnics and controlling related to designing products and technologies of mechatronics, electromechanics, movement control.
- understand and describe the structure, the operation of units and elements of mechatronic systems, the configuration and connection of system elements in engineering, electrotechnics and control technique.
- apply technical standards related to operating mechatronic systems and intelligent machines, the principles of adjusting and maintenance mechatronic systems in engineering, electrotechnic, controlling approaches and know their economical correspondences.
- diagnose errors, select the right error treatment in engineering, electrotechnic, control technique approaches.
- to integrate knowledge from the fields of electronic, engineering and informatics and systemic thinking with experts of different fields, to carry out professional negotiation, introduce his/her thoughts in his/her professional filed clearly both in written and oral forms.
- understand and use the proper online and printed literature in English and with this knowledge he/she keeps his/her professional development continuous.
- complete monotonous practical tasks with steadiness and tolerance.
- work in groups and accept his/her status in a group and identify with it.

## Basics of A/V Technology

Type of subject: compulsory

ECTS Credit Points: 4

Evaluation: exam

Year, Semester: 3rd year, 5th semester

Its prerequisite: Applied Automatization I

Further courses are built on it: Yes/No

Number of teaching hours/week (lecture + practice): 2+2

## Topics:

- basic concepts: terms, quantities, phenomena and their connections
- hearing: hearing mechanism, auditory organs, non-linear phenomena (loudness, pitch, masking), directional hearing (perception of direction), auditory lab (hearing test and basic phenomena)
- building acoustics: room acoustics, noise and vibration protection, further questions concerning acoustics (mechanics, electricity), reverberation time and sound-proofing measurement, noise level measurement
- electroacoustics: converters, microphone, pickup, speakers and speaker systems , transformer, electro-dynamic effects, speaker measurement, experiments with interference effect
- sound generation: speech sound, natural sources of sound, instrument acoustics, knowledge of musical instruments
- sight: sight mechanism, eye, perception of colors, stereopsis, light measurement lab
- visual technology: light technics (physical definitions), sight technics (the power and conscious use of visual elements, settings), lighting technology (natural and artificial light sources, mapping, lightning design) visualization technics (screens, projectors in different sizes), visual technology lab
- reproduction: realistic reproduction, virtual reality

## Literature

Ballou, G. (2008). Handbook for Sound Engineers, 4th Edition, Focal Press. ISBN-13: 978-0240809694

Gibson, D. (2005). The Art of Mixing: A Visual Guide to Recording, Engineering, and Production (2nd ed.). Artistpro. ISBN-13: 978-1931140454

Senior, M. (2018). Mixing Secrets for the Small Studio (Sound On Sound Presents. . .) (2nd ed.). Routledge. ISBN-13: 978-1138556379

Bishop, R. H. (2002). The Mechatronics Handbook. The University of Texas at Austin Austin, Texas. CRC Press.

## Professional competences to be acquired

a) knowledge

He/She knows

- the systems, sensors and actuators of mechatronics, electromechanical, information, motion control and their structural units, fundamental operation in engineering, in electrotechnics and in controlling.
- the fundamental measurement procedures and their tools, equipment, measurement instruments applied in electronics and engineering.
- the domestic and international standards, regulations.
- the security, health and environment protection (SHE), common standards of quality management and controlling (QA/QC) related to his professional field.
- the fundamentals of the professional field, limits and requirements of logistics, management, environmental protection, quality assurance, occupational health, information technology, law, economics.

b) skills

He/She is able to

- apply basic calculations, modelling principles, methods in the field of engineering, electrotechnics and controlling related to designing products and technologies of mechatronics, electromechanics, movement control.
- understand and describe the structure, the operation of units and elements of mechatronic systems, the configuration and connection of system elements in engineering, electrotechnics and control technique.
- apply technical standards related to operating mechatronic systems and intelligent machines, the principles of adjusting and maintenance mechatronic systems in engineering, electrotechnic, controlling approaches and know their economical correspondences.
- diagnose errors, select the right error treatment in engineering, electrotechnic, control technique approaches.
- to integrate knowledge from the fields of electronic, engineering and informatics and systemic thinking with experts of different fields, to carry out professional negotiation, introduce his/her thoughts in his/her professional filed clearly both in written and oral forms.
- understand and use the proper online and printed literature in English and with this knowledge he/she keeps his/her professional development continuous.
- complete monotonous practical tasks with steadiness and tolerance.
- work in groups and accept his/her status in a group and identify with it.
- shares his/her experience with his/her colleagues to promote their development.

