University of Debrecen
Faculty of Science and Technology

INSTITUTE OF PHYSICS
Department of Electrical and Electronic Engineering

ELECTRICAL ENGINEERING BSC PROGRAM

2020.

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DEAN’S WELCOME

Welcome to the Faculty of Science and Technology!

This is an exciting time for you, and I encourage you to take advantage of all that the Faculty of Science and Technology UD offers you during your bachelor’s or master's studies. I hope that your time here will be both academically productive and personally rewarding

Being a regional centre for research, development and innovation, our Faculty has always regarded training highly qualified professionals as a priority. Since the establishment of the Faculty in 1949, we have traditionally been teaching and working in all aspects of Science and have been preparing students for the challenges of teaching. Our internationally renowned research teams guarantee that all students gain a high quality of expertise and knowledge. Students can also take part in research and development work, guided by professors with vast international experience.

While proud of our traditions, we seek continuous improvement, keeping in tune with the challenges of the modern age. To meet our region’s demand for professionals, we offer engineering courses with a strong scientific basis, thus expanding our training spectrum in the field of technology. Recently, we successfully re-introduced dual training programmes in our constantly evolving engineering courses.

We are committed to providing our students with valuable knowledge and professional work experience, so that they can enter the job market with competitive degrees. To ensure this, we maintain a close relationship with the most important companies in our extended region. The basis for our network of industrial relationships are in our off-site departments at various different companies, through which market participants - future employers - are also included in the development and training of our students.

Prof. dr. Ferenc Kun
Dean

UNIVERSITY OF DEBRECEN

Legal status of the University of Debrecen: state university

Founder of the University of Debrecen: Hungarian State Parliament

Supervisory body of the University of Debrecen: Ministry of Education

Number of Faculties at the University of Debrecen: 14

Faculty of Agricultural and Food Sciences and Environmental Management

Faculty of Child and Special Needs Education

Faculty of Dentistry

Faculty of Economics and Business

Faculty of Engineering

Faculty of Health

Faculty of Humanities

Faculty of Informatics

Faculty of Law

Faculty of Medicine

Faculty of Music

Faculty of Pharmacy

Faculty of Public Health

Faculty of Science and Technology

Number of students at the University of Debrecen: 26938

Full time teachers of the University of Debrecen: 1542

207 full university professors and 1159 lecturers with a PhD.

FACULTY OF SCIENCE AND TECHNOLOGY

The Faculty of Science and Technology is currently one of the largest faculties of the University of Debrecen with about 3000 students and more than 200 staff members. The Faculty has got 6 institutes: Institute of Biology and Ecology, Institute of Biotechnology, Institute of Chemistry, Institute of Earth Sciences, Institute of Physics and Institute of Mathematics. The Faculty has a very wide scope of education dominated by science and technology (10 Bachelor programs and 12 Master programs), additionally it has a significant variety of teachers' training programs. Our teaching activities are based on a strong academic and industrial background, where highly qualified teachers with a scientific degree involve student in research and development projects as part of their curriculum. We are proud of our scientific excellence and of the application-oriented teaching programs with a strong industrial support. The number of international students of our faculty is continuously growing (currently 570 students). The attractiveness of our education is indicated by the popularity of the Faculty in terms of incoming Erasmus students, as well.

THE ORGANIZATIONAL STRUCTURE OF
THE FACULTY

Dean: Prof. Dr. Ferenc Kun, University Professor
E-mail: ttkdekan@science.unideb.hu

Vice Dean for Educational Affairs: Prof. Dr. Gábor Kozma, University Professor
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Consultant on External Relationships: Prof. Dr. Attila Bérczes, University Professor
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Quality Assurance Coordinator: Dr. Zsolt Radics, Assistant Professor
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Dean's Office
Head of Dean's Office: Mrs. Katalin Tóth
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Registrar's Office
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E-mail: kerekes.ildiko@science.unideb.hu

English Program Officer: Mr. Imre Varga
Address: 4032 Egyetem tér 1., Chemistry Building, A/101
E-mail: vargaimre@unideb.hu

DEPARTMENTS OF INSTITUTE OF PHYSICS

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Mr. Lajos Harasztosi	Teacher of engineering	lajos.harasztosi@science.unideb.hu	F9

ACADEMIC CALENDAR

General structure of the academic semester (2 semesters/year):

Study period	1st week	Registration*	1 week
	2nd – 15th week	Teaching period	14 weeks
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.

For further information please check the following link:
http://www.edu.unideb.hu/tartalom/downloads/University_Calendars_2020_21/2021_Science.pdf

THE ELECTRICAL ENGINEERING BACHELOR PROGRAM

Information about the Program

Name of BSc Program:	Electrical Engineering BSc Program
Specialization available:	Information Technology Industrial Process Control Electric Power Systems
Field, branch:	Engineering
Qualification:	Electrical Engineer
Mode of attendance:	Full-time
Faculty, Institute:	Faculty of Science and Technology Institute of Physics
Program coordinator:	Dr. Sándor Misák, College Associate Professor
Duration:	7 semesters
ECTS Credits:	210

Goal of qualification of the Bachelor programme, the professional competence to be acquired:

The goal of the qualification is to educate electrical engineers who have an integrated knowledge in the natural sciences, technical fields, IT and economy. Graduates in possession of their gained knowledge are capable of meeting the challenge of arising electrical engineering tasks. **Accordingly, as they have bachelor degree and professional qualification of electrical engineering they can contribute to development of** electronic devices, equipment, complex systems and facilities, performing measurement, classification, quality and control tasks in the course of their production and operation. Electrical engineers can participate in setting operation of electrical devices, electronic systems, they can be employed as operational engineer, service-provider, service engineer, integration engineer, product manager requiring electrical engineer knowledge, additionally; they can hold related leading positions. Students participating in this programme have been prepared for a creative engineering work in a specialized professional area within the field of study (according to their specialization), in addition they have got adequate theoretical grounding in the underlying principles of electronic and electrical engineering to continue the second cycle of the qualification later on, in the master course.

Professional competences to be acquired

An Electrical Engineer:

a) Knowledge:

- Has a knowledge of the general and specialized principals of mathematics, natural- and social science rules, associations, and processes required in the field of electrical engineering.

- Has a knowledge of the most important theories, associations and their terminologies in the field of electrical engineering.
- Has a knowledge of the basic facts, boundaries and limitations of electrical engineering.
- Has a knowledge of the design and development principals of electrical engineering.
- Has a basic knowledge of the materials employed in electrical engineering, the process of their production, and requirements of their application.
- Has a knowledge of the basic planning principals and methods of electronics, info-communication, control engineering, electrical technology and electrical energetics.
- Has a knowledge of the operational principals, structural elements of electronic units, and devices used in electrical engineering.
- Has a knowledge of the measuring procedures used in electrical engineering, their devices and tools.
- Has a knowledge of the requirements of occupational health and safety protection, fire protection and environmental protection in association with electrical engineering.
- Has a knowledge of the base, boundaries and requirements of logistics, management, environmental protection, quality assurance, information technology, law and economics associated with electrical engineering.
- Has a knowledge of the methods of learning and data collecting, their ethical boundaries and problem solving techniques.

b) Abilities:

- An electrical engineer is capable of routinely designing and constructing analogue and digital circuits, based on their electronic and microelectronic knowledge.
- An electrical engineer is capable of designing, analysing and fixing electronic equipment and systems.
- An electrical engineer is capable of operating and programming computers, based on their hardware and software knowledge.
- An electrical engineer is capable of the practical application of theoretical electrical and non-electrical measuring methods.
- An electrical engineer is capable of completing assignments requiring knowledge of electro-industrial materials and technologies.
- An electrical engineer is capable of using control engineering devices.
- An electrical engineer is capable of completing engineering assignments in association with electricity supply, storage and transformation.
- An electrical engineer is capable of completing assignments in association with basic telecommunication technique and info-communication systems.
- An electrical engineer is capable of completing engineering assignments such as design, development, installation and commissioning, operation, service, and maintenance.
- An electrical engineer is capable of completing labour protection assignments.
- An electrical engineer is capable of applying calculation, modelling principles and methods with regard to electrical products and product development.
- An electrical engineer is capable of interpreting and describing the structure and operation of structural units of electrical systems, the formation and relations of units applied in the system.

- An electrical engineer is capable of complying with the technical directives for the operation of electrical systems, applying the principals of setting and operation of electrical devices and their economical correlations.
- An electrical engineer is capable of controlling and checking technological manufacturing process with respect to quality assurance and quality control.
- An electrical engineer is capable of diagnosing failure and fixing it.
- An electrical engineer is capable of using ICT devices.
- An electrical engineer is capable of applying methods of learning and data collection improvement knowledge with regard to their specialty.
- An electrical engineer is capable of adopting online and printed scientific literature in line with their speciality, to solve engineering problems.
- An electrical engineer is capable of communicating, in accordance with their speciality, verbally and in writing in their mother tongue and in at least one foreign language.
- An electrical engineer possess stamina to do practical activities.

c) Attitude:

- An electrical engineer endeavours, by means of their knowledge acquired through their studies, to as far as possible observe and interpret phenomena established in accordance with the rules.
- An electrical engineer is open and receptive to adopting innovative methods.
- An electrical engineer complies with employment rules and regulations.
- An electrical engineer is determined to keep the quality requirements and to have them kept.
- An electrical engineer keeps, within the field of their speciality, the occupational health and safety protection, fire protection proceedures and has them kept. They are committed to continuing professional development.
- An electrical engineer endeavours to make joint decisions, as far as possible, with their colleagues. Being a leading post electrical engineer is to be responsive to the opinions of the staff holding subordinate posts.
- An electrical engineer shares their experience with their colleagues.
- EleAn etrical engineer abides by the law and ethical standards.
- An electrical engineer is committed to health and safety protection.

d) Autonomy and responsibility:

- An electrical engineer is capable of establishing, interpreting and comprehending stand-alone questions in the field of their speciality.
- An electrical engineer selects and applies stand-alone relevant problem-solving methods when solving electrical engineering problems.
- An electrical engineer works in cooperation with other experts to achieve a project goals.
- An electrical engineer takes responsibility for their professional decisions and the working process done by themselves or that done by others following their instructions.
- An electrical engineer is a suitably self-guiding and leading person in the technical field.
- An electrical engineer directs, according to the instructions of their labour supervisor, the work of employees in their charge and supervises the operation of machineries.
- An electrical engineer is responsive to the needs of employees under their control and assists their professional development.

- An electrical engineer appraises the efficiency, successfulness and safety of work of employees in their charge.

Completion of the Academic Program

The 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 programs and student achievement. ECTS in no way regulates the content, structure and/or equivalence of study programs.

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 programme is based on the following disciplines:

– *scientific basic knowledge:* 40-50 credits

mathematics (min. 12 credits), physics, IT, electric industrial knowledge of materials, additional scientific basic knowledge in accordance with the traditions and possibilities of the institute;

– *economic and human knowledge:* 14-30 credits

economics, management and enterprise-economics, legal knowledge, additional economic and human knowledge in accordance with the traditions and possibilities of the institute;

– *main professional subjects:* 70-103 credits

electricity, electronics, digital techniques, programming, professional basic knowledge (telecommunications, measurement techniques, automation, microelectronics, electronic technology, electrical power systems), additional knowledge in accordance with the traditions and possibilities of the institute.

Minimum of credit points assigned to free-optional subjects: 10

Credit points assigned to thesis: 15

Credits total: 210

During the program students have to complete a total amount of 210 credit points. It means approximately 30 credits pro semester. The curriculum contains the list of subjects (with credit points) and the recommended order of completing subjects which takes into account the prerequisite(s) of each subject. You can find the recommended list of subjects/semesters in chapter “Guideline”.

Credit requirements for qualification (according to the programme and graduation requirements):

- scientific basic knowledge **42** credits
- economic and human knowledge **16** credits
- main professional subjects **92** credits
- differentiated professional knowledge **50** credits
- free-optional subjects **10** credits

The pre-condition to obtain credit for the given subject is the mark 2 (pass) or more, on the five-grade scale. The prerequisite of obtaining the pass (2) grade for a given **subject – announced as a lecture –** is passing written tests (not more than three) on fixed level determined by the lecturer of the subject at the beginning of the semester, and also passing the semester final exam. In case of subjects including practical course and being completed with exam, the prerequisite of entering for the exam is the fulfilment of the practical course of the subject.

The pre-condition of obtaining credits for courses closing with awarding **practical grade** is the active participation in at least 80% of the calculation practices, and the fulfilment of all written tests on prefixed level, passing at least 2 but no more than 4 tests, determined by the lecturer of subject.

Students are required to perform all of the practices at the **laboratory work (practices).**

Internship: Requirements of summer internship accomplished outside the university. The summer internship should be performed in an external professional practising place, in an institution, in a suitable organisation, or in a practice area of a higher education institution, according to the study timetable, after the 6^{th} semester. Students can apply for the summer internship providing that they have already begun their study in one of the specializations.

The length of summer internship is at least 6 weeks, which can be performed in parts, in more than one place.

All students are required to prepare and submit ***a work summary of about 10 to 15 pages***. The topic has to be approved by the supervisor at the company/organization, as the aim is to get students involved in the application of certain technologies, devices and technological services.