## Signs and Processing

Type of subject: compulsory

ECTS Credit Points: 6

Evaluation: exam

Year, Semester: 3rd year, 5th semester

Its prerequisite: Applied Automatization I

Further courses are built on it: Yes/No

Number of teaching hours/week (lecture + practice): 2+4

Topics:

- continuous signals: description of continuous signals (level, spectrum parameters)
- analysis: representation (linear/logarithmic scale, polar diagram), interpolation
- spectral analysis: base functions, basic assumptions, Fourier analysis, congenialities, further frequency analyses (Wavelet, windowing, etc.), 2D frequency analysis (cosine transform, etc.)
- geometry: length, surface, volume calculation, pi, coordinate systems, basic calculations
- discrete signals: sampling and its results/consequences, quantization and its results/consequences, the effects of finite number representation (fixed-point and floating-point arithmetic)
- discrete networks: delays, amplification: filtering, IIR filters, FIR filters, 2D filters
- filtering: correction filters: EQ, inverse filter, etc.; creative filters: filter banks, vocoder, formant filter
- nonlinear signal processing: modulated delay effect: chorus, flanger; modulated delay effect: pitch shift; delay network: echo, delay, multitap delay, reverb; linear process lab (Ableton/Cubase/PT); dynamics processing: compressor, limiter, expander, multitrack dynamics processing; nonlinear process lab (Ableton/Cubase/PT); dynamic effects: wah, rotary
- analysis: pitch recognition, voice recognition (1D), shape recognition (2D), echo recognition and reduction (echo-cancellation), sight lab (sight testing, color perception test, basic phenomena)

Literature

Ballou, G. (2008). Handbook for Sound Engineers, 4th Edition, Focal Press. ISBN-13: 978-0240809694

Tietze, U., Schenk, C., & Gamm, E. (2015). Electronic Circuits. Springer Publishing. ISBN 978-3540786559

Professional competences to be acquired

a) knowledge

He/She knows

- the applied materials and their production, characteristics in the field of mechatronics and the conditions of their application.
- the systems, sensors and actuators of mechatronics, electromechanical, information, motion control and their structural units, fundamental operation in engineering, in electrotechnics and in controlling.

- the fundamental design principles, methods in mechatronics including engineering and precision constructions and the fundamentals of designing analogue and digital circuits.
- the fundamental methods of calculation, modelling and simulation of engineering, electrical and control systems.
- the instruments, subassemblies, fundamental design and programming methods of computerized control, measurement data collection, embedded systems, optical detections, image processing
- the fundamental measurement procedures and their tools, equipment, measurement instruments applied in electronics and engineering.
- the domestic and international standards, regulations.

b) skills

He/She is able to

- understand and describe the structure, the operation of units and elements of mechatronic systems, the configuration and connection of system elements in engineering, electrotechnics and control technique.
- control and check technological manufacturing processes bearing in mind the elements of quality control.
- diagnose errors, select the right error treatment in engineering, electrotechnic, control technique approaches.
- to integrate knowledge from the fields of electronic, engineering and informatics and systemic thinking with experts of different fields, to carry out professional negotiation, introduce his/her thoughts in his/her professional filed clearly both in written and oral forms.

## A/V System Technology

Type of subject: compulsory

ECTS Credit Points: 6

Evaluation: mid-semester grade

Year, Semester: 3rd year, 6th semester

Its prerequisite: Basics of Sound and Light, Basics of A/V Technology, Signs and Processing

Further courses are built on it: Yes/No

Number of teaching hours/week (lecture + practice): 2+4

### Topics:

- basic concepts: information, transfer characteristics, system modelling, linear transfer characteristics, nonlinear transfer characteristics
- modulation: amplitude modulation, frequency modulation
- coding: error detection, error correction, encryption

- system management (theatre, corporate, smart building, etc.): specification, designing, validation, calculations, documentation, tendering, implementation, installation, handover-takeover, validation, measurements, operation, maintenance, upgrading, legal questions during the life cycle
- PAG/NAG lab

## Literature

Ballou, G. (2008). Handbook for Sound Engineers, 4th Edition, Focal Press. ISBN-13: 978-0240809694

Senior, M. (2018). Mixing Secrets for the Small Studio (Sound On Sound Presents. . .) (2nd ed.). Routledge. ISBN-13: 978-1138556379

Professional competences to be acquired

a) knowledge

He/She knows

- the applied materials and their production, characteristics in the field of mechatronics and the conditions of their application.
- the systems, sensors and actuators of mechatronics, electromechanical, information, motion control and their structural units, fundamental operation in engineering, in electrotechnics and in controlling.
- the fundamental methods of calculation, modelling and simulation of engineering, electrical and control systems.
- the fundamental measurement procedures and their tools, equipment, measurement instruments applied in electronics and engineering.
- the domestic and international standards, regulations.
- the security, health and environment protection (SHE), common standards of quality management and controlling (QA/QC) related to his professional field.
- the fundamentals of the professional field, limits and requirements of logistics, management, environmental protection, quality assurance, occupational health, information technology, law, economics.
- the methods of learning, knowledge acquisition, data collection and their ethic limits, problem solving techniques.
- the basics of corporate finances and the methods and tools of cost-benefit analysis on the bases of engineering.

b) skills

He/She is able to

- understand and describe the structure, the operation of units and elements of mechatronic systems, the configuration and connection of system elements in engineering, electrotechnics and control technique.
- apply technical standards related to operating mechatronic systems and intelligent machines, the principles of adjusting and maintenance mechatronic systems in engineering, electrotechnic, controlling approaches and know their economical correspondences.