Model Curriculum of Electrical Engineering BSc Program

	semesters							ECTS credit points	evaluation
	1.	2.	3.	4.	5.	6.	7.		
	contact hours, types of teaching (l – lecture, p – practice, lab – laboratory), credit points (cr)								
Fundamentals of Natural Sciences subject group (42 credits)									
1. TTMBE0810 Mathematics 1. TTMBG0810 Mathematics 1. *László Kozma, Zoltán Muzsnay*	56 l / 4 cr 28 p / 2 cr							4+2=6	exam, mid-semester grade
2. TTMBE0811 Mathematics 2. TTMBG0811 Mathematics 2. *László Kozma, Zoltán Muzsnay*		56 l / 4 cr 28 p / 2 cr						4+2=6	exam, mid-semester grade
3. TTMBE0812 Mathematics 3. TTMBG0812 Mathematics 3. *László Kozma, Ágota Figula*			28 l / 3 cr 28 p / 2 cr					3+2=5	exam, mid-semester grade
4. TTFBE1101 Physics 1. TTFBG1101 Physics 1. *Balázs Ujvári, Sándor Egri*	42 l / 4 cr 14 p / 1 cr							4+1=5	exam, mid-semester grade
5. TTFBE1102 Physics 2. TTFBG1102 Physics 2. *Balázs Ujvári, Sándor Egri*		42 l / 4 cr 14 p / 1 cr						4+1=5	exam, mid-semester grade
6. TTFBE1113 Materials Science for Electrical Engineering TTFBG1103 Materials Science for Electrical Engineering *Lajos Daróczi, István Csarnovics*	28 l / 3 cr 28 p / 2 cr							3+2=5	exam, mid-semester grade
7. TTFBE1104 Informatics 1. TTFBL1104 Informatics 1. *Gyula Zilizi, Árpád Rácz*	28 l / 4 cr 28 lab / 1 cr							3+2=5	exam, mid-semester grade
8. TTFBE1105 Informatics 2. TTFBL1105 Informatics 2. *Gyula Zilizi, Árpád Rácz*		28 l / 4 cr 28 lab / 1 cr						3+2=5	exam, mid-semester grade
Economics and Human Knowledge subject group (16 credits)									
9. TTTBE0030-K1 EU Studies *Károly Teperics*	14 l / 1 cr							1	exam

10. TTBEBVVM-KT1 Introduction to Economics *István Kovács*			28 l / 3 cr					3	exam
11. JA-BIOBSc3 Basics of Labour Law *György Nádas*						28 l / 3 cr		3	exam
12. TTFBE1112 Intellectual Property Protection *László Mátyus, Tamás Bene*						28 l, 14 p 3 cr		3	exam
13. TTBEBVVM-KT2 Enterprise Economics *András Nábrádai*			28 l / 3 cr					3	exam
14. TTBEBVM-KT6 Quality Management *Ágnes Kotsis*							28 l / 3 cr	3	exam
Advanced Professional Module subject group (92 credits)									
15. TTFBE1201 Programming 1. TTFBL1201 Programming 1. *Ferenc Kun*	28 l / 2 cr 28 lab / 2 cr							2+2=4	exam, mid-semester grade
16. TTFBE1202 Programming 2. *Ferenc Kun*		14 l, 28 lab / 3 cr						3	mid-semester grade
17. TTFBE1203 Introduction to Measurements and Instrumentation *Sándor Egri*		14 l, 28 lab / 3 cr						3	mid-semester grade
18. TTFBL1213 Introduction to LabVIEW Programming *István Szabó*			28 lab / 2 cr					2	mid-semester grade
19. TTFBE1204 Measurements and Instrumentation *László Oláh*				28 l, 28 lab / 5 cr				5	mid-semester grade
20. TTFBE1205 Electricity 1. TTFBG1205 Electricity 1. *Réka Trencsényi*	28 l / 2 cr 28 p / 3 cr							2+3=5	exam, mid-semester grade
21. TTFBE1206 Electricity 2. TTFBG1206 Electricity 2. *Réka Trencsényi*		42 l / 3 cr 28 p / 3 cr						3+3=6	exam, mid-semester grade
22. TTFBE1207 Electricity 3. TTFBG1217 Electricity 3. *Réka Trencsényi*			28 l / 2 cr 14 p / 1 cr					2+1=3	exam, mid-semester grade

23. TTFBE1208 Electronics 1. TTFBG1208 Electronics 1. *Gyula Zilizi*		28 l / 3 cr 28 p / 2 cr						3+2=5	exam, mid-semester grade
24. TTFBE1209 Electronics 2. TTFBG1209 Electronics 2. *Gyula Zilizi, Lajos Harasztosi*			42 l / 3 cr 28 p / 3 cr					3+3=6	exam, mid-semester grade
25. TTFBL1230 Electronics 3. *László Oláh*				42 lab / 3 cr				3	mid-semester grade
26. TTFBE1211 Digital Electronics 1. TTFBL1211 Digital Electronics 1. *Gyula Zilizi*			42 l / 3 cr 28 lab / 2 cr					3+2=5	exam, mid-semester grade
27. TTFBE1222 Digital Electronics 2. *Gyula Zilizi*				28 l, 42 lab / 6 cr				6	mid-semester grade
28. TTFBE1223 Electrotechnology *Árpád Rácz*				14 l, 28 lab / 3 cr				3	mid-semester grade
29. TTFBL1227 Basics of Technical Drawing *Zsolt Szabó*					42 lab / 3 cr			3	mid-semester grade
30. TTFBE1225 Microelectronics *Sándor Misák*					28 l / 3 cr			3	exam
31. TTFBE1216 Electric Power Systems TTFBG1216 Electric Power Systems *János Kósa, Árpád Rácz*					28 l / 3 cr 28 p / 2 cr			3+2=5	exam, mid-semester grade
32. TTFBE1218 Automation and Control Engineering 1. TTFBG1218 Automation and Control Engineering 1. *Sándor Misák*					28 l / 3 cr 28 p / 2 cr			3+2=5	exam, mid-semester grade
33. TTFBE1221 Electronic Technology TTFBL1221 Electronic Technology *István Csarnovics*						28 l / 3 cr 28 lab / 2 cr		3+2=5	exam, mid-semester grade
34. TTFBE1219 Automation and Control Engineering 2. TTFBG1219 Automation and Control Engineering 2. *Gábor Katona*						28 l / 3 cr 28 p / 2 cr		3+2=5	exam, mid-semester grade

35. TTFBE1214 Telecommunication and infocommunication *István Szabó*						28 l / 3 cr 14 lab / 1 cr		3+1=4	exam, mid-semester grade
36. TTFBE1220 Labour Protection and Safety Technology *Réka Trencsényi*						28 l / 3 cr		3	exam
37. TTFBG1520 Upgrade Electricity *Sándor Egri*		28 p / 0 cr						0	mid-semester grade
Selected Specialization subject group (50 credits)									
38. Specialization Subject 1.					42 l, 28 lab / 6 cr			6	exam, mid-semester grade
39. Specialization Subject 2. (project)					28 l, 56 lab / 7 cr			7	exam, mid-semester grade
40. Specialization Subject 3.						28 l, 28 lab / 5 cr		5	exam, mid-semester grade
41. Specialization Subject 4.						42 l / 4 cr		4	exam
42. Specialization Subject 5.							28 l / 3 cr	3	exam
43. Individual Laboratory						140 lab / 10 cr		10	mid-semester grade
44. Diploma Thesis							210 p / 15 cr	15	mid-semester grade
45. Professional Practice *Réka Trencsényi*	*Mandatory Summer Internship after the 6th semester, at least 6 weeks. The Internship may be performed in parts and at different places. Registration on subject is carried out next semester after obtaining of completion endorsement.*								
Free-optional subject group (10 credits)									
46. Free-optional Subject 1.						28 l, 14 p / 3 cr	28 l, 14 p / 3 cr	6	exam
47. Free-optional Subject 2.						28 l / 2 cr	28 l / 2 cr	4	exam
48. Sport	28 p / 0 cr	28 p / 0 cr	28 p / 0 cr	28 p / 0 cr				0	

1. Infotechnology specialization subject group

38. TTFBE1311 Programmable Logic Devices TTFBL1311 Programmable Logic Devices *Balázs Ujvári*					28 l / 2 cr 28 lab / 3 cr			2+3=5	exam, mid-semester grade
39. TTFBE1312 Application technics of embedded systems (project) TTFBL1312 Application technics of embedded systems (project) *Csaba Cserháti*					14 l / 1 cr 42 lab / 4 cr			1+4=5	exam, mid-semester grade
49. TTFBE1316 Digital Signal Processing TTFBL1316 Digital Signal Processing *István Szabó*					14 l / 2 cr 14 lab / 1 cr			2+1=3	exam, mid-semester grade
40. TTFBE1314 Nanoelectronics and Nanotechnology *István Csarnovics*						28 l, 14 p / 4 cr		4	exam
41. TTFBE1315 Photonics TTFBL1315 Photonics *István Csarnovics*						28 l / 3 cr 28 lab / 2 cr		3+2=5	exam, mid-semester grade
42. TTFBE1313 Technical image processing *Csaba Cserháti*							14 l, 28 lab / 3 cr	3	mid-semester grade
43. TTFBL1301 Individual Laboratory						140 lab / 10 cr		10	mid-semester grade
44. TTFBG1302 Diploma Thesis							210 p / 15 cr	15	mid-semester grade

2. Industrial Process Control specialization

38. TTFBE1321 Industrial Process Control TTFBL1321 Industrial Process Control					42 l / 4 cr 28 lab / 2 cr			4+2=6	exam, mid-semester grade

39. TTFBE1322 Smart Sensor and Measure Systems (project) TTFBL1322 Smart Sensor and Measure Systems (project)					28 l / 2 cr 56 lab / 5 cr			2+5=7	exam, mid-semester grade
40. TTFBE1323 Electrical Switching Gears TTFBG1323 Electrical Switching Gears						28 l / 3 cr 28 p / 1 cr		3+1=4	exam, mid-semester grade
41. TTFBE1324 Electrical Machines and Drives TTFBL1324 Electrical Machines and Drives						28 l / 3 cr 28 lab / 2 cr		3+2=5	exam, mid-semester grade
42. TTFBE1325 Power Electronics							28 l / 3 cr	3	exam
43. TTFBL1301 Individual Laboratory						140 lab / 10 cr		10	mid-semester grade
44. TTFBG1302 Diploma Thesis							210 p / 15 cr	15	mid-semester grade

3. Electric Power Systems specialization									
38. TTFBE1331 Electricity grid and operations TTFBG1331 Electricity grid and operations					42 l, 28 lab / 6 cr			6	exam, mid-semester grade
39. TTFBE1332 IoT solutions for Electrical Power Systems (project) TTFBL1332 IoT solutions for Electrical Power Systems (project)					28 l, 56 lab / 7 cr			7	exam, mid-semester grade

40. TTFBE1323 Electrical Switching Gears TTFBG1323 Electrical Switching Gears						28 l / 3 cr 28 p / 1 cr		3+1=4	exam, mid-semester grade
41. TTFBE1324 Electrical Machines and Drives TTFBL1324 Electrical Machines and Drives						28 l / 3 cr 28 lab / 2 cr		3+2=5	exam, mid-semester grade
42. TTFBE1335 Renewable Energy Systems							28 l / 3 cr	3	exam
43. TTFBL1301 Individual Laboratory						140 lab / 10 cr		10	mid-semester grade
44. TTFBG1302 Diploma Thesis							210 p / 15 cr	15	mid-semester grade

Work and Fire Safety Course

According to the Rules and Regulations of University of Debrecen a student has to complete the online course for work and fire safety. Registration for the course and completion are necessary for graduation.

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.

Internship

Students majoring in the Electrical Engineering BSc have to carry out a 6 weeks internship involved in the model curriculum. The internship course must be signed up for previously via the NEPTUN study registration system in the fall semester (7^{th} semester). Its execution is the criteria requirement of getting the pre-degree certificate (absolutorium).

Objective of the internship, competences

To get students acquainted both with an industrial environment where the practical methods of production can be observed and the necessary expertise and engineering skills relating to a specific job can be acquired and with professional work in conformity with their major at the company or institution and join in the daily working process.

Under professional supervision students are introduced to the various phases of producing electrical instruments and systems: planning, developing, implementing and controlling; quality assurance and technical services.

They have to resolve tasks independently assigned by their supervisor and gain experiences may be utilized later in the labour market. During the internship common and professional competences may be acquired. Common competences: precise working on schedule either individually or in team, talk shop applying correct technical terms. Professional competences: applying the professional skill gained during the training and acquiring new knowledge.

Students gain new practices and to apply the theoretical knowledge acquired during the studies in certain professional fields.

Places suitable for internship

All the organizations, institutions and companies in Hungary or abroad, provide students with the opportunity to acquire proficiency in accordance with their specialization in the field of operation, repairing technology, installation, management and development of different machines and vehicles, may be a suitable place.

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’s 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.

Pre-degree Certification

A pre-degree certificate is issued by the Faculty after completion of the bachelor’s (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 as set out in Section 10 in Rules and Regulations of University of Debrecen, internship (mandatory) – with the exception of preparing thesis – and gained the necessary credit points (210). 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.

Possibilities and Rules of Specialization

There are three specializations at the electrical engineering basic program: **Infotechnology, Industrial Process Control, Electric Power Systems.**

Main rule: students have to choose specialization in the **fourth semester**. Subjects of specializations start in the fifth semester for the full time course. The headcount of the specializations is published by the institute in March every year, students have thereafter to submit their application forms to the head of the institute within the given deadline.

Professional precondition of taking a specialization is the previous fulfilment of all of the following subjects:

- Physics 2. (TTFBE1102)
- Mathematics 3. (TTMBE0812)
- Measurements and Instrumentation (TTFBE1204)
- Electricity 3. (TTFBE1207)
- Electronics 3. (TTFBL1230)
- Digital Electronics 2. (TTFBE1222)

In addition to above-mentioned subjects:

Infotechnology specialization:

- Microelectronics (TTFBE1225)

Industrial Process Control specialization:

- Automation and Engineering Control 1. (TTFBE1218)

Electric Power Systems specialization:

- Electric Power Systems (TTFBE1216)

should be completed.

The ranking of the candidates is based on the weighted average of professional credits obtained. If the number of candidates for a specialization exceeds the maximum, students will be set against the ranking and admitted accordingly, or they will be redirected to the other specialization. Normally, only one specialization can be completed financed by the state. To perform a second specialization is only possible according to the faculty rules.

Individual Laboratory, Diploma Thesis

In the thesis, the candidate is required to present the solution of an individual engineering problem achieved under the control of their supervisor and has to prove at the defence of thesis their own contribution to the assignment. The thesis cannot be merely founded on reviewing and processing the special (professional) literature. It is of utmost importance that this requirement should be made clear for every candidate.

Individual engineering assignments refer to tasks solved using the application level knowledge in the area of the design, development, introduction into operation, running, supply, and maintenance.

The Individual Laboratory work serves the preparation for the thesis, involving the solution of the laboratory and practical assignments.

Further information related to the assignment of the thesis and the individual laboratory (requirements to the text formatting and thesis content, deadlines, submission procedures, submission steps, etc.) is published on the home page of Electronic and Electrical Engineering Department (http://eed.science.unideb.hu/thesis/) in the autumn semesters of the academic years for students started their specialization study.

Thesis book volume is 40-60 pages. It consists of table of contents, abbreviations, thesis content (introduction; 1., 2., 3., …, (chapter titles follow thesis assignment), conclusion), references, appendixes.

The precondition of taking the subject of Thesis (TTFBL1302) is to perform the subject of Individual Laboratory (TTFBL1301).

The study preconditions of the subject of Individual Laboratory (TTFBL1301) are the fulfilments of the following subjects on the specializations:

Infotechnology specialization:

- Programmable Logic Devices (TTFBE1311),
- Application Technics of Embedded Systems (TTFBE1312).

Industrial Process Control specialization:

- Industrial Process Control (TTFBE1321),
- Smart Sensor- and Measure Systems (TTFBE1322).

Electric Power Systems specialization:

- Electricity grid and operations (TTFBE1331),
- IoT solutions for Electrical Power Systems (TTFBE1332).

Final Exam

<u>Structure, form and mode of appraisal of the final examination</u>

The final examination is an oral examination taken in the final examination board presence. The final examination board is appointed by the head of Institute of Physics. The number of members of the final examination committee is 3 or more. Permanent members of the final examination board are the coordinator of the academic programme and the coordinator of the given specialization. The student's university supervisor can participate in the work of the board in the course of the defense of thesis. The tutor in charge of the given subject can be taken into the work of the board. In case a board member is unable to be present, the head of institute can appoint another university tutor for substitution.

The BSc final examination can assess whether the candidate possesses a stable professional basic knowledge in the most important topics, and is familiar enough with a special topic within the specialization.

<u>The examination consists of the following three parts:</u>

1. The defence of the thesis;
2. Oral examination in the general (main) subject;
3. Oral examination in the specialized subject.

<u>Appraisal of the examination:</u>

1. <u>Appraisal of the thesis</u>

The supervisor appraises the thesis of the candidate in written form and makes a proposal to the grade. The grade given by the board can differ from that proposed by the supervisor.

The professional content of the thesis and the presentation/ defense of the work is appraised separately and awarded two grades by the board. The average value of the grades obtained to the thesis is counted for the classification of the certificate.

2. The grade of the final examination is the average of the grades of the general- and specialized subject.

Programme of the final examination

The series of themes containing about 30 themes from the final examination subjects is published by the Institute of Physics. Students in advance have access to these themes.

General and specialized subject themes to the final examination contain about 15 credits of theoretical course material in different proportion.

Subjects of the final examination:

General subject (independently of specialization): **Fundamentals of Electrical Engineering**

An exam subject consists of materials of courses below:

- Electricity 1. (TTFBE1205),
- Electricity 2. (TTFBE1206),
- Electricity 3. (TTFBE1207),
- Electronics 1. (TTFBE1208),
- Electronics 2. (TTFBE1209),
- Digital Electronics 1. (TTFBE1211),
- Digital Electronics 2. (TTFBE1222),
- Introduction to Measurements and Instrumentation (TTFBE1203),
- Measurements and Instrumentation (TTFBE1204).

Specialized subject (depends on specialization):

Infotechnology specialization

An exam subject consists of materials of courses below:

- Programmable Logic Devices (TTFBE1311),
- Application Technics of Embedded Systems (TTFBE1312),
- Technical Image Processing (TTFBE1313),
- Nanoelectronics and Nanotechnology (TTFBE1314),
- Photonics (TTFBE1315),
- Digital Signal Processing (TTFBE1316).

Industrial Process Control specialization

An exam subject consists of materials of courses below:

- Industrial Process Control (TTFBE1321),
- Smart Sensor and Measure Systems (TTFBE1322),
- Electrical Switching Gears (TTFBE1323),
- Electrical Machines and Drives (TTFBE1324),
- Power Electronics (TTFBE1325).

Electric Power Systems specialization

An exam subject consists of materials of courses below:

- Electricity grid and operations (TTFBE1331),
- IoT solutions for Electrical Power Systems (TTFBE1332),
- Electrical Switching Gears (TTFBE1323),

- Electrical Machines and Drives (TTFBE1324),
- Renewable Energy Systems (TTFBE1333).

Assessment of BSc Degree Diploma

The assessment of the certificate is the average of the following grades:

- **the (accumulated) weighted study average counted for the whole study,**
- **the average of the grades obtained for the thesis and defense,**
- **the average of the final examination grades obtained for the general and the specialized subjects.**

Course Descriptions of Electrical Engineering BSc Program

Fundamentals of Natural Sciences Subject Group

Title of course: Mathematics 1. **Code**: TTMBE0810-EN	**ECTS Credit points**: 4
Type of teaching, contact hours - lecture: 4 hours/week - practice: - - laboratory: -	
Evaluation: exam	
Workload (estimated), divided into contact hours: - lecture: 56 - practice: - - laboratory: - - home assignment: 44 - preparation for the exam: 50 Total: 150	
Year, semester: 1st year, 1st semester	
Its prerequisite(s): -	
Further courses built on it: TTMBE0811_EN, TTMBG0811_EN	

Topics of course

Sets. Real numbers. Complex numbers. Sequences and series. Convergence, limits. Real functions. Limit, continuity and differentiation of functions. Monotonicity, convexity, inflection. Approximation with polynomials, Taylor formula. Definition and calculation of definite, indefinite and improprius integrals. Ordinary differential equations. Vector spaces. Matrices, operations with matrices. Determinants and properties; the matrix rank. Linear equation systems. Euclidean spaces and their transformations.

Literature

Compulsory: -

Recommended:

1. Thomas, Weir & Hass: Thomas' Calculus.
2. K. A. Stroud: Calculus and Mathematical Analysis.
3. K. A. Stroud: Engineering Mathematics.
4. E. Mendelson: Schaum's 3000 Solved Problems in Calculus.

Schedule:

1st week

Operations with sets, set algebra. Descartes product, relations, functions. Special functions: injectivity, surjectivity, bijectivity. The inverse of a function. Real numbers. Exact lower and upper bounds. Open and closed sets. Bolzano-Weierstrass theorem.

2nd week

Complex numbers. The algebraic structure of the set of complex numbers. The complex plane. Trigonometric form of complex numbers, multiplication, division, n-th power, n-th root.

3rd week

Sequences. Convergence and limit of real sequences. Monotonous, bounded, convergent sequences, Cauchy's convergence criteria. Algebraic operations with convergent sequences. Squeezing theorem. The generalization of the notion of limit.

4th week

Series. The convergence of series. Arithmetic series and geometric series. The harmonic series. Leibniz type series. Convergence tests: ratio and root tests. Power series.

5th week

Limits and continuity of functions. Properties of continuous functions. Continuity of the composition and the inverse function. Special properties of continuous functions defined on an interval. Elementary functions.

6th week

Differentiation. The geometric meaning of the derivative. Rules of differentiation. Derivative of a function of a function: the chain rule. The derivative of the inverse function. Relationship of monotonicity and the derivative. Roll’s theorem and Lagrange’s theorem. Conditions for the existence of extreme values. Derivative of elemental functions.

7th week

Higher order derivatives. Convexity and the derivatives. Approximating with polynomials, Taylor formula. Conditions for the existence of extreme value.

8th week

Primitive functions, the indefinite integral. Integration methods. Definite integral. Basic properties of the definite integrals. Integration of a continuous functions. The Newton-Leibniz formula.

9th week

Improper integrals. Applications.

10th week

Ordinary differential equations. The solution of separable, homogeneous and linear differential equations.

11th week

Vector space. Linear dependent and independent system of vectors. Base, dimension. Subspace. Vector space generated by a set of vectors. Rank of a system. Linear maps.

12th week

Matrices, matrix algebra. Determinants and their calculation. The rank of a matrix. The inverse of a matrix. Matrix representation of linear maps.

13th week

System of linear equations. Homogeneous and inhomogeneous systems. Gauss elimination, Cramer rule. Applications.

14th week

Euclidean spaces. Inner product, standard, angle, distance. Schwarz and Minkowski inequality. Orthogonality. Orthogonal projection. Symmetrical and orthogonal transformations.

Requirements:

- for a signature

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

- for a grade

The course ends in an **examination**. Only students who have grade from the practice can take part of the exam. The exam is written.

The grade is given according to the following table:

Score	Grade
0-49	fail (1)
50-62	pass (2)
63-74	satisfactory (3)
75-86	good (4)
87-100	excellent (5)

If the score of any test is below 50, students can take a retake test in conformity with the EDUCATION AND EXAMINATION RULES AND REGULATIONS.

-an offered grade: -

Person responsible for course: Dr. Zoltán Muzsnay, associate professor, PhD

Lecturer: Dr. Zoltán Muzsnay, associate professor, PhD

Title of course: Mathematics 1. **Code**: TTMBG0810-EN	**ECTS Credit points**: 2
Type of teaching, contact hours - lecture: - - practice: 2 hours/week - laboratory: -	
Evaluation: exam	
Workload (estimated), divided into contact hours: - lecture: - - practice: 28 - laboratory: - - home assignment: 18 - preparation for the exam: - Total: 46	
Year, semester: 1st year, 1st semester	
Its prerequisite(s): -	
Further courses built on it: TTMBE0811_EN, TTMBG0811_EN	

Topics of course

Sets. Real numbers. Complex numbers. Sequences and series. Convergence, limits. Real functions. Limit, continuity and differentiation of functions. Monotonicity, convexity, inflection. Approximation with polynomials, Taylor formula. Definition and calculation of definite, indefinite and improprius integrals. Ordinary differential equations. Vector spaces. Matrices, operations with matrices. Determinants and properties; the matrix rank. Linear equation systems. Euclidean spaces and their transformations.

Literature

Compulsory: -

Recommended:

1. Thomas, Weir & Hass: Thomas' Calculus.
2. K. A. Stroud: Calculus and Mathematical Analysis.
3. K. A. Stroud: Engineering Mathematics.
4. E. Mendelson: Schaum's 3000 Solved Problems in Calculus.

Schedule:

1st week

Operations with sets, set algebra. Descartes product, relations, functions. Special functions: injectivity, surjectivity, bijectivity. The inverse of a function. Real numbers. Exact lower and upper bounds. Open and closed sets. Bolzano-Weierstrass theorem.

2nd week

Complex numbers. The algebraic structure of the set of complex numbers. The complex plane. Trigonometric form of complex numbers, multiplication, division, n-th power, n-th root.

3rd week

Sequences. Convergence and limit of real sequences. Monotonous, bounded, convergent sequences, Cauchy's convergence criteria. Algebraic operations with convergent sequences. Squeezing theorem. The generalization of the notion of limit.

4th week

Series. The convergence of series. Arithmetic series and geometric series. The harmonic series. Leibniz type series. Convergence tests: ratio and root tests. Power series.

5th week

Limits and continuity of functions. Properties of continuous functions. Continuity of the composition and the inverse function. Special properties of continuous functions defined on an interval. Elementary functions.

6th week

Differentiation. The geometric meaning of the derivative. Rules of differentiation. Derivative of a function of a function: the chain rule. The derivative of the inverse function. Relationship of monotonicity and the derivative. Roll’s theorem and Lagrange’s theorem. Conditions for the existence of extreme values. Derivative of elemental functions.

7th week

Higher order derivatives. Convexity and the derivatives. Approximating with polynomials, Taylor formula. Conditions for the existence of extreme value.

8th week

Test.

Primitive functions, the indefinite integral. Integration methods. Definite integral. Basic properties of the definite integrals. Integration of a continuous functions. The Newton-Leibniz formula.

9th week

Improper integrals. Applications.

10th week

Ordinary differential equations. The solution of separable, homogeneous and linear differential equations.

11th week

Vector space. Linear dependent and independent system of vectors. Base, dimension. Subspace. Vector space generated by a set of vectors. Rank of a system. Linear maps.

12th week

Matrices, matrix algebra. Determinants and their calculation. The rank of a matrix. The inverse of a matrix. Matrix representation of linear maps.

13th week

System of linear equations. Homogeneous and inhomogeneous systems. Gauss elimination, Cramer rule. Applications.

14th week

Test.

Requirements:

- for a signature

Participation at practice classes 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. Attendance at practice classes will be recorded by the practice leader. Being late is equivalent with an absence.

- for a grade

During the semester one test is written.

The grade is given according to the following table:

Score	Grade

0-49	fail (1)
50-59	pass (2)
60-74	satisfactory (3)
75-84	good (4)
85-100	excellent (5)

If the score of any test is below 50, students can take a retake test in conformity with the EDUCATION AND EXAMINATION RULES AND REGULATIONS.

-an offered grade: -

Person responsible for course: Dr. Zoltán Muzsnay, associate professor, PhD

Lecturer: Dr. Zoltán Muzsnay, associate professor, PhD

Title of course: Mathematics 2. **Code**: TTMBE0811-EN	**ECTS Credit points**: 4
Type of teaching, contact hours - lecture: 4 hours/week - practice: - - laboratory: -	
Evaluation: exam	
Workload (estimated), divided into contact hours: - lecture: 56 - practice: - - laboratory: - - home assignment: 44 - preparation for the exam: 50 Total: 150	
Year, semester: 1st year, 2nd semester	
Its prerequisite(s): TTMBE0810-EN	
Further courses built on it: TTMBE0812_EN, TTMBG0812_EN	

Topics of course

Functions of several variables. Limit value, continuity, differentiation. Total derivative, partial derivatives, directional derivative. Partial Differential Equations. Multiple Integral. Elements of vector analysis. Curves, surfaces. Vector Fields. Gradient, rotation, divergence. Line, surface and volume integrals. Stokes', Green's and Gauss' theorems. Probability. Conditional probability. Total probability theorem, Bayes' theorem. Independence of events. Random variables. Discrete and continuous random variables. Probability distribution, density function. Expected value, standard deviation. Elements of statistics.

Literature

Compulsory: -

Recommended:

1. Thomas, Weir & Hass: Thomas' Calculus.
2. P. Sahoo: Probability and Mathematical Statistics.
3. E. Mendelson: Schaum's 3000 Solved Problems in Calculus.

Schedule:

1st week

Rn: the n-dimensional Euclidean space. Sequences in Rn. Function of several variables with real and vector values.

2nd week

Limit and continuity of multivariable functions.

3rd week

Total derivative and partial derivatives of a multivariable functions. Chain rule. Inverse function theorem. The implicit function theorem.

4th week

Directional derivative. Gradient and its application. Extreme values of real functions of several variables.

5th week

Multiple integral. Calculation of multiple integral, successive integration. Integration in normal domains.

6th week

Partial differential equations and systems of differential equations. Basic definitions and examples. Some elementary examples and problems.

7th week

Elements of vector analysis. Curves, surfaces. Vector Fields. Gradient, rotation, divergence.

8th week

Line integral. Basic properties. Applications.

9th week

Surface integral. Volume integrial. Basic properties. Stokes', Green's and Gauss' theorems.

10th week

Element of the probability theory. Conditional probability. Total probability theorem, Bayes' theorem. Independence of events.

11th week

Concept of random variables. Probability distribution. Discrete probability variables. Some special discrete probability distributions: Bernoulli distribution, Binomial distribution, Geometric distribution, Binomial, Hypergeometric, and Poisson distribution. Continuous probability distributions, density function. Some special continuous distribution: uniform, normal, and exponential distributions.

12th week

Expected value of random variables, Variance of random variables. Examples. Markov and Chebychev inequality, the law of large numbers.

13th week

Two Random Variables. Bivariate discrete and continuous random variables. Covariance of bivariate random variables. Correlation and independence.

14th week

Element of statistics.

Requirements:

- for a signature

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

- for a grade

The course ends in an **examination**. Only students who have grade from the practice can take part of the exam. The exam is written.

The grade is given according to the following table:

Score	Grade
0-49	fail (1)
50-62	pass (2)
63-74	satisfactory (3)
75-86	good (4)
87-100	excellent (5)

If the score of any test is below 50, students can take a retake test in conformity with the EDUCATION AND EXAMINATION RULES AND REGULATIONS.

-an offered grade: -

Person responsible for course: Dr. Zoltán Muzsnay, associate professor, PhD
Lecturer: Dr. Zoltán Muzsnay, associate professor, PhD

Title of course: Mathematics 2. **Code**: TTMBG0811-EN	**ECTS Credit points**: 2
Type of teaching, contact hours - lecture: - - practice: 2 hours/week - laboratory: -	
Evaluation: exam	
Workload (estimated), divided into contact hours: - lecture: - - practice: 28 - laboratory: - - home assignment: 18 - preparation for the exam: - Total: 46	
Year, semester: 1st year, 2nd semester	
Its prerequisite(s): TTMBE0810-EN	
Further courses built on it: TTMBE0812_EN, TTMBG0812_EN	

Topics of course

Functions of several variables. Limit value, continuity, differentiation. Total derivative, partial derivatives, directional derivative. Partial Differential Equations. Multiple Integral. Elements of vector analysis. Curves, surfaces. Vector Fields. Gradient, rotation, divergence. Line, surface and volume integrals. Stokes', Green's and Gauss' theorems. Probability. Conditional probability. Total probability theorem, Bayes' theorem. Independence of events. Random variables. Discrete and continuous random variables. Probability distribution, density function. Expected value, standard deviation. Elements of statistics.