- diagnose errors, select the right error treatment in engineering, electrotechnic, control technique approaches.
- to integrate knowledge from the fields of electronic, engineering and informatics and systemic thinking with experts of different fields, to carry out professional negotiation, introduce his/her thoughts in his/her professional filed clearly both in written and oral forms.
- understand and use the proper online and printed literature in English and with this knowledge he/she keeps his/her professional development continuous.
- complete monotonous practical tasks with steadiness and tolerance.
- work in groups and accept his/her status in a group and identify with it.

## Informatics

Type of subject: compulsory

ECTS Credit Points: 6

Evaluation: mid-semester grade

Year, Semester: 3rd year, 6th semester

Its prerequisite: Basics of Sound and Light, Basics of A/V Technology, Signs and Processing

Further courses are built on it: Yes/No

Number of teaching hours/week (lecture + practice): 4+4

## Topics:

- Basic concepts: data, information, signal (representation and operations), number systems and representation, Neumann principles
- Signal: Analog and digital signals, logical circuits, Boole algebra, logical functions
- Data: Data compression methods (LZ77, LZ78, LZW, FFT), wavelet transform, lossy compression principles
- Hardware: Neumann architecture, computer generations, hardware elements (clock signal; electron tube, transistor, IC, processor, microprocessor; memory (RAM, ROM, PROM, EPROM, EEPROM); data storage (primary, secondary, tertiary); I/O)
- Software: data structures (array, list, stack, queue, tree, file), algorithms (search, sort), programming (historical introduction, classification, pseudo code, block diagram, development models), (variable, data types, control structures, loops, conditional statements)
- Network: historical introduction, architecture (topology, protocol, IP standards)

## Literature

Thomas L. Floyd: Digital Fundamentals, Prentice Hall, 2009, ISBN-10: 0138146462

David McMahon, Signals & Systems Demystified, McGraw-Hill, 2006

Y. Daniel Liang: Introduction to Java Programming, 10th ed., Pearson, 2014, ISBN13: 978- 0133813463.

A. S. Tanenbaum, D. J. Wetherall: Computer Networks, 5th edition, Pearson, 2011.

"Edward Crookshanks: Practical Software Development Techniques ISBN 978-1-4842- 0728-4

## Professional competences to be acquired

a) knowledge

He/She knows

- the fundamental methods of calculation, modelling and simulation of engineering, electrical and control systems.
- the instruments, subassemblies, fundamental design and programming methods of computerized control, measurement data collection, embedded systems, optical detections, image processing
- the methods of learning, knowledge acquisition, data collection and their ethic limits, problem solving techniques.

b) skills

He/She is able to

- to integrate knowledge from the fields of electronic, engineering and informatics and systemic thinking with experts of different fields, to carry out professional negotiation, introduce his/her thoughts in his/her professional filed clearly both in written and oral forms.
- understand and use the proper online and printed literature in English and with this knowledge he/she keeps his/her professional development continuous.
- complete monotonous practical tasks with steadiness and tolerance.
- work in groups and accept his/her status in a group and identify with it.

## Audiovisual Culture and Production

Type of subject: compulsory

ECTS Credit Points: 4

Evaluation: exam

Year, Semester: 3rd year, 6th semester

Its prerequisite: Basics of Sound and Light, Basics of A/V Technology, Signs and Processing

Further courses are built on it: Yes/No

Number of teaching hours/week (lecture + practice): 2+2

## Topics:

- history of art: basics about sound, music, image and film history
- audiovisual aesthetics: music editing and mixing
- music theory: basic concepts of solfège, speech recording and mixing (audio and video)
- production, content production: preparation, the process of sound and video recording, editing, post-production, distribution, archiving

### Literature

Required literature:

1. La Torre M. (1999) Defining the Audiovisual Industry. In: The Economics of the Audiovisual Industry: Financing TV, Film and Web. Palgrave Macmillan, London. – ISBN 978-1-137-37847-7

Recommended literature:

2. The Recording Engineer's Handbook (4th edition) - Bobby Owsinski - ISBN-13: 978-0998503356
3. The Mixing Engineer's Handbook (4th edition) - Bobby Owsinski - ISBN-13: 978-0998503349
4. The Filmmaker's Handbook (5th edition, 2019) - Steven Ascher - ISBN-13: 978-0452297289

### Professional competences to be acquired

a) knowledge

He/She knows

- the fundamental measurement procedures and their tools, equipment, measurement instruments applied in electronics and engineering.
- the domestic and international standards, regulations.

b) skills

He/She is able to

- control and check technological manufacturing processes bearing in mind the elements of quality control.
- to integrate knowledge from the fields of electronic, engineering and informatics and systemic thinking with experts of different fields, to carry out professional negotiation, introduce his/her thoughts in his/her professional filed clearly both in written and oral forms.
- understand and use the proper online and printed literature in English and with this knowledge he/she keeps his/her professional development continuous.
- complete monotonous practical tasks with steadiness and tolerance.