Literature

Compulsory: -

Recommended:

1. Thomas, Weir & Hass: Thomas' Calculus.
2. P. Sahoo: Probability and Mathematical Statistics.
3. E. Mendelson: Schaum's 3000 Solved Problems in Calculus.

Schedule:

1st week

Rn: the n-dimensional Euclidean space. Sequences in Rn. Function of several variables with real and vector values.

2nd week

Limit and continuity of multivariable functions.

3rd week

Total derivative and partial derivatives of a multivariable functions. Chain rule. Inverse function theorem. The implicit function theorem.

4th week

Directional derivative. Gradient and its application. Extreme values of real functions of several variables.

5th week

Multiple integral. Calculation of multiple integral, successive integration. Integration in normal domains.

6th week

Partial differential equations and systems of differential equations. Basic definitions and examples. Some elementary examples and problems.

7th week

Test.

Elements of vector analysis. Curves, surfaces. Vector Fields. Gradient, rotation, divergence.

8th week

Line integral. Basic properties. Applications.

9th week

Surface integral. Volume integrial. Basic properties. Stokes', Green's and Gauss' theorems.

10th week

Element of the probability theory. Conditional probability. Total probability theorem, Bayes' theorem. Independence of events.

11th week

Concept of random variables. Probability distribution. Discrete probability variables. Some special discrete probability distributions: Bernoulli distribution, Binomial distribution, Geometric distribution, Binomial, Hypergeometric, and Poisson distribution. Continuous probability distributions, density function. Some special continuous distribution: uniform, normal, and exponential distributions.

12th week

Expected value of random variables, Variance of random variables. Examples. Markov and Chebychev inequality, the law of large numbers.

13th week

Two Random Variables. Bivariate discrete and continuous random variables. Covariance of bivariate random variables. Correlation and independence.

14th week

Test.

Element of statistics.

Requirements:

- for a signature

Participation at practice classes 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. Attendance at practice classes will be recorded by the practice leader. Being late is equivalent with an absence.

- for a grade

During the semester one test is written.

The grade is given according to the following table:

Score	Grade
0-49	fail (1)
50-59	pass (2)
60-74	satisfactory (3)
75-84	good (4)
85-100	excellent (5)

If the score of any test is below 50, students can take a retake test in conformity with the EDUCATION AND EXAMINATION RULES AND REGULATIONS. *-an offered grade:* -
Person responsible for course: Dr. Zoltán Muzsnay, associate professor, PhD
Lecturer: Dr. Zoltán Muzsnay, associate professor, PhD

Title of course: Mathematics 3. **Code**: TTMBE0812-EN	**ECTS Credit points**: 3

Type of teaching, contact hours
- lecture: 2 hours/week
- practice: -
- laboratory: -

Evaluation: exam

Workload (estimated), divided into contact hours:
- lecture: 28
- practice: -
- laboratory: -
- home assignment: 31
- preparation for the exam: 31

Total: 90

Year, semester: 2nd year, 1st semester

Its prerequisite(s): TMBE0811 Mathematics 2.

Further courses built on it: -

Topics of course

Solving problems of: Differentiation of complex functions. The Cauchy-Riemann equations. Contour integral. Cauchy's integral theorem. Series representations of analytic functions. Power series. Laurent series. The residue theory. Spaces of integrable functions. Fourier series and its complex form. Bases in spaces of functions. Elements of functional analysis. Hilbert spaces. Linear forms and operators. Fourier transformation and applications. Laplace transformation and applications for investigation of differential equations.

Literature

Compulsory:

1. E.B. Saff, A.D. Snider: Fundamentals of Complex Analysis with Applications to Engineering and Science. Third Edition, Pearson Education, Inc. 2003.

Recommended:

1. W. Rudin: Functional analysis, Second Edition, McGraw-Hill, Inc. 1991.
2. F. Riesz-B. Sz.-Nagy: Functional Analysis, Dover Publications, Inc. 1990.

Schedule:

1st week

The Algebra of Complex Numbers. Topology of the complex plane. Sequences and series. Convergence. Geometric series and applications: Comparison test and Ratio test.

2nd week

Continuity and differentiability of complex functions. The Cauchy-Riemann equations. Harmonic functions.

3rd week

Convergence of sequence of functions: pointwise and uniform. Power series and radius of convergence of power series. Power series of the exponential function and the proof of the convergence. Trigonometric, hyperbolic functions and their inverses. The logarithmic function.

4th week

Complex integral. Contour integral. The Cauchy's integral theorem and its proof. Conseqences of the Cauchy's integral theorem. Primitive function.

5th week

The Cauchy’s integral formula and its conseqences. Taylor series of analytic functions. Bounds for analytic functions. Liouville’s theorem.

6th week

The maximum principle and its consequences. The Hadamard’s triangle theorem. The converse of the Cauchy’s integral theorem: Morera’s theorem, Weierstrass’ theorem. Laurent series. Classifications of isolated singularities.

7th week

Casorati-Weierstrass’s theorem. Picard’s theorem. The residue theorem and its application. Rouche’s theorem.

8th week

Euclidean spaces: scalar product, norm, distance, angle. The proof of the Cauchy-Schwarz-Bunyakovszki’s inequality. The Gram-Schmidt’s orthogonalization process.

9th week

Spaces of integrable functions. The L^2 space. Riesz-Fischer’s theorem. The L^p space. Important inequalities.

10th week

Orthogonal systems. Bessel’s inequality. Fourier series. Riesz-Fischer’s theorem for orthogonal systems. Parseval’s formula.

11th week

Hilbert spaces. Linear operators of Hilbert spaces. The Gram-Schmidt’s orthogonalization process. Existence of complete orthogonal system in L^2 space. Legendre’s polynomials. Classical orthogonal polynomials.

12th week

The Fourier’s orthogonalization system and the proof of orthogonality. The expansion of functions in Fourier series. Sufficient conditions of convergence.

13th week

Complex Fourier series. Integral transformations and the proof of their elementary properties. Convolution.

14th week

Applying the integral transformations for solving differential equations. Differential equations with constant coefficients of second order.

Requirements:

- for a signature

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

During the semester there are two tests: the mid-term test in the 8th week and the end-term test in the 14th week. Students have to sit for the tests

- for a grade

The course ends in an **examination**. Only students who have grade from the practice can take part of the exam. The exam is written. Based on the examination, the exam grade is calculated as an average of them:

- the result of the examination
- the result of the mid-term and end-term tests.

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

Score	Grade
0-49	fail (1)
50-62	pass (2)
63-74	satisfactory (3)
75-86	good (4)
87-100	excellent (5)

If the score of any test is below 50, 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 of the mid-term and end-term tests is at least satisfactory (3). The offered grade is the average of them.
Person responsible for course: Dr. Ágota Figula, associate professor, PhD
Lecturer: Dr. Ágota Figula, associate professor, PhD

Title of course: Mathematics 3. **Code**: TTMBG0812-EN	**ECTS Credit points: 2**

Type of teaching, contact hours
- lecture: -
- practice: 2 hours/week
- laboratory: -

Evaluation: exam

Workload (estimated), divided into contact hours:
- lecture:
- practice: 28 hours
- laboratory: -
- home assignment: 32 hours
- preparation for the exam: -

Total: 60

Year, semester: 2nd year, 1st semester

Its prerequisite(s): TTFBE0811 Mathematics 2.

Further courses built on it: -

Topics of course

Solving problems of: Differentiation of complex functions. The Cauchy-Riemann equations. Contour integral. Cauchy’s integral theorem. Series representations of analytic functions. Power series. Laurent series. The residue theory. Spaces of integrable functions. Fourier series and its complex form. Bases in spaces of functions. Elements of functional analysis. Hilbert spaces. Linear forms and operators. Fourier transformation and applications. Laplace transformation and applications for investigation of differential equations.

Literature

Compulsory:
1. E.B. Saff, A.D. Snider: Fundamentals of Complex Analysis with Applications to Engineering and Science. Third Edition, Pearson Education, Inc. 2003.

Recommended:
1. W. Rudin: Functional analysis, Second Edition, McGraw-Hill, Inc. 1991.
2. F. Riesz-B. Sz.-Nagy: Functional Analysis, Dover Publications, Inc. 1990.

Schedule:

1st week
The algebra of complex numbers, the topology of the complex plane and of the limits of complex sequences.

2nd week
Continuity and differentiability of complex functions. The Cauchy-Riemann equations. Harmonic functions.

3rd week
Determination of the limits of complex series. Application the geometric series: Comparison test and Ratio test.

4th week
Finding the contour integral of functions. Applying the Cauchy-Riemann’s integral theorem.

5th week
Application of the Cauchy-Riemann integral formula. Expansion in Taylor series of functions.

6th week
Expansion in Laurent series of functions.

7th week
Determination of isolated singularitites.

8th week
Finding the residue of functions. Application of the Rouche's theorem.

9th week
Application of the residue theorem for computation of integrals.

10th week
Computation of scalar product, norm, distance and angle in Euclidean spaces. Applications of the Gram-Schmidt's process.

11th week
The classical orthogonal polynomial systems. Computation of Fourier series.

12th week
Fourier trigonometric systems and expansions in Fourier series of periodic functions.

13th week
Application of integral transformations: Laplace transformation.

14th week
Fourier transformation.

Requirements:

- for a signature

Participation in practice classes 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. 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.

During the semester there are two tests: the mid-term test in the 8th week and the end-term test in the 14th week. Students have to sit for the tests.

- for a grade

The course ends in grade for the class, practice work. Based on the average of the homework assignments presented in the class and the two tests, the grade is calculated as an average of them:

- the average grade of the homework assignments presented in the class
- the result of the two tests.

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

Score	Grade
0-49	fail (1)
50-62	pass (2)
63-74	satisfactory (3)
75-86	good (4)
87-100	excellent (5)

If the score of any test is below 50, students can take a retake test in conformity with the EDUCATION AND EXAMINATION RULES AND REGULATIONS.

Person responsible for course: Dr. Ágota Figula, associate professor, PhD

Lecturer: Dr. Ágota Figula, associate professor, PhD

Title of course: Physics 1.
Code: TTFBE1101-EN

ECTS Credit points: 4

Type of teaching, contact hours
- lecture: 2 hours/week
- practice: 2 hours/week
- laboratory: -

Evaluation: exam

Workload (estimated), divided into contact hours:
- lecture: 28 hours
- practice: 28 hours
- laboratory: -
- home assignment: 24 hours
- preparation for the exam: 24 hours

Total: 90 hours

Year, semester: 1st year, 1st semester

Its prerequisite(s): –

Further courses built on it: -

Topics of course

Physical quantities, standards, units. Kinematics in one dimension. Kinematics in three dimensions. Dynamics. Force laws. Ballistic motions. Center of mass, constrained motion. Collisions. Work and energy. Oscillations. Elasticity. Wave motion. Temperature.

Literature

J.W. Jewett Jr, R.A. Serway: Physics for Scientists and Engineers

Schedule:

1st week

Physical quantities, standards, units: definition of length, equivalence relations and classes, scales, standards of length, time and mass, basic and derived physical quantities, units and prefixes in SI, physical dimensions, dimensional analysis

2nd week

Kinematics in one dimension: Cartesian, spherical and cylindrical coordinate systems, vectors,operations with vectors, position vector, position function, average and instantaneous speed, average and instantaneous acceleration in one dimension

3rd week

Kinematics in three dimensions: displacement vector and path, average and instantaneous velocity, average and instantaneous acceleration in three dimensions, circular motion, tangential and normal acceleration, angular velocity, angular acceleration, relative motions, Galilean transformation, Coriolis acceleration

4th week

Dynamics: Newton's first law, inertial frames, experimental laws of two-body interactions, inertial mass, momentum, conservation of momentum, Newton's second law, Newton's third law

5th week

Force laws: basic interactions in nature, the role of force laws in equations of motion, force law of gravitation, force law of electrostatic interaction between two point charges, force law of a charged particle moving in magnetic field, force law of an idealized spring, force law of friction, force law of drag forces

6th week

Ballistic motions: analytic solution of the equation of motion near the surface of the Earth, describing the path, calculating the parameters of the special points of the path, numerical solution of the equation of motion near the surface of the Earth

7th week

Center of mass, constrained motion: center of mass defined in the discreet and in the continuum limit, density, internal and external forces, constrained motion on a slope, constrained motion of a pendulum

8th week

Collisions: describing collisions in the center-of-mass and in the laboratory frame, elastic and inelastic collisions, kinetic energy, collisions in one dimension, special cases of one-dimensional collisions

9th week

Work and energy: work, work-energy theorem, work of the gravitational pull of the Earth, work of an idealized spring, power, potential energy, conservation of total mechanical energy, conservative and dissipative forces, potential energy of a body under the influence of an idealized spring, potential energy of a body under the influence of gravitation

10th week

Oscillations: analyzing the motion of a pendulum, simple harmonic oscillations, addition of two simple harmonic oscillations, Lissajous figures, damped oscillations, forced oscillations, coupled oscillations

11th week

Elasticity: tensile stress, shearing stress, uniform compression, relative deformation, Young's modulus, shear modulus, compression modulus, Hooke's law, elastic energy, elastic energy density

12th week

Wave motion: mechanical waves, transverse and longitudinal waves, one-dimensional wave motion in a streched string, wave speed, wave function, wave equation, harmonic waves, wavelength, wave number, time period, energy transports in wave motion, kinetic and potential energy density of an elastic medium, energy density current, intensity

13th week

Wave motion: multi-dimensional wave motion, wavefronts, spherical waves, plane waves, principle of linear superposition, interference, coherent waves, standing waves, sound waves, intensity, pitch and tone, fundamental frequency and overtones, diffraction, Huygens' principle, Huygens–Fresnel principle

14th week

Temperature: extensive and intensive quantities, thermal equilibrium, zeroth law of thermodynamics, empirical measuring scales, Celsius scale, Kelvin scale, triple-point temperature, Gay-Lussac's law, constant-volume gas scales, ideal gas

Requirements:

The course exam is a written examination. In the exam theoretical questions and practical problems must be answered and solved in 100 minutes. The evaluation of the exam occurs based on the following grading:

0–59 % → 1,

60–69 % → 2, *70–79 % → 3,* *80–89 % → 4,* *90–100 % → 5*
Person responsible for course: Dr. Balázs Ujvári, assistant professor, PhD
Lecturer: Dr. Balázs Ujvári, assistant professor, PhD

Title of course: Physics 1. **Code**: TTFBG1101-EN	**ECTS Credit points: 1**

Type of teaching, contact hours

- lecture: -
- practice: 2 hours/week
- laboratory: -

Evaluation: exam

Workload (estimated), divided into contact hours:

- lecture: 28 hours
- practice: 28 hours
- laboratory: -
- home assignment: 2 hours
- preparation for the exam:

Total: 30 hours

Year, semester: 1st year, 1st semester

Its prerequisite(s): –

Further courses built on it: -

Topics of course

Physical quantities, standards, units. Kinematics in one dimension. Kinematics in three dimensions. Dynamics. Force laws. Ballistic motions. Center of mass, constrained motion. Collisions. Work and energy. Oscillations. Elasticity. Wave motion. Temperature.