## Project of Mechatronics

## Individual Project Work

# DIPLOMA

Within 30 days of the successful final exam the diploma is issued and given out by the Faculty at the graduate's special request. Otherwise, the diploma will be awarded to him/her at the graduation ceremony of the Faculty.

The diploma is an official document decorated with the coat of arms of Hungary which verifies the successful completion of studies in the Mechatronics Engineering undergraduate program. The diploma contains the following data: name of HEI (higher education institution); institutional identification number; serial number of diploma; name of diploma holder; date and place of his/her birth; level of qualification; training program; specialisation; mode of attendance; place, day, month and year issued. Furthermore, it has to contain the dean's (or vice-dean's) original signature and the seal of HEI. It has to contain the dean's (in case of being prevented from attending the vice-dean for educational affairs) original signature and the imprint of the official stamp of the tertiary institute.

At the graduate's special request, a certificate on the completion of studies is issued. The document does not contain any reference to qualification, it merely proves that the candidate has taken a successful final exam. The Faculty keeps a record of the certificates issued.

## Calculation of a diploma grade according to this formula:

Grade0.3×B+0.2×C+0.5×A, where

A: Average of comprehensive exams A=0.3 x mathematics comp. exam+0.7 x mechatronics comprehensive exam

B: Average of the grades of the state exam topics

C: Grade for defending thesis

On the basis of the calculated average grade the classification of the award:

| | |
|---|---|
| Outstanding | 4,81 – 5,00 |
| Excellent | 4,51 – 4,80 |
| Good | 3,51 – 4,50 |
| Satisfactory | 2,51 – 3,50 |
| Pass | 2,00 – 2,50 |

## Diploma with Honours

A diploma with honours is permitted where a student obtained grade 5 in all subjects of the final exam and for the thesis defence. The average of thesis grade, his/her exam grades and mid-semester grades during his/her studies is at least 4 and the student did not receive a grade lower than satisfactory (3) during all his/her studies.

MODEL CURRICULUM OF MECHATRONICS ENGINEERING BSC – SPECIALISATION IN MECHATRONIC SYSTEMS

The curriculum of the program is available in excel format on the webpage of the Faculty of Engineering (https://eng.unideb.hu/en/node/195).

| Nr. | Subject group | Subject name | Subject code | 1st semester | | | | 2nd semester | | | | 3rd semester | | | | 4th semester | | | | 5th semester | | | | 6th semester | | | | 7th semester | | | | Prerequisite(s) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | L | P | E | C | L | P | E | C | L | P | E | C | L | P | E | C | L | P | E | C | L | P | E | C | L | P | E | C | |
| 1. | Natural Sciences | Mathematics I | MK3MAT1A08RX17-EN | 4 | 4 | m | 8 | | | | | | | | | | | | | | | | | | | | | | | | | |
| 2. | | Mathematics II | MK3MAT2A06RX17-EN | | | | | 2 | 4 | m | 6 | | | | | | | | | | | | | | | | | | | | | MK3MAT1A08RX17-EN |
| 3. | | Mathematics Comprehensive Exam | MK3MATSA00RX17-EN | | | | | 0 | 0 | FE | 0 | | | | | | | | | | | | | | | | | | | | | MK3MAT2A06RX17-EN at the same time,or later |
| 4. | | Mathematics III | MK3MAT3A04RX17-EN | | | | | | | | | 2 | 2 | m | 4 | | | | | | | | | | | | | | | | | MK3MAT2A06RX17-EN |
| 5. | | Engingeering Physics | MK3MFIZA04RX17-EN | 2 | 2 | e | 4 | | | | | | | | | | | | | | | | | | | | | | | | | |
| 6. | | Computer-Aided Modelling | MK3SZABA04RX17-EN | | | | | 0 | 4 | m | 4 | | | | | | | | | | | | | | | | | | | | | |
| 7. | | Informatics (Programming in C) | MK3INFCA04RX17-EN | 0 | 4 | m | 4 | | | | | | | | | | | | | | | | | | | | | | | | | |
| 8. | | Electromagnetism | MK3EMAGA04RX17-EN | 2 | 2 | e | 4 | | | | | | | | | | | | | | | | | | | | | | | | | |
| 9. | | Statics and Strength of Materials | MK3STSZG04XX17-EN | | | | | | | | | 2 | 2 | m | 4 | | | | | | | | | | | | | | | | | MK3MFIZA04RX17-EN |
| 10. | | Dynamics and Vibration | MK3MREZG04XX17-EN | | | | | | | | | | | | | 2 | 2 | e | 4 | | | | | | | | | | | | | MK3MFIZA04RX17-EN |
| 11. | | Materials Engineering | MK3ANISG06RX17-EN | | | | | 3 | 2 | m | 6 | | | | | | | | | | | | | | | | | | | | | MK3MFIZA04RX17-EN |
| 12. | Economics and Humanities | Law and Ethics | MK3JOGEM04XX17-EN | 2 | 0 | m | 4 | | | | | | | | | | | | | | | | | | | | | | | | | |
| 13. | | Economics for Engineering | MK3KOZMM04XX17-EN | | | | | 1 | 2 | e | 4 | | | | | | | | | | | | | | | | | | | | | |
| 14. | | Microeconomics and Economical Processes of Enterprises | MK3MIKVM04XX17-EN | | | | | | | | | 1 | 2 | e | 4 | | | | | | | | | | | | | | | | | MK3KOZMM04XX17-EN |
| 15. | | Quality and Technical Management | MK3MINMM04XX17-EN | | | | | | | | | | | | | | | | | 2 | 2 | e | 4 | | | | | | | | | MK3MIKVM04XX17-EN |
| 16. | Specific Compulsory Subjects | Basics of Mechatronics | MK3MEALR04RX17-EN | 2 | 2 | e | 4 | | | | | | | | | | | | | | | | | | | | | | | | | |
| 17. | | Informatics (Labview) | MK3LABVA04RX17-EN | | | | | 0 | 4 | m | 4 | | | | | | | | | | | | | | | | | | | | | |
| 18. | | Electrotechnics | MK3ELTER06RX17-EN | | | | | 2 | 2 | e | 6 | | | | | | | | | | | | | | | | | | | | | |
| 19. | | Electronics I | MK3ELT1R06RX17-EN | | | | | | | | | 2 | 4 | e | 6 | | | | | | | | | | | | | | | | | MK3EMAGA04RX17-EN |
| 20. | | Mechatronic Devices (Sensors, Actuators, Motors) | MK3ERZBR04RX17-EN | | | | | | | | | | | | | 2 | 2 | m | 4 | | | | | | | | | | | | | MK3ELTER06RX17-EN |
| 21. | | Mechanical Machines and Machine Elements | MK3MGEPG04RX17-EN | | | | | | | | | 2 | 2 | e | 6 | | | | | | | | | | | | | | | | | MK3MFIZA04RX17-EN |
| 22. | | Manufacturing Technologies | MK3GYARG04RX17-EN | | | | | | | | | 2 | 2 | m | 4 | | | | | | | | | | | | | | | | | MK3MFIZA04RX17-EN |
| 23. | | Measurement and Data Acquisition | MK3MERAR06RX17-EN | | | | | | | | | | | | | 2 | 2 | m | 6 | | | | | | | | | | | | | MK3ELT1R06RX17-EN |