Literature

J.W. Jewett Jr, R.A. Serway: Physics for Scientists and Engineers

Schedule:

1st week

Physical quantities, standards, units: definition of length, equivalence relations and classes, scales, standards of length, time and mass, basic and derived physical quantities, units and prefixes in SI, physical dimensions, dimensional analysis

2nd week

Kinematics in one dimension: Cartesian, spherical and cylindrical coordinate systems, vectors,operations with vectors, position vector, position function, average and instantaneous speed, average and instantaneous acceleration in one dimension

3rd week

Kinematics in three dimensions: displacement vector and path, average and instantaneous velocity, average and instantaneous acceleration in three dimensions, circular motion, tangential and normal acceleration, angular velocity, angular acceleration, relative motions, Galilean transformation, Coriolis acceleration

4th week

Dynamics: Newton's first law, inertial frames, experimental laws of two-body interactions, inertial mass, momentum, conservation of momentum, Newton's second law, Newton's third law

5th week

Force laws: basic interactions in nature, the role of force laws in equations of motion, force law of gravitation, force law of electrostatic interaction between two point charges, force law of a charged particle moving in magnetic field, force law of an idealized spring, force law of friction, force law of drag forces

6th week

Ballistic motions: analytic solution of the equation of motion near the surface of the Earth, describing the path, calculating the parameters of the special points of the path, numerical solution of the equation of motion near the surface of the Earth

7th week

Center of mass, constrained motion: center of mass defined in the discreet and in the continuum limit, density, internal and external forces, constrained motion on a slope, constrained motion of a pendulum

8th week

Collisions: describing collisions in the center-of-mass and in the laboratory frame, elastic and inelastic collisions, kinetic energy, collisions in one dimension, special cases of one-dimensional collisions

9th week

Work and energy: work, work-energy theorem, work of the gravitational pull of the Earth, work of an idealized spring, power, potential energy, conservation of total mechanical energy, conservative and dissipative forces, potential energy of a body under the influence of an idealized spring, potential energy of a body under the influence of gravitation

10th week

Oscillations: analyzing the motion of a pendulum, simple harmonic oscillations, addition of two simple harmonic oscillations, Lissajous figures, damped oscillations, forced oscillations, coupled oscillations

11th week

Elasticity: tensile stress, shearing stress, uniform compression, relative deformation, Young's modulus, shear modulus, compression modulus, Hooke's law, elastic energy, elastic energy density

12th week

Wave motion: mechanical waves, transverse and longitudinal waves, one-dimensional wave motion in a streched string, wave speed, wave function, wave equation, harmonic waves, wavelength, wave number, time period, energy transports in wave motion, kinetic and potential energy density of an elastic medium, energy density current, intensity

13th week

Wave motion: multi-dimensional wave motion, wavefronts, spherical waves, plane waves, principle of linear superposition, interference, coherent waves, standing waves, sound waves, intensity, pitch and tone, fundamental frequency and overtones, diffraction, Huygens' principle, Huygens–Fresnel principle

14th week

Temperature: extensive and intensive quantities, thermal equilibrium, zeroth law of thermodynamics, empirical measuring scales, Celsius scale, Kelvin scale, triple-point temperature, Gay-Lussac's law, constant-volume gas scales, ideal gas

Requirements:

The course exam is a written examination. In the exam theoretical questions and practical problems must be answered and solved in 100 minutes. The evaluation of the exam occurs based on the following grading:

0–59 % → 1,

60–69 % → 2, *70–79 % → 3,* *80–89 % → 4,* *90–100 % → 5*
Person responsible for course: Dr. Balázs Ujvári, assistant professor, PhD
Lecturer: Dr. Balázs Ujvári, assistant professor, PhD

Title of course: Physics 2 **Code**: TTFBE1102-EN	**ECTS Credit points: 4**

Type of teaching, contact hours

- lecture: 2 hours/week
- practice: 2 hours/week
- laboratory: -

Evaluation: exam

Workload (estimated), divided into contact hours:

- lecture: 28 hours
- practice: 28 hours
- laboratory: -
- home assignment: 24 hours
- preparation for the exam: 24 hours

Total: 90 hours

Year, semester: 1st year, 2nd semester

Its prerequisite(s): Physics 1

Further courses built on it: -

Topics of course

Geometrical optics. Wave properties of light. Electrostatics. Gauss' law. Electric potential. Capacitors. Electric current. Direct current circuits. Magnetic field. Sources of magnetic field. Solenoids, displacement current. Induction. LC and RLC circuits. Electromagnetic waves.

Literature

J.W. Jewett Jr, R.A. Serway: Physics for Scientists and Engineers

Schedule:

1st week

Geometrical optics: law of reflection, law of refraction, total reflection, imaging by concave and convex mirrors, imaging by a single spherical refractive surface, imaging by converging and diverging thin lenses, lense distortions

2nd week

Wave properties of light: coherent light waves, interference, diffration, Young’s double-slit experiment, thin-film interference, single-slit diffraction, diffraction gratings

3rd week

Electrostatics: electric charge, insulators, conductors and semi-conductors, Coulomb's law, electric field, field vector, field lines, electric field of a point charge, electric dipoles, linear, surface and volume charge distributions

4th week

Gauss' law: electric flux through open and closed surfaces, Gauss' law and its applications, electric field of a uniformly charged infinite line, electric field of a uniformly charged infinite plane, electric charge of a uniformly charged spherical volume

5th week

Electric potential: comparison of the force laws of gravitational and electrostatical interactions, work done by electric field, potential energy, potential energy of two-body and many-body systems, potential, potential due to a single point charge and charge distributions

6th week

Capacitors: parallel-plate, cylindrical and spherical capacitors, capacitance, energy and energy density stored by the electrostatic field, capacitors with dielectrics, equivalent capacitance of capacitors connected in parallel and series

7th week

Electric current: electric current, electric current density, resistance, resistivity, conductivity, differential and integral form of Ohm's law, temperature dependence of resistivity, electric power

8th week

Direct current circuits: equivalent resistance of resistors connected in parallel and series, ideal and non-ideal batteries, electromotive force, Kirchhoff's junction law, Kirchhoff's loop law, transient phenomena in RC circuits

9th week

Magnetic field: magnetic field, field vector, field lines, electric charge moving in magnetic field, Lorentz's force, cyclotron, magnetic force acting on a current-carrying conductor

10th week

Sources of magnetic field: Biot–Savart law, magnetic field of a current-carrying straight wire, magnetic force between two parallel conductors, definition of the unit of electric current, Ampere's law

11th week

Solenoids, displacement current: magnetic field of a solenoid, magnetic flux through open and closed surfaces, Gauss' law of magnetism, displacement current, Ampere–Maxwell law

12th week

Induction: induced electormotive force, Faraday's law of induction, Lenz's law, eddy currents, self-induction, inductance, transient phenomena in RL circuits

13th week

LC and RLC circuits: energy conditions in LC circuits, analogy to free harmonic oscillations of a mechanical system, energy conditions in RLC circuits, analogy to damped oscillations of a mechanical system

14th week

Electromagnetic waves: differential and integral form of Maxwell's equations, linearly polarized plane electromagnetic waves

Requirements:

The course exam is a written examination. In the exam theoretical questions and practical problems must be answered and solved in 100 minutes. The evaluation of the exam occurs based on the following grading:

0–59 % → 1,

60–69 % → 2,

70–79 % → 3,

80–89 % → 4,

90–100 % → 5

Person responsible for course: Dr. Balázs Ujvári, assistant professor, PhD

Lecturer: Dr. Balázs Ujvári, assistant professor, PhD

Title of course: Physics 2 **Code**: TTFBG1102-EN	**ECTS Credit points: 1**

Type of teaching, contact hours
- lecture: -
- practice: 2 hours/week
- laboratory: -

Evaluation: exam

Workload (estimated), divided into contact hours:
- lecture: -
- practice: 28 hours
- laboratory: -
- home assignment: 2 hours
- preparation for the exam: -

Total: 30 hours

Year, semester: 1st year, 2nd semester

Its prerequisite(s): Physics 1

Further courses built on it: -

Topics of course

Geometrical optics. Wave properties of light. Electrostatics. Gauss' law. Electric potential. Capacitors. Electric current. Direct current circuits. Magnetic field. Sources of magnetic field. Solenoids, displacement current. Induction. LC and RLC circuits. Electromagnetic waves.

Literature

J.W. Jewett Jr, R.A. Serway: Physics for Scientists and Engineers

Schedule:

1st week

Geometrical optics: law of reflection, law of refraction, total reflection, imaging by concave and convex mirrors, imaging by a single spherical refractive surface, imaging by converging and diverging thin lenses, lense distortions

2nd week

Wave properties of light: coherent light waves, interference, diffration, Young’s double-slit experiment, thin-film interference, single-slit diffraction, diffraction gratings

3rd week

Electrostatics: electric charge, insulators, conductors and semi-conductors, Coulomb's law, electric field, field vector, field lines, electric field of a point charge, electric dipoles, linear, surface and volume charge distributions

4th week

Gauss' law: electric flux through open and closed surfaces, Gauss' law and its applications, electric field of a uniformly charged infinite line, electric field of a uniformly charged infinite plane, electric charge of a uniformly charged spherical volume

5th week

Electric potential: comparison of the force laws of gravitational and electrostatical interactions, work done by electric field, potential energy, potential energy of two-body and many-body systems, potential, potential due to a single point charge and charge distributions

6th week

Capacitors: parallel-plate, cylindrical and spherical capacitors, capacitance, energy and energy density stored by the electrostatic field, capacitors with dielectrics, equivalent capacitance of capacitors connected in parallel and series

7th week

Electric current: electric current, electric current density, resistance, resistivity, conductivity, differential and integral form of Ohm's law, temperature dependence of resistivity, electric power

8th week

Direct current circuits: equivalent resistance of resistors connected in parallel and series, ideal and non-ideal batteries, electromotive force, Kirchhoff's junction law, Kirchhoff's loop law, transient phenomena in RC circuits

9th week

Magnetic field: magnetic field, field vector, field lines, electric charge moving in magnetic field, Lorentz's force, cyclotron, magnetic force acting on a current-carrying conductor

10th week

Sources of magnetic field: Biot–Savart law, magnetic field of a current-carrying straight wire, magnetic force between two parallel conductors, definition of the unit of electric current, Ampere's law

11th week

Solenoids, displacement current: magnetic field of a solenoid, magnetic flux through open and closed surfaces, Gauss' law of magnetism, displacement current, Ampere–Maxwell law

12th week

Induction: induced electormotive force, Faraday's law of induction, Lenz's law, eddy currents, self-induction, inductance, transient phenomena in RL circuits

13th week

LC and RLC circuits: energy conditions in LC circuits, analogy to free harmonic oscillations of a mechanical system, energy conditions in RLC circuits, analogy to damped oscillations of a mechanical system

14th week

Electromagnetic waves: differential and integral form of Maxwell's equations, linearly polarized plane electromagnetic waves

Requirements:

The course exam is a written examination. In the exam theoretical questions and practical problems must be answered and solved in 100 minutes. The evaluation of the exam occurs based on the following grading:

0–59 % → 1,

60–69 % → 2,

70–79 % → 3,

80–89 % → 4,

90–100 % → 5

Person responsible for course: Dr. Balázs Ujvári, assistant professor, PhD

Lecturer: Dr. Balázs Ujvári, assistant professor, PhD

Title of course: Materials Science for Electrical Engineering **Code**: **TTFBE1113**	**ECTS Credit points: 3**

Type of teaching, contact hours
- lecture: 2 hours/week
- practice: -
- laboratory: -

Evaluation: exam

Workload (estimated), divided into contact hours:
- lecture: 28 hours
- practice: -
- laboratory: -
- home assignment: 20 hours
- preparation for the exam: 20 hours

Total: 68 hours

Year, semester: 1st year, 1st semester

Its prerequisite(s): -

Further courses built on it: TTFBE1225

Topics of course

Electrons in atoms, the periodic table, interatomic bonds, fundamentals of crystallography and diffractometry, crystalline and amorphous solids, methods of single crystal growing, production of metallic glasses, crystal defects. Phase transformations, two and multicomponent systems, phase transformations, phase diagrams, diffusion. Mechanical properties, fundamentals of elasticity, plastic deformation. Experimental methods, mechanical testing, thermal analysis, microscopic methods. Electrical properties, Drude-model, elements of band theory, insulators, conductors, semiconductors, superconductivity. Magnetic properties, magnetic materials, measurement methods of magnetic properties. Dielectric materials, piezo and ferroelectricity, applications. Optical properties and optical materials. The most important structural materials, steels and other alloys, ceramics, polimers: properties, production and applications. Nanostructures and nanomaterials.

Literature

Compulsory:

W.D. Callister: Fundamentals of Materials Science and Engineering, John Wiley and Sons Inc. 2001

Recommended:

M.A. Omar: Elementary Solid State Physics, Addison-Wesley Publishing Company, 1993

M. Ashby, H. Shercliff, D. Cebon: Materials Engineering, Science, Processing and Design, Elsevier 2007

Schedule:

1st week

Electrons in atom, atomic orbitals, quantum numbers, periodic table

2nd week

Interatomic bonds (covalent, ionic, metallic, Van der Waals), crystalline and amorphous solids.

3rd week

Elements of crystallography, crystal systems, Bravais-lattices, diffraction on crystals, Bragg's-law, diffractometers.

4th week

Single and policrystalline materials, textures. Production of single crystals, and metallic glasses. Crystal defects (point defects, vacancies, dislocations, stacking faults, twins, grain boundaries)

5th week

Phase transformations, thermal analysis, two and multicomponent systems, phase diagrams

6th week

Diffusion in solids, Fick's laws, diffusion mechanisms, diffusion in the technology

7th week

Mechanical properties, principles of elasticity, elastic constants, tensile test, plastic deformation

8th week

Microscopic methods in the materials science. Optical and electron microscopy (TEM, SEM, STM, AFM) physical background, instrumentation, application examples.

9th week

Electrical properties of solids, model of Drude, elements of band theory, insulators conductors, semiconductors.

10th week

The temperature dependence of conductivity. Intrinsic and doped semiconductors, electrons and holes, donor and acceptor elements, p-n junction.

11th week

Magnetic materials, para, dia and ferromagnetic materials, magnetization curve of ferromagnets, measurement of magnetization curves, Barkhausen effect, hard and soft ferromagnets, production and applications.

12th week

Dielectric material, piezoelectricity, ferroelectricity. Optical properties and optical materials

13th week

The most important structural materials, steels and other alloys, ceramics, polimers: properties, production and applications

14th week
Non-conventional materials: superconductors, nanostructures, non-linear properties

Requirements:
- for a signature
Attendance at **lectures** is recommended, but not compulsory. Condition for sign obtaining is a successful (at least passed grade) pass of the TTFBG1103 practice.

- for a grade

The course ends in an **examination**.