| 24. | | Environment, Health and Safety, Ergonomics (Basics of EHS) | MK3EHSAK04RX17-EN | | | | | | | | | | | | | 2 | 2 | e | 4 | | | | | | | | | | | | | |
| 25. | | Applied Automatization I | MK3AUT1R06RX17-EN | | | | | | | | | | | | | 2 | 4 | e | 6 | | | | | | | | | | | | | MK3ELT1R06RX17-EN |
| 26. | | Applied Automatization I | MK3AUT2R06RX17-EN | | | | | | | | | | | | | | | | | 0 | 6 | m | 6 | | | | | | | | | MK3AUT1R06RX17-EN |
| 27. | | Pneumatics and Hydraulics | MK3PNEUR04RX17-EN | | | | | | | | | | | | | 0 | 4 | m | 4 | | | | | | | | | | | | | MK3MEALR04RX17-EN |
| 28. | | Electropneumatics and Electrohydraulics | MK3EPNER06RX17-EN | | | | | | | | | | | | | | | | | 0 | 4 | m | 6 | | | | | | | | | MK3PNEUR04RX17-EN |
| 29. | | Electrical Machines and Drives | MK3VHAJR06RX17-EN | | | | | | | | | | | | | | | | | | | | | 2 | 4 | m | 6 | | | | | MK3ERZBR04RX17-EN |
| 30. | | Thermodynamic Processes | MK3TERFR04RX17-EN | | | | | | | | | | | | | | | | | | | | | 2 | 2 | e | 4 | | | | | MK3MEALR04RX17-EN |
| 31. | | Mechatronics Comprehensive Exam | MK3MSZIR00RX17-EN | | | | | | | | | | | | | | | | | | | | | 0 | 0 | FE | 0 | | | | | Basics of Mechatronics, Electrotechnics, Electronics I, Applied Automatization I-II, Electropneumatics and Electrohydraulics |
| 32. | Differentiated Professional Subjects | Modelling and Simulation Prototype Technologies I | MK3MOD1R06R117-EN | | | | | | | | | | | | | | | | | 2 | 4 | m | 6 | | | | | | | | | MK3AUT1R06RX17-EN |
| 33. | | Modelling and Simulation Prototype Technologies II | MK3MOD2R06R117-EN | | | | | | | | | | | | | | | | | | | | | 2 | 4 | e | 6 | | | | | MK3MOD1R06R117-EN |
| 34. | | Robots and Robotics Technology | MK3ROBTR06R117-EN | | | | | | | | | | | | | | | | | 2 | 4 | e | 6 | | | | | | | | | MK3ERZBR04RX17-EN;MK3AUT1R06RX17-EN |
| 35. | | Caxx Techniques | MK3CAXXR06R117-EN | | | | | | | | | | | | | | | | | | | | | 2 | 4 | m | 6 | | | | | MK3MOD1R06R117-EN |
| 36. | | Cyber-Physical Systems | MK3KIBRR06R117-EN | | | | | | | | | | | | | | | | | | | | | 0 | 4 | m | 6 | | | | | MK3MOD1R06R117-EN |
| 37. | | Project of Mechatronics | MK3MPROR15R117-EN | | | | | | | | | | | | | | | | | | | | | | | | | 0 | 20 | m | 15 | MK3MSZIR00RX17-EN;MK3MOD2R06R117-EN;MK3CAXXR06R117-EN;MK3KIBRR06R117-EN |
| 38. | | BSc Thesis | MK3SZAKR15RX17-EN | | | | | | | | | | | | | | | | | | | | | | | | | 0 | 5 | m | 15 | |
| | | Optional Subjects (min. 10 credit points) | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | | Industrial Training (6 weeks) | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | | | *Total:* | **12** | **14** | | | **8** | **18** | | | **11** | **14** | | | **10** | **16** | | | **6** | **20** | | | **8** | **18** | | | **0** | **25** | | | Abbreviations: |
| | | | *Classes per week total:* | 26 | | | | 26 | | | | 25 | | | | 26 | | | | 26 | | | | 26 | | | | 25 | | | | L= Lecture, P= Practice, E= Evaluation, C= Credits |
| | | | *Credits:* | **28** | | | | **30** | | | | **28** | | | | **28** | | | | **28** | | | | **28** | | | | **30** | | | | e= exam, m= mid-semester grade, FE= final exam (comprehensive exam), s=signature |
| | | | *Credits total:* | **210** | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | | | *Comprehensive Exam* | | | 0 | | | | 1 | | | | 0 | | | | 0 | | | | 0 | | | | 1 | | | | 0 | | |
| | | | *Exam* | | | 3 | | | | 2 | | | | 3 | | | | 3 | | | | 2 | | | | 2 | | | | 0 | | |
| | | | *Mid-Semester Grade* | | | 3 | | | | 4 | | | | 3 | | | | 3 | | | | 3 | | | | 3 | | | | 2 | | |

# MODEL CURRICULUM OF MECHATRONICS ENGINEERING BSC – AUDIOVISUAL SPECIALISATION

The curriculum of the program is available in excel format on the webpage of the Faculty of Engineering (https://eng.unideb.hu/en/node/195).

| Nr. | Subject groups | Subject | Code | 1st semester | | | | 2nd semester | | | | 3rd semester | | | | 4th semester | | | | 5th semester | | | | 6th semester | | | | 7th semester | | | | Prerequisite |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | L | P | E | C | L | P | E | C | L | P | E | C | L | P | E | C | L | P | E | C | L | P | E | C | L | P | E | C | |
| 1 | Basics of Natural Sciences | Mathematics I | MK3MAT1A08RX17-EN | 4 | 4 | m | 8 | | | | | | | | | | | | | | | | | | | | | | | | | |
| 2 | | Mathematics II | MK3MAT2A06RX17-EN | | | | | 2 | 4 | m | 6 | | | | | | | | | | | | | | | | | | | | | Mathematics I |
| 3 | | Mathematics Comprehensive Exam | MK3MATSA00RX17-EN | | | | | 0 | 0 | c | 0 | | | | | | | | | | | | | | | | | | | | | Mathematics II at the same time,or later |
| 4 | | Mathematics III | MK3MAT3A04RX17-EN | | | | | | | | | 2 | 2 | m | 4 | | | | | | | | | | | | | | | | | Mathematics II |
| 5 | | Engingeering Physics | MK3MFIZA04RX17-EN | 2 | 2 | e | 4 | | | | | | | | | | | | | | | | | | | | | | | | | |
| 6 | | Computer-Aided Modelling | MK3SZABA04RX17-EN | | | | | 0 | 4 | m | 4 | | | | | | | | | | | | | | | | | | | | | |
| 7 | | Informatics (Programming in C) | MK3INFCA04RX17-EN | 0 | 4 | m | 4 | | | | | | | | | | | | | | | | | | | | | | | | | |
| 8 | | Electromagnetism | MK3EMAGA04RX17-EN | 2 | 2 | e | 4 | | | | | | | | | | | | | | | | | | | | | | | | | |
| 9 | | Statics and Strength of Materials | MK3STSZG04XX17-EN | | | | | | | | | 2 | 2 | m | 4 | | | | | | | | | | | | | | | | | Engingeering Physics |
| 10 | | Dynamics and Vibration | MK3MREZG04XX17-EN | | | | | | | | | | | | | 2 | 2 | e | 4 | | | | | | | | | | | | | Engingeering Physics |
| 11 | | Materials Engineering | MK3ANISG06RX17-EN | | | | | 3 | 2 | m | 6 | | | | | | | | | | | | | | | | | | | | | Engingeering Physics |
| 12 | Economics and Humanities | Law and Ethics | MK3JOGEM04XX17-EN | 2 | 0 | m | 4 | | | | | | | | | | | | | | | | | | | | | | | | | |
| 13 | | Economics for Engineering | MK3KOZMM04XX17-EN | | | | | 1 | 2 | e | 4 | | | | | | | | | | | | | | | | | | | | | |
| 14 | | Microeconomics and Economical Processes of Enterprises | MK3MIKVM04XX17-EN | | | | | | | | | 1 | 2 | e | 4 | | | | | | | | | | | | | | | | | Economics for Engineering |
| 15 | | Quality and Technical Management | MK3MINMM04XX17-EN | | | | | | | | | | | | | | | | | 2 | 2 | e | 4 | | | | | | | | | Microeconomics and Economical Processes of Enterprises |
| 16 | Professional Compulsory Subjects | Basics of Mechatronics | MK3MEALR04RX17-EN | 2 | 2 | e | 4 | | | | | | | | | | | | | | | | | | | | | | | | | |
| 17 | | Informatics (Labview) | MK3LABVA04RX17-EN | | | | | 0 | 4 | m | 4 | | | | | | | | | | | | | | | | | | | | | |
| 18 | | Electrotechnics | MK3ELTER06RX17-EN | | | | | 2 | 2 | e | 6 | | | | | | | | | | | | | | | | | | | | | |
| 19 | | Electronics I | MK3ELT1R06RX17-EN | | | | | | | | | 2 | 4 | e | 6 | | | | | | | | | | | | | | | | | Electromagnetism |
| 20 | | Mechatronic Devices (Sensors, Actuators, Motors) | MK3ERZBR04RX17-EN | | | | | | | | | | | | | 2 | 2 | m | 4 | | | | | | | | | | | | | Electrotechnics |
| 21 | | Mechanical Machines and Machine Elements | MK3MGEPG04RX17-EN | | | | | | | | | 2 | 2 | e | 6 | | | | | | | | | | | | | | | | | Engingeering Physics |
| 22 | | Manufacturing Technologies | MK3GYARG04RX17-EN | | | | | | | | | 2 | 2 | m | 4 | | | | | | | | | | | | | | | | | Engingeering Physics |
| 23 | | Measurement and Data Acquisition | MK3MERAR06RX17-EN | | | | | | | | | | | | | 2 | 2 | m | 6 | | | | | | | | | | | | | Electronics I |
| 24 | | Environment, Health and Safety, Ergonomics (Basics of EHS) | MK3EHSAK04RX17-EN | | | | | | | | | | | | | 2 | 2 | e | 4 | | | | | | | | | | | | | |
| 25 | | Applied Automatization I | MK3AUT1R06RX17-EN | | | | | | | | | | | | | 2 | 4 | e | 6 | | | | | | | | | | | | | Electronics I |
| 26 | | Applied Automatization I | MK3AUT2R06RX17-EN | | | | | | | | | | | | | | | | | 0 | 6 | m | 6 | | | | | | | | | Applied Automatization I |
| 27 | | Pneumatics and Hydraulics | MK3PNEUR04RX17-EN | | | | | | | | | | | | | 0 | 4 | m | 4 | | | | | | | | | | | | | Basics of Mechatronics |
| 28 | | Electropneumatics and Electrohydraulics | MK3EPNER06RX17-EN | | | | | | | | | | | | | | | | | 0 | 4 | m | 6 | | | | | | | | | Pneumatics and Hydraulics |