Grades:

0-50%	1
51-62%	2
63-75%	3

76-87% 4 88-100% 5
Person responsible for course: Dr. Lajos Daróczi, associate professor, PhD
Lecturer: Dr. Lajos Daróczi, associate professor, PhD

Title of course: Materials Science for Electrical Engineering **Code**: **TTFBG1103**	**ECTS Credit points: 2**
Type of teaching, contact hours - lecture: - practice: 2 hours/week - laboratory: -	
Evaluation: grade	
Workload (estimated), divided into contact hours: - lecture: - practice: 28 hours - laboratory: - - home assignment: 20 hours - preparation for the exam: - Total: 48 hours	
Year, semester: 1st year, 1st semester	
Its prerequisite(s): -	
Further courses built on it: TTFBE1225	

Topics of course

Electrons in atoms, the periodic table, interatomic bonds, fundamentals of crystallography and diffractometry, crystalline and amorphous solids, methods of single crystal growing, production of metallic glasses, crystal defects. Phase transformations, two and multicomponent systems, phase transformations, phase diagrams, diffusion. Mechanical properties, fundamentals of elasticity, plastic deformation. Experimental methods, mechanical testing, thermal analysis, microscopic methods. Electrical properties, Drude-model, elements of band theory, insulators, conductors, semiconductors, superconductivity. Magnetic properties, magnetic materials, measurement methods of magnetic properties. Dielectric materials, piezo and ferroelectricity, applications. Optical properties and optical materials. The most important structural materials, steels and other alloys, ceramics, polimers: properties, production and applications. Nanostructures and nanomaterials.

Literature

Compulsory:
W.D. Callister: Fundamentals of Materials Science and Engineering, John Wiley and Sons Inc. 2001
Recommended:
M.A. Omar: Elementary Solid State Physics, Addison-Wesley Publishing Company, 1993
M. Ashby, H. Shercliff, D. Cebon: Materials Engineering, Science, Processing and Design, Elsevier 2007

Schedule:

1st week

Calculation of electron energy levels of H atom.

2nd week

Electron structure of elements and simple molecules

3rd week

Elemental crystallography, Miller indices, directions, planes in the crystal.

4th week

Diffraction, Bragg-law, evaluation of diffraction patterns

5th week

Calculation of concentrations, evaluation of phase diagrams in two component systems, evaluation of DSC curves

6th week

Diffusion in solids, Fick's laws, solution of simple diffusion problems

7th week

Mechanical properties, principles of elasticity, elastic constants, Hook's law

8th week

Mid term test

9th week

Electrical properties, Drude-model, Hall effect, mobility of charge carriers, temperature dependence of conductivity in metals.

10th week

Calculation of electron and hole concentrations, conductivity in intrinsic and extrinsic semiconductors, temperature dependence of conductivity

11th week

Magnetic materials, magnetization curves, calculation of simple magnetic circuits

12th week

Dielectrics, calculation of dipole moment, polarization, capacitance, pizoelectricity

13th week

Optical properties, refraction, transmission, absorption

14th week
End term test

Requirements:
- for a signature

Attendance at **practices** is compulsory. Condition for sign obtaining is the successful (at least passed grade) write of two tests according to semester assessment timing

- for a grade

The grades are calculated from the results of the tests.
Grades:

0-50%	1
51-62%	2
63-75%	3
76-87%	4
88-100%	5

Person responsible for course: Dr. Lajos Daróczi, associate professor, PhD

Lecturer: Dr. Lajos Daróczi, associate professor, PhD

Title of course: Informatics 1. **Code**: TTFBE1104-EN	**ECTS Credit points:** 3

Type of teaching, contact hours
- lecture: 2 hours/week

Evaluation: exam

Workload (estimated), divided into contact hours:
- lecture: 28 hours
- practice: -
- laboratory: -
- home assignment: 28 hours
- preparation for the exam: 24 hours

Total: 80 hours

Year, semester: 1st year, 1st semester

Its prerequisite(s): -

Further courses built on it: TFBE1105-EN

Topics of course

Introduction to the history of informatics. Boolean algebra. General architecture of computers. Structure and operation of processors. Types of memory (register, cache, RAM, ROM) and their operation. Peripherals: storage units (HDD, SSD, ODD), input- and output units. Definition of operating systems. Process, scheduler, memory management, file management, interrupt system. Linux and Windows operating systems. Metrics of computer performance; improving performance.

Literature

Compulsory:
- Course materials

Recommended:
- Andrew S. Tanenbaum – Structured Computer Organization, 2006.
- Andrew S. Tanenbaum, Herbert Bos – Modern Operating Systems, 2014.

Schedule for lecture:

1st week

Introduction to the course. History of informatics. General architecture of computers.

2nd week

Boolean algebra

3rd week

Structure and operation of microprocessors.

4th week

Memory types (register, cache, RAM, ROM) and their features

5th week

Peripherals: storage units (HDD, SSD, ODD)

6th week

Peripherals: input and output units

7th week

1st test for proposed mark

8th week

Definition of operating systems

9th week

Process, scheduler, memory management

10th week

File management, interrupt system

11th week

The Linux operating system

12th week

The Windows operating system

13th week

Metrics of computer performance, improving performance

14th week

2nd test for proposed mark

Requirements:

- for a lecture grade

The course ends in an examination. The requirement for examination is having pass (2) or better practical mark (TTFBL1104-EN).

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 table:

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 two theoretical tests during the semester is at least satisfactory (3) and the average of the mid-term and end-term tests is at least satisfactory (3). The offered grade is the average of the theoretical test. Taking the tests are not mandatory.

Person responsible for course: Dr. Gyula Zilizi, associate professor, PhD

Lecturer: Dr. Gyula Zilizi, associate professor, PhD, Árpád Rácz assistant lecturer

Title of course: Informatics 1. **Code**: TFBL1104-EN	**ECTS Credit points:** 2

Type of teaching, contact hours
- lecture: -
- practice: -
- laboratory: 2 hours/week

Evaluation: term grade

Workload (estimated), divided into contact hours:
- lecture: -
- practice: -
- laboratory: 28 hours
- home assignment: 28 hours
- preparation for the exam: 28 hours

Total: 84 hours

Year, semester: 1st year, 1st semester

Its prerequisite(s): -

Further courses built on it: Informatics 2. (TTFBL1105-EN)

Topics of course

Numeral systems, number representation. Boolean logic, simplification of logical functions. BCD, ASCII code tables. Units in informatics. Word-processing, spreadsheets. Technical documentation.

Literature

Compulsory:
- Course materials

Recommended:
- Andrew S. Tanenbaum – Structured Computer Organization, 2006.
- Andrew S. Tanenbaum, Herbert Bos – Modern Operating Systems, 2014.

Schedule for the laboratory:

1st week

Introduction to the class and to the requirements

2nd week

Number systems in informatics, number system conversion

3rd week

Boolean logic, simplification of logical functions

4th week

Representation of numbers

5th week

BCD, ASCII code tables, units in informatics

6th week

Practice, preparing for the first test

7th week

First test

8th week

Word-processing

9th week

Spreadsheets

10th week

Technical documentation, measurement report

11th week

PowerPoint and presentation

12th week

Practice, preparing for the second test

13th week

Second test

14th week

Possibility to redo tests

Requirements:

- for a term grade

Two successful tests are required for completion of this class. Maximum two missed classes are allowed for the semester.

One test is in written form with theoretical questions and calculations. One test is on computer with practical tasks.

0-50 %	failed (1)
51-62 %	pass (2)
63-75 %	satisfactory (3)
76- 87 %	good (4)
88-100%	excellent (5)

Person responsible for course: Dr. Gyula Zilizi associate professor

Lecturer: Árpád Rácz, assistant lecturer

Title of course: Informatics 2. **Code**: TTFBE1105-EN	**ECTS Credit points:** 3

Type of teaching, contact hours
- lecture: 2 hours/week

Evaluation: exam

Workload (estimated), divided into contact hours:
- lecture: 28 hours
- practice: -
- laboratory: -
- home assignment: 28 hours
- preparation for the exam: 24 hours

Total: 80 hours

Year, semester: 1st year, 2nd semester

Its prerequisite(s): TTFBL1104-EN

Further courses built on it: -

Topics of course

General concept and operation of computer networks:
History of computer networks, terminology, transmission media, topologies, OSI model, protocols, Ethernet, TCP, IP protocol, Internet, Domain names, NAT, WiFi.
General concept and operation of databases:
Definitions, relational databases, normal forms, dependencies, SQL language.
Introduction to advanced computer applications:
Microcontrollers, Small-Board-Computers, ARM architecture, Android operating system, Cloud, Cluster, Bigdata.

Literature

Compulsory:
- Course materials

Recommended:
- Andrew S. Tanenbaum, David J. Wetherall – Computer Networks, 2010.
- Jeffrey D. Ullmann, Jennifer Widom – First Course in Database Systems, 2007.

Schedule for lecture:

1st week
Introduction to the course

2nd week
Basics of computer networks (history, basic elements)

3rd week
Basics of computer networks (transmission media, topologies)

4th week
Basics of computer networks (OSI model, protocols)

5th week
Basics of computer networks (Ethernet, TCP, IP protocols)

6th week
Basics of computer networks (Internet, Domain names, NAT, WiFi)

7th week
1st test for proposed mark
8th week
Database basics (basic elements)
9th week
Database basics (relational databases, normal forms)
10th week
Database basics (SQL language)
11th week
Modern computer systems (Microcontrollers, Single-Board-Computers)
12th week
Modern computer systems (ARM architecture, Android operating system)
13th week
Modern computer systems (Cloud, Cluster, Bigdata)
14th week
Concept of Smart Grid

Requirements:

- for a lecture grade
The course ends in an **examination**. The requirement for examination is having pass (2) or better practical mark (TTFBL1105-EN).

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 table:

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 two theoretical test during the semester is at least satisfactory (3) and the average of the mid-term and end-term tests is at least satisfactory (3). The offered grade is the average of the theoretical test. Taking the tests are not mandatory.

Person responsible for course: Dr. Gyula Zilizi, associate professor, PhD

Lecturer: Dr. Gyula Zilizi, associate professor, PhD, Árpád Rácz assistant lecturer

Title of course: Informatics 2. **Code**: TTFBL1105-EN	**ECTS Credit points:** 2

Type of teaching, contact hours
- lecture: -
- practice: -
- laboratory: 2 hours/week

Evaluation: term grade

Workload (estimated), divided into contact hours:
- lecture: -
- practice: -
- laboratory: 28 hours
- home assignment: 28 hours
- preparation for the exam: 28 hours

Total: 84 hours

Year, semester: 1st year, 2nd semester

Its prerequisite(s): Informatics 1. TTFBL1104-EN

Further courses built on it: -

Topics of course

Linux in general and its usage. Single-board computers. Network management in Windows and Linux. Configuration of computer network devices. Basic SQL knowledge.

Literature

Compulsory:
- Course materials

Recommended:
- Tanenbaum, A.S.: Computer Networks, Prentice Hall
- Hector Garcia-Molina, Jeff Ullman, Jennifer Widom - Database Systems: The Complete Book

Schedule for the laboratory:

1st week

Introduction to the class and to the requirements

2nd week

Linux in general.

3rd week

Single-board computers, Raspberry Pi

4th week

Linux in practice (basic steps in the terminal)

5th week

Linux in practice (basic terminal tools)

6th week

Linux in practice (file management)

7th week

Practice, preparing for the first test
8th week
First test.
9th week
Computer network devices, computer network tools on Windows and Linux
10th week
Basic SQL commands
11th week
Basic SQL commands
12th week
Practice, preparing for the second test
13th week
Second test
14th week
Possibility to redo tests

Requirements:
- for a term grade
Two successful tests are required for completing this class. Max. two missed classes are allowed during the semester.
Both tests contain theoretical questions and practical tasks.

0-50 %	failed (1)
51-62 %	pass (2)
63-75 %	satisfactory (3)
76- 87 %	good (4)
88-100%	excellent (5)

Person responsible for course: Dr. Gyula Zilizi associate professor

Lecturer: Árpád Rácz, assistant lecturer

Title of course: EU studies **Code**: TTTBE0030-K1-EN	**ECTS Credit points:** 1
Type of teaching, contact hours - lecture: 1 hour/week - practice: - - laboratory: -	
Evaluation: exam	
Workload (estimated), divided into contact hours: - lecture: 14 hours - practice: - - laboratory: - - home assignment: - - preparation for the exam: 40 hours Total: 54 hours	
Year, semester: 1st year, 1st semester	
Its prerequisite(s): -	
Further courses built on it:	

Topics of course

The aim of the course is to give an overall picture for the students of the history of the development of the Community and the operation of its institutional system. It also aims at introducing the students to the enlargement process and the most important cooperation areas. On the level of EU policies, the issues of agriculture, regional policy, Economic and Monetary Union and the Schengen Area are discussed. The primary goal is that the future diploma holders have realistic knowledge about the functioning of the European Union, and of the international background of the Hungarian EU membership.

Literature

Bergmann, Julian – Niemann, Arne (2013): Theories of European Integration and their Contribution to the Study of European Foreign Policy, Paper prepared for the 8th Pan-European Conference on International Relations, Warsaw 2013. p22. Ott, Andrea – Vos, Ellen (eds.) (2009): Fifty Years of European Integration: Foundations and Perspectives. T.M.C. Asser Press, Springer. 480pp. ISBN: 978-90-6704-254-3 Official website: https://europa.eu/european-union/about-eu_en

Schedule:

1st week
History of the Integration. Integration theories, stages of integration around the world. Specific features of the European integration process before the Second World War. Impacts of the Second World War on the history of the cooperation. Predecessors, impacts of the European Coal and Steel Community (ECSC) on the foundation of the European Economic Community. Steps towards the European Union.

2nd week
Process of the enlargement of the organisation. Preconditions of the enrolment of new members. Events of the period prior to the First Enlargement (1973). Steps, principles, causes and consequences of the Enlargements. Relationships between the decision-making mechanism and the Enlargement.

3 rd week
Specific features of the enlargements after the turn of the millennium. Transformation of East Central Europe, and the unique features of its membership. Copenhagen criteria, pre-accession funds, prolonged negotiation process. Brexit.

4 th week
History and principles of the creation of the institutional system. Taking-over the institutional system of the European Coal and Steel Community. Tasks of the most important institutions, operational mechanism, democratic deficit. Reform process of the institutional system, concepts laid down in the Constitutional Treaty. Decision-making in the EU.

5 th week
Agricultural policy. History of the development of the CAP. The most important tools and sources of the funds. Horizontal measures. Current state of the common agricultural policy and its expected future. Reform attempts in agriculture. Hungary and common agricultural policy. Sharing the fish stocks of the seas.

6 th week
Regional policy in the European Union. History of the regional policy. Regionalism – regionalisation in the EU Member States. General features of the regional policy. NUTS nomenclature. Regional disparities in the Community. Funds and main objectives. Decision-making in regional policy. Hungary and the regional policy.

7 th week
Economic and Monetary Union (EMU). History of the European monetary co-operation. The European Monetary System (EMS). Role of the Maastricht Treaty in the monetary co-operation. Stages on the development of the Monetary Union. Convergence criteria. The euro and the currency market. Hungary and the Monetary Union.

8 th week
Judicial co-operation in the Community. Legal order in the European Union. Role of the primary EU legislation in the European Community. European Community justice. Institutions serving the needs of judicial co-operation.

9 th week
History of co-operations in home affairs. Schengen Convention. Regulations related to crossing state borders. Border checks. Checks between state borders, migration policy.

10 th week
External relations. Principles of the common foreign trade policy. Autonomous import and export regulation. Issues related to the impediment to trade. External relations: African, Caribbean and Pacific Group of States (ACP), Global Mediterranean Policy, associated countries.

11 th week
EU Budget: revenue side. Components of the EU budget and recent changes in the proportions. History of the EU budget. Budget revenues: duties, value-added tax (VAT), gross national product (GNP) sources.