| 29 | | Electrical Machines and Drives | MK3VHAJR06RX17-EN | | | | | | | | | | | | | | | | | | | | | 2 | 4 | m | 6 | | | | | Mechatronic Devices (Sensors, Actuators, Motors) |
| 30 | | Thermodynamic Processes | MK3TERFR04RX17-EN | | | | | | | | | | | | | | | | | | | | | 2 | 2 | e | 4 | | | | | Basics of Mechatronics |
| 31 | | Mechatronics Comprehensive Exam | MK3MSZIR00RX17-EN | | | | | | | | | | | | | | | | | | | | | 0 | 0 | c | 0 | | | | | Pre-requirement subjects of the comprehensive exam: Basics of Mechatronics, Electrotechnics, Electronics I, Applied Automatization I-II, Electropneumatics and Electrohydraulics |
| 34 | Field-specific Vocational Subjects | Basics of Sound and Light | | | | | | | | | | | | | | | | | | 2 | 2 | e | 4 | | | | | | | | | Applied Automatization I |
| 35 | | Basics of A/V Technology | | | | | | | | | | | | | | | | | | 2 | 2 | e | 4 | | | | | | | | | Applied Automatization I |
| 36 | | Signs and Processing | | | | | | | | | | | | | | | | | | 2 | 4 | m | 6 | | | | | | | | | Applied Automatization I |
| 37 | | A/V System Technology | | | | | | | | | | | | | | | | | | | | | | 2 | 4 | m | 6 | | | | | Basics of Sound and Light, Basics of A/V Technology, Signs and Processing |
| 38 | | Informatics | | | | | | | | | | | | | | | | | | | | | | 4 | 4 | m | 6 | | | | | Basics of Sound and Light, Basics of A/V Technology, Signs and Processing |
| | | Audiovisual Culture and Production | | | | | | | | | | | | | | | | | | | | | | 2 | 2 | e | 4 | | | | | Basics of Sound and Light, Basics of A/V Technology, Signs and Processing |
| 39 | | Project of Mechatronics | MK3MPROR15R117-EN | | | | | | | | | | | | | | | | | | | | | | | | | 0 | 20 | m | 15 | Mechatronics Comprehensive Exam, Basics of Sound and Light, Basics of A/V Technology, Signs and Processing |
| 41 | | BSc Thesis | MK3SZAKR15RX17-EN | | | | | | | | | | | | | | | | | | | | | | | | | 0 | 5 | m | 15 | |
| 42 | Optional Subjects* | Optional Subject I | | | | | | | | | | | | | 3 | | | | | | | | | | | | | | | | | |
| 43 | | Optional Subject II | | | | | | | | | | | | | | | | | 2 | | | | | | | | | | | | | |
| 44 | | Optional Subject III | | | | | | | | | | | | | | | | | | | | | 2 | | | | | | | | | |
| 45 | | Optional Subject IV | | | | | | | | | | | | | | | | | | | | | | | | | 3 | | | | | |
| 46 | | Internship** | MK3SZGYR00RX17-EN | | | | | | | | | | | | | | | | | | | | | 6 weeks | | s | 0 | | | | | |
| | | | | L | P | E | C | L | P | E | C | L | P | E | C | L | P | E | C | L | P | E | C | L | P | E | C | L | P | E | C | |
| | | **Total / semester:** | | 12 | 14 | | 28 | 8 | 18 | | 30 | 11 | 14 | | 31 | 10 | 16 | | 30 | 8 | 20 | | 32 | 12 | 16 | | 29 | 0 | 25 | | 30 | |
| | | number of exam subjects | | | | 3 | | | | 2 | | | | 3 | | | | 3 | | | | 3 | | | | 2 | | | | 0 | | |
| | | number of mid-semester grade subjects | | | | 3 | | | | 4 | | | | 3 | | | | 3 | | | | 3 | | | | 3 | | | | 2 | | |
| | | number of comprehensive exam subjects | | | | 0 | | | | 1 | | | | 0 | | | | 0 | | | | 0 | | | | 1 | | | | 0 | | |
| | | number of subjects | | | | 6 | | | | 7 | | | | 6 | | | | 6 | | | | 6 | | | | 6 | | | | 2 | | |
| | | number of teaching hours / semester | | 26 | | | | 26 | | | | 25 | | | | 26 | | | | 28 | | | | 28 | | | | 25 | | | | |

| | | | |
|---|---|---|---|
| | | **Total:** | |
| | number of exam subjects | 16 | |
| | number of mid-semester grade subjects | 21 | |
| | number of comprehensive exam subjects | 2 | |
| | number of subjects | 39 | |
| | number of teaching hours | 184 | |
| | number of optional credits | 10 | |
| | total number of credits | 210 | |

| **Abbreviations:** |
|---|
| **L = Number of Lectures / week** |
| **P = Number of Practices / week** |
| **E = Evaluation** |
| c = comprehensive exam |
| e = exam |
| m = mid-semester grade |
| s = signature |
| **C = Credits** |

| **Criterion subjects:** |
|---|
| *Optional Subjects (Rules and Regulations XIII. Faculty of Engineering 10. § (2)). Minimum of credits assigned to optional subjects: 10 credits. The suggedted order and credit number in the curriculum is only a recommendation. |
| **Internship (requirement: signature, lenght: 6 weeks after the 6th semester; students must register for the subject in the 6th semester) |
| Work and Fire Safety (requirement: signature, students must register for the subject in the 1st semester based on Rules and Regulations XIII. Faculty of Engineering 5. § (6)) |
| Physical Education (requirement: signature, Rules and Regulations 10. §) |