12 th week
Expenditures: agricultural policy, structural funds, external aid, research and development, pre-accession assistances, administrative expenditures. Economic characteristics. Budget procedure.

13 th week

Migration and the European Union. Theoretical background to the migration crisis in 2015 and its practical consequences. History of the migration routes and movements. Natural and social (political) causes contributing to the crisis situation.

14 th week
Common vision for the European co-operation. Possible development paths in the future of the European Union. Federal Europe or Europe of Nations? Reform options. Problem-solving attempts. Brexit.

Requirements:
- *for a signature*
There is no requirement for a signature.
- *for a grade*
Assessment is based on a written exam which will be evaluated according to the following grading schedule:
0 -50% – fail (1)
50%+1 point -63% – pass (2)
64% -75% – satisfactory (3)
76% -86% – good (4)
87% -100% – excellent (5)

Person responsible for course: Dr. Károly Teperics, associate professor, PhD

Lecturer: Dr. Károly Teperics, associate professor, PhD

Title of course: Introduction to economics **Code**: TTBEBVVM-KT1-EN	**ECTS Credit points:** 3
Type of teaching, contact hours - lecture: 2 hours/week - practice: - - laboratory: -	
Evaluation: exam	
Workload (estimated), divided into contact hours: - lecture: 28 hours - practice: - - laboratory: - - home assignment: - - preparation for the exam: 62 hours Total: 90 hours	
Year, semester: 1st year, 1st semester (or any later fall semester)	
Its prerequisite(s): -	
Further courses built on it:	

Topics of course
10 principles of economics, how markets work: demand and supply analysis, the effects of governmental interventions, cost of production, profit-maximizing behaviour of firms, analysis of perfect competition and monopoly
Literature
Mankiw, Gregory: Principles of Economics. Fifth Edition. South-Western, Mason, USA, 2009. Heyne, Paul – Boettke, Peter – Prychitko, David: The Economic Way of Thinking. Twelfth Edition. Pearson Education International, New Jersey, 2010.

Schedule:

1st week
Introduction: Basic concepts and fundamental questions of economics
SR: Understanding the basic concepts and the economic way of thinking

2nd week
Human needs, scarcity, inputs, trade and its benefits
SR: Knowing the concept of scarcity and how free-will trade makes everyone better off

3rd week
Principles of economics
SR: Understanding the meaning of the 10 main principles

4th week
Production possibilities frontier, opportunity cost

SR: Knowing the role of opportunity cost in the model of PPF curve

5th week
Demand and Supply
SR: Understanding the model of market, able to derive the changes of variables

6th week
Market allocation
SR:Able to characterize the equilibrium and disequilibrium

7th week
Welfare economics
SR: Concept of consumer and producer surplus and Dead Weight Loss

8th week
Application: Governmental interventions
SR: Able to identify the effects of government's interventions on market and the welfare of the society

9th week
Cost of production
SR: The main types of cost and their relationship

10th week
Competitive industry I.
SR: Criteria of perfect competition, and profit-maximization

11th week
Competitive industry II.
SR: Welfare effects and industry in the long run

12th week
Monopoly I.
SR: Criteria of monopoly, and profit-maximization

13th week
Monopoly II.
SR: Understanding the welfare effects of monopoly

14th week
Summary, discussion of questions emerging during the semester.
SR: --

Requirements:
- for a signature
There is no requirement for a signature.
- for a grade

Assessment is based on a written exam which will be evaluated according to the following grading schedule: 0 -50% – fail (1) 50%+1 point -63% – pass (2) 64% -75% – satisfactory (3) 76% -86% – good (4) 87% -100% – excellent (5)
Person responsible for course: Dr. Judit Kapás, professor
Lecturer: Dr. István Kovács, assistant professor

Title of course: Basics of labour law **Code**: JA-BIOBSc3-EN	**ECTS Credit points:** 3

Type of teaching, contact hours
- lecture: 28
- practice: -
- laboratory: -

Evaluation: exam

Workload (estimated), divided into contact hours:
- lecture: 28
- practice: -
- laboratory: -
- home assignment:
- preparation for the exam:

Total: 28

Year, semester: 2nd semester

Its prerequisite(s):

Further courses built on it:

Topics of course

The object is to familiarize students with labour law as well as practical knowledge that is commonplace in everyday life and can be used by students. The topics of the subject embrace the entire economic labour law, including the most basic individual and collective labour law institutions.

Literature

Act I of 2012 on the Labour Code

Schedule:

1. The concept and subject of the history of the development of labour law. Scope of basic labour laws, purpose of the labour code, basic rules for exercising rights and fulfilling obligations, basic behavioural requirements (principles).

2. Legal statements and calculation of deadlines; labour law on invalidity. Unilateral Declaration of Rights, Commitment, Employer Rules, an information and condition.

3. Changes in the relationship between the subject of the employment relationship and the employer. The labour law legal entity on the employee and employer side, to establish the employment relationship issues,

4. The system of content elements of the employment contract and employment relationship. The modification and modification of employment contract. Employment other than employment contract rules.

5. The question of exercising employer rights. The system of rights and obligations a labour law; denial of instruction and instruction; other legal consequences in case of non-compliance.

6. Rules for determining working time; in extraordinary working hours Work Rules in Labour Code. The system of rest periods and their rewards in the Labour Code.

7. Questions of remuneration for work. Wage protection, another payroll. The study contract and non-compete agreement.

8. General rules on liability and liability for damages. The employee dogmatic questions of his liability for damages.

9. Employer's liability for damages in the light of the civil liability regime.

10. The system of the cessation of an employment relationship and the termination of employment. The mutual consent, the termination without notice.

11. Principles and general rules of termination. Termination with immediate effect; collective redundancy reduction rules. The notice period and severance pay. Procedure a termination and termination of employment.

12. Atypical employment relationships.

13. Collective labour dispute and the labour legal proceeding.

14. The industrial relations.

Requirements: - *for a grade*

The course ends in an **examination.**

Person responsible for course: Dr. Nádas György Ph.D.

Lecturer: Dr. Nádas György Ph.D., Dr. Rab Henriett Ph.D., Dr. Zaccaria Márton Leó Ph.D.

Title of course: Enterprise Economics **Code**: TTBEBVVM-KT2-EN	**ECTS Credit points:** 3

Type of teaching, contact hours
- lecture: 2 hours/week
- practice: -
- laboratory: -

Evaluation: exam

Workload (estimated), divided into contact hours:
- lecture: 28 hours
- practice: -
- laboratory: -
- home assignment: 28 hours
- preparation for the exam: 34 hours

Total: 90 hours

Year, semester: 1rt year, 1st semester

It's prerequisite(s): -

Further courses built on it: -

Topics of course

Students will become familiar with the general management tasks such as planning, organization, human resources management, incentive, control. The course is also responsible to provide students with the concept, grouping them basic economic knowledge, management of the value creation for businesses. Students have to be taught the main elements of stock and flow process, value creation procedure, life cycle theory, basic elements of business planning.

Literature

Compulsory:
1. Nábrádi A. (2015): Entrepreneurship, Debreceni Egyetem ISBN 978-963-12-3048-22.
2. Andy Schmitz (2013): Principles of Managerial Economics, http://lardbucket.org

Schedule:

1st week

The management and its tasks, the design of the organization team building incentives and demands on audit responsibilities with the essential requirements.

2nd week

The company and its business relationship with the grouping of businesses, the main similarities and differences in the operation, management and responsibilities of the different types of businesses.

3rd week

The business process flow, revenue management.

4th week

The business process flow, expense management, tasks management to the increase in the income level.

5th week

The efficiency and management context, the conditions of effective management.

6th week

First written exam.

7th week

Fixed assets management.

8th week

The investments and investment efficiency calculations.

9th week

The management of working capital.

10th week

Production value management processes.

11th week

Second written exam.

12th week

Introduction to Human Resources Management.

13th week

Introduction to business planning process.

14th week

Introduction to strategic planning..

Requirements:

- for a signature

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

During the semester there are two tests: the mid-term test in the 6th week and the end-term test in the 11th week. Students have to sit for the tests

- for a grade

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

- 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 table:

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 of the mid-term and end-term tests is at least satisfactory (3). The offered grade is the average of them.

Person responsible for course: Dr. András Nábrádi, professor, PhD

Lecturer: Dr. András Nábrádi, professor, PhD

Title of course: Quality Management **Code**: TTBEBVM-KT6-EN	**ECTS Credit points:** 3

Type of teaching, contact hours
- lecture: 2 hours/week
- practice: -
- laboratory: -

Evaluation: exam

Workload (estimated), divided into contact hours:
- lecture: 28 hours
- practice: -
- laboratory: -
- home assignment: -
- preparation for the exam: 62 hours

Total: 90 hours

Year, semester:

Its prerequisite(s):

Further courses built on it: -

Topics of course

The series of lectures are based on the topics of Quality Managment. This course introduces the participants into the philosophy, the theories and the basic calculations of quality management. Lectures give opportunity to discuss the topics and to get practice in basics techniques of measuring quality, quality improvement, statistical process control, quality management, international standards of quality.

Literature

Compulsory:
- Foster S. Thomas (2017): *Managing Quality: Integrating the Supply Chain.* 6th edition. Pearson Prentice-Hall, New-Jersey, ISBN-13: 978-0133798258

Recommended:
- Joel E. Ross – Susan Perry (2004): Total Quality Management, Text, Cases and Readings. 3rd Edition, Vanity Books International.
- David L. Goetsch - Stanley Davis (2015): Quality Management for Organizational Excellence: Introduction to Total Quality. 8th Edition. Pearson Prentice-Hall, New-Jersey,ISBN-13: 978-0133791853

Schedule:

1st week:
Basic issues of quality: quality of products,KANO-model

2nd week:
Basic issues of quality: quality of services, SERVQUAL model

3rd week:
Product Design – Paired comparison

4th week:
Quality theories- Taguchi method (Design of Experiments)

5th week:
Tools of quality - 7 basic tools of quality (Ishikawa)

6th week:
Statistical Process Control I – Charts for Variables

7th week:
Statistical Process Control II – Charts for Attributes

8th week:
Process Capability

9th week:
Quality management: International Quality standards (ISO, TQM, EFQM model)

10th week:
LEAN Manufacturing and Quality

11th week:
Six Sigma System

12th week:
Product Design – Quality Function Deployment

13th week:
Risk Evalutaion: Failure Mode and Effects Analysis

14th week:
Practicing Case Studies

Requirements:
- for a signature
Attendance at **lectures** is recommended, but not compulsory.

- for a grade
The course ends in an **examination**. The grade for the examination is given according to the following table:

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.

Person responsible for course: Dr. Agnes Kotsis, assistant professor, PhD

Lecturer: Dr. Agnes Kotsis, assistant professor, PhD

Title of course: Programming 1. **Code**: TTFBE1201	**ECTS Credit points:** 2

Type of teaching, contact hours
- lecture: 2 hours/week
- practice: -
- laboratory: -

Evaluation: exam

Workload (estimated), divided into contact hours:
- lecture: 28 hours
- practice: -
- laboratory: -
- home assignment: 17 hours
- preparation for the exam: 15 hours

Total: 60 hours

Year, semester: 1st year, 1st semester

Its prerequisite(s): -

Further courses built on it: TTFBE1202 Programming 2

Topics of course

Programming languages; methodology of program development; basics of algorithmic problem solving; most important algorithms. Data structures and computer representation of data. Construction of a C program; structured programming. Data types of the C language, declaration and initialization of variables. Functions of standard input and output. Library functions of mathematics. Evaluation of expressions in the C language. Control of the program flow; conditional statements. Loop commands. Array as a derived data type; processing arrays with loop commands. File operations. High level and bit level logical operators. Definition and declaration of functions. Generic structure of C functions. Passing parameters by value and by address. Function calls.

Literature

Compulsory:

- B. W. Kernigan and D. M. Ritchie, The C programming language (Prentice Hall, 2007).
- J. R. Hanly and E. B. Koffmann, Problem Solving and Program Design in C (7th Edition), (Pearson, 2004).

Recommended:

- P. van der Linden, Expert C Programming: Deep C Secrets, (SunSoft Press, 1994).

Schedule:

1st week

Introduction to C programming: development of programming languages, machine code, as-sembly, and high level programming languages, C as a high level programming language. Steps of program development, source code, compiler, executable code. Advantages and disad-vantages of compilers and interpreters. Types of errors, syntactical and semantical errors, de-bugging.

2nd week

Basics of algorithmic thinking, requirements of algorithms. Most important algorithms: Mini-mum and maximum search.

3rd week

Algorithms of sorting, insertion into sorted lists with linear and binary search, merging sorted lists. Characterization of the efficiency of algorithms.

4th week

Data structures and the computer representation of different data types. Signed and unsigned (positive, negative) integers, fixed point representation. Data types in C.

5th week

Floating point representation of real numbers, determination of the range and precision of da-ta. ASCII representation of characters. Data types of the C language, type modifyers.

6th week

General structure of a C program, function oriented program development. Declaration and initialization of variables. Header files and library functions. Functions of standard input and output.

7th week

Mid-term test. Symbolic constants in C. Arithmetic, incrementing, and decrementing operators. Library functions of mathematics. Evaluation of expressions in C. Command line algorithms.

8th week

Control of the program flow, branching the program execution, conditional statements. Loop commands in C with tests before and after the execution of the core of the loop.

9th week

Logical operators and their expressions. High level logical expressions. Control structures with logical expressions

10th week

Derived data types, arrays, vectors, and matrices in C. Processing arrays with loops.

11th week

Processing files, writing into a file, reading from a file. Library functions of standard input and output with files

12th week

Bit level logical operators. Operations at the level of bits, reading and setting the value of bits. Construction of mascs for bit level operations.

13th week

Functions in C. Definition and declaration of functions, function call. Boolean functions, functions without returned value, procedures

14th week

End-term test. Parameter passing to functions, passing one- and two-dimensional arrays to functions. Matrix operations with user defined functions. Bit manipulation with functions.

Requirements:

- for a signature

Attendance at **lectures** is recommended, but not compulsory. Condition to obtain signature is the successful (grade 2 or higher) accomplishment of one of the two tests according to semester assessment timing.

During the semester two tests are written: the mid-term test in the 7th week and the end-term test in the 14th week. Students' participation at the tests is mandatory.

The minimum requirement for the mid-term and end-term tests is 60%. Based on the total score of the two tests, the grade is determined according to the following scheme:

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 get a retake opportunity according to the EDUCATION AND EXAMINATION RULES AND REGULATIONS of the university.

- *for a grade*
The course ends in an **examination**. Obtaining signature is a precondition for exam eligibility. Successful completion of the practical class of Programming 1 (grade 2 or higher) is also a precondition for exam eligibility. Results of two tests are counted in the final grade at a 60% weight. The remaining 40% of the grade is based on a written exam where evaluation is performed according to the above scoring scheme.

-*an offered grade:*
it may be offered for students if the average grade of the two theoretical tests during the semester is at least satisfactory (3) and the average of the mid-term and end-term tests is at least satisfactory (3). The offered grade is the average of the theoretical test.

Person responsible for course: Prof. Dr. Kun Ferenc, full professor, PhD

Lecturer: Prof. Dr. Kun Ferenc, full professor, PhD

Title of course: Programming 1. **Code**: TTFBL1201	**ECTS Credit points:** 2

Type of teaching, contact hours
- lecture: -
- practice: 2 hours/week
- laboratory: -

Evaluation: term grade

Workload (estimated), divided into contact hours:
- lecture: -
- practice: 28 hours
- laboratory: -
- home assignment: 20 hours
- preparation for the tests: 12 hours

Total: 60 hours

Year, semester: 1st year, 1st semester

Its prerequisite(s): -

Further courses built on it: TTFBE1202 Programming 2.

Topics of course

Programming languages; methodology of program development; basics of algorithmic problem solving; most important algorithms. Data structures and computer representation of data. Construction of a C program; structured programming. Data types of the C language, declaration and initialization of variables. Functions of standard input and output. Library functions of mathematics. Evaluation of expressions in the C language. Control of the program flow; conditional statements. Loop commands. Array as a derived data type; processing arrays with loop commands. File operations. High level and bit level logical operators. Definition and declaration of functions. Generic structure of C functions. Passing parameters by value and by address. Function calls.

Literature

Compulsory:

- B. W. Kernigan and D. M. Ritchie, The C programming language (Prentice Hall, 2007).
- J. R. Hanly and E. B. Koffmann, Problem Solving and Program Design in C (7th Edition), (Pearson, 2004).

Recommended:

- P. van der Linden, Expert C Programming: Deep C Secrets, (SunSoft Press, 1994).

Schedule:

1st week

First C program. Steps of program development: source code, compiler, executable code. Pro-gram developing environments under windows and linux. Header files. Functions of standard input and output.

2nd week

Functions of standard input and output. Data types of C, declaration and initialization of var-iables. Type modifyers. Operator of storage length. Simple arithmetic operations.

3rd week

Constants. Arithmetic, incrementing and decrementing operators and their expressions. Library functions of mathematics. Evaluation of expressions in C. The conditional operator.

4th week

Control of the program flow, branching the program execution into two and more directions, conditional statements.

5th week

Logical operators and complex logical expressions to control the structure of C programs.

6th week

Repeated execution of program blocks, organizing loops of execution with loop command.

7th week

Mid-term test. Array as a derived data type, declaration of arrays. Processing data arrays with loop commands.

8th week

Processing external files in a C program. Functions of standard input and output for file processing.

9th week

Command line arguments in C, control of the program with command line arguments.

10th week

Efficient programming of algorithms. Minimum and maximum search in arrays. The second largest element of a numerical array.

11th week

Efficient programming of algorithms. Sorting arrays into ascending and descending order. Insertion into sorted arrays, merging sorted arrays.

12th week

Bit level programming: Reading out and setting the value of a bit. Construction of mascs with bit level operations.

13th week

User defined functions in C. Definition and declaration of functions. Function call. Functions and procedures.

14th week

End-term test. Processing one- and two-dimensional arrays with functions. Bit level operations with functions.

Requirements:

- for a term grade

Attendance of practical classes is mandatory. Three classes can be missed during the semester.

During the semester two tests are written: the mid-term test in the 7th week and the end-term test in the 14th week. Students' participation at the tests is mandatory.

The minimum requirement for the mid-term and end-term tests is 60%. Based on the total score of the two tests, the grade is determined according to the following scheme:

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 get a retake opportunity according to the EDUCATION AND EXAMINATION RULES AND REGULATIONS of the university.

Person responsible for course: Prof. Dr. Kun Ferenc, full professor, PhD

Lecturer: Prof. Dr. Kun Ferenc, full professor, PhD

Title of course: Programming 2. **Code**: TTFBE1202	**ECTS Credit points:** 3

Type of teaching, contact hours
- lecture: 1 hours/week
- practice: 2 hours/week
- laboratory: -

Evaluation: term grade

Workload (estimated), divided into contact hours:
- lecture: 14 hours
- practice: 28 hours
- laboratory: -
- home assignment: 28 hours
- preparation for the exam: 20 hours

Total: 90 hours

Year, semester: 1st year, 2nd semester

Its prerequisite(s): TTFBE1201 Programming 1

Further courses built on it: -

Topics of course

Memory treatment, memory address of a variable, the pointer data type. Pointer arrays and function pointers. Passing parameters to functions by value and by memory address. The process of function execution. Advanced data structure in C. User defined data structures. Pointers in structures, forward and backward linked lists. Strings, functions of the string.h header file. The process of program compilation, the pre-compiler. Pre-compiler directives. Inserting files into C programs, the structure of header files, the include directive. User defined header files. Directives of conditional compilation, efficient program structuring with the directives of conditional compilation. Developing programs of multiple files. In-line function, function overloading and generalized functions. Basic principles of object oriented program development. Class and object and their implementation. Constructors and destructors. Using objects in C++ programs.

Literature

Compulsory:
- B. W. Kernigan and D. M. Ritchie, The C programming language (Prentice Hall, 2007).
- J. R. Hanly and E. B. Koffmann, Problem Solving and Program Design in C (7th Edition), (Pearson Education Inc. 2004).
- Bjarne Stroustup, The C++ programming language (Pearson Education Inc. 2013).

Recommended:
- P. van der Linden, Expert C Programming: Deep C Secrets, (SunSoft Press, 1994).

Schedule:

1st week

Memory treatment, memory address of a variable, the pointer data type, declaration and initialization.

2nd week

Equivalence of pointers and arrays, operations with pointers, incrementation and decrementation. Pointers and arrays. FILE pointer and file buffer.

3rd week

Pointers and functions. Passing parameters to functions by value and by address, the logic of function execution. Local and global variables. Processing arrays in functions. Pointer as return type of a function. Pointer pointing to a pointer. Function pointers.

4th week

Complex data structures: declaration and definition of structures, structure template. Data members. Representation of structures in the memory. Structures for complex numbers and vectors in two and three dimensions. Structures with structure data members. Operations with structures, initialization and equality.

5th week

Structures and functions: passing structures to functions, structure as a return type of a function. Functions for operations with structures of complex numbers and vectors.

6th week

Dynamic memory allocation. Function of stdlib.h header file for dynamic memory treatment: malloc, calloc, realloc, and free functions in practice.

7th week

Mid-term test. Pointers and structures. Processing structure arrays with pointers, the arrow operator. Complex data structures including pointers, linked lists: forward and backward lists. Inserting an element into a list, deleting a list element. Efficient processing of lists.

8th week

Strings in C. Declaration and initialization of strings. Processing strings with pointers. Functions of the string.h header file.

9th week

The process of program compilation, the pre-compiler. Pre-compiler directives and their execution. Symbolic constants and their applications in C programs, the define directive. Inserting files into C programs, the structure of header files, the include directive.

10th week

Directives of conditional compilation, efficient program structuring with the directives of conditional compilation. User defined header files. Developing programs of multiple files, compilation with the make command.

11th week

Function-like macros. Comparison of macros and functions. Function overloading. Generalized functions, function template and its efficient usage.

12th week

The methodology of function- and object-oriented program development. Principles of object oriented programming. Classes and objects. Basics of C++ programming.

13th week

Classes and object, data members and member functions. Data hiding, controlling the access to data members and to member functions. Constructors and destructors.

14th week

End-term test. Implementation of classes, implementation of member functions in header files. Developing object oriented programs, using objects, data members and member function in C++ programs.

Requirements:
- for a term grade
Attendance of practical classes is mandatory. Three classes can be missed during the semester. The attendance of lectures is recommended but not compulsory.

During the semester two tests are written: the mid-term test in the 7th week and the end-term test in the 14th week. Students' participation at the tests is mandatory.

The minimum requirement for the mid-term and end-term tests is 60%. Based on the total score of the two tests, the grade is determined according to the following scheme:

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 get a retake opportunity according to the EDUCATION AND EXAMINATION RULES AND REGULATIONS of the university.

Person responsible for course: Prof. Dr. Kun Ferenc, full professor, PhD

Lecturer: Prof. Dr. Kun Ferenc, full professor, PhD

Title of course: Introduction to measurements and instrumentation **Code**: TTFBE1203-E-EN, TTFBE1203-GY-EN	**ECTS Credit points:** 2

Type of teaching, contact hours

- lecture: 1 hours/week
- practice: 0 hours/week
- laboratory:2 hours/week-

Evaluation: practical mark

Workload (estimated), divided into contact hours:

- lecture: 14 hours
- practice: 0 hours
- laboratory:28 hours-
- home assignment: 6 hours
- preparation for the exam: 12 hours

Total: 60 hours

Year, semester: 1st year, 2nd semester

Its prerequisite(s):

Further courses built on it: -

Topics of course

The aim of the subject is to learn the basic principles of electrical measurements and usage of digital multimeters and oscilloscopes. To get to know about the uncertainty of the measurement, fundamental knowledge about errors. Determination of the error of the measurement from the manual of the DMM or from evaluation of measured data. Firm knowledge and also practical skill about how to measure electrical quantities with DMM (voltage, current, resistance, inductivity, capacity, power), how to characterize AC signals by using oscilloscope. Creating simple serial and parallel circuits for the measurements.

Literature

Compulsory:

- Electrical measurement, Signal Processing and Displays (selected chapters only), CRC press, 2004, edited by John G. Webster, ISBN: 0-8493-1733-9

Recommended:

- S Tumanski. Principles of electrical measurement, CRC press (Taylor and Francis), 2006, ISBN: 0-7503-1038-927-4

Schedule:

1st week

Measurement, uncertanity, SI units; measuring R with DMM

2nd week

Relative and absolute error, classification of the errors. Importance of choosing the proper range for the measurement. Meauring V with DMM

3rd week

Accuracy, resolution of a DMM. Measuring I with DMM

4th week

How multimeter is working? Verifying Ohm’s law.

5th week

AC signal, basics of oscilloscope measurement. Measuring with oscilloscope

6th week

test 1, practical 1

7th week

Power supplies and signal generators (CC, CV mode), Function generator.

8th week

Extending the range of the Volt or Ammeter. Measuring with oscilloscope (amplitude, time period).

9th week

Mean values for AC signals. Measuring with oscilloscope (Phase shift and time shift, X-Y mode)

10th week

Methods for measuring resistance. Measuring resistance with different methods.

11th week

Measuring capacity and inductivity. Using LCR meter.

12th week

Basics of power and energy measurement. Measuring power with DMM

13th week

test 2 practical 2

14th week

Revision

Requirements:

- for a signature

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

Participation at **practice classes at the lab** 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 (practically at the last week), to be 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 an absence because of the lack of active participation in class.

Students have to **submit all the two tasks both practical and theoretical** as scheduled minimum on a sufficient level.

During the semester there are two weeks for doing the tasks: the mid-term test in the 6th week and the end-term test in the 13th week. Students have to sit for the tasks.

- for a grade

The course ends with a **practical mark**. Result is based on the average of the grades of the tasks (two practical and two theoretical), the final grade is calculated as an average of them:

The minimum requirement for the mid-term and end-term tests and practical tasks respectively is about 60%. Based on the score of these tasks separately, the grade for them is given according to the following table:

Score	Grade
0-13	fail (1)
14-16	pass (2)
17-19	satisfactory (3)
20-22	good (4)
23-25	excellent (5)

If the score of any task is below 14, students can take a retake the task in oral form and in conformity with the EDUCATION AND EXAMINATION RULES AND REGULATIONS.

Person responsible for course: Dr. Sándor Egri, assistant professor, PhD.

Lecturer: Dr. Sándor Egri, assistant professor, PhD

Title of course: Introduction to LabVIEW programming **Code**: TTFBL1213	**ECTS Credit points:** 2

Type of teaching, contact hours

- lecture: -
- practice: -
- laboratory: 2 hours/week

Evaluation: practical grade

Workload (estimated), divided into contact hours:

- lecture: -
- practice: -
- laboratory: 28 hours
- home assignment: 32 hours
- preparation for the exam: -

Total: 60 hours

Year, semester: 2nd year, 1st semester

Its prerequisite(s): TFBE1203 Introduction to programming, TFBE1202 Introduction to measurement technology

Further courses built on it: TFBE1204 Measurement and Instrumentation

Topics of course

Introduction to the Graphic Programming and dataflow concepts. Understanding the user interface: front panel, block diagram, toolbars, libraries, help system. Key Concepts: controls and indicators, vi and sub-vi. programming structures: event sequence, cycle, conditional structures, formula nodes. Data Structures: Data Types, Arrays,. strings, clusters, and operations. Basic Tasks: Signal Generation, Analysis and display: signal processing package and graph types, file operations

Literature

Compulsory:

- *digitally available materials on moodle*

Recommended:

- LabVIEW core 1. National Instruments
- LabVIEW core 2. National Instruments.
- Teaching notes and courses available on the National Instruments website based on the academic site licence.

Schedule:

1st week

Introduction of the dataflow based graphical programing paradigm. Develop LabView programs under the supervision of a LabVIEW architect engineer.

2nd week

Getting familiar with the development environment. Creating an application. Debugging and correcting a program.

3rd week

Program development steps. Creating an application. Debugging and correcting a program

4th week

Implementation of cyclic program flow control in LabView. Using loops: while loop, for loop, data trough channels, timing.

5th week

Advanced data types in LabVIEW. Data structures: Creating and using array and cluster datatypes. Error cluster.

6th week

Controlling code execution. Decision making structures Conditional code execution. Enumerated data types. Error handling

7th week

Developing modular programs. Modularity. Building subVi's. Connector and icon plane

8th week

Measurement configuration and data collection. Aquiring measurements from hardware. The NiMAX utility. DaqmX functions.

9th week

Storing measurement data. Accessing files. File formats, file i/o functions. The TDMS format.

10th week

Creating responsive well structured programs. Design patterns. Sequential and state machine programming. Event handling.

11th week

Parallel programming in LabVIEW . Communicating data between parallel loops. Application of Queus and notifiers.

12th week

Implementing well structured dataflow programs. Implementing design patterns: producer/consumer design pattern

13th week

Object oriented access of LabVIEW components. Controlling the user interface. Vi server architecture. Property nodes, invoke nodes. Typed data structures. Global variables

14th week

Test based practice of LabVIEW knowledge. Requirements of the CLAD exam. Preparation for the exam.

Requirements:

- *for a signature*

Attendance at **laboratory practices** is compulsory.

- *for a grade*

- Evaluation of Practice Preparation and Submitted programs

- Test questions results based on the level of a CLAD exam

The minimum requirement for the grade is 60%. Based on the score of the tests separately, the grade is given according to the following table:

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 they pass the official CLAD exam

Person responsible for course: Dr. István Szabó
Lecturer: Dr. István Szabó

Title of course: Measurements and Instrumentation **Code**: TTFBE1204	**ECTS Credit points:** 5

Type of teaching, contact hours
- lecture: 2 hours/week
- practice: -
- laboratory: 2 hours/week

Evaluation: exam

Workload (estimated), divided into contact hours:
- lecture: 28 hours
- practice: -
- laboratory: 28 hours
- home assignment: 66 hours
- preparation for the exam: 28 hours

Total: 150 hours

Year, semester: 2nd year, 2nd semester

Its prerequisite(s): TTMBE0812 Mathematics 3. and TTFBL1223 Introduction to LabVIEW Programming

Further courses built on it:

Topics of course

Power and energy measurements; determination of impedances; time and frequency measurements; sources and loads; signal analyzers; calibration of the instruments. Computer controlled measurements; unified connection systems; data transfer modes between the computers and measuring equipment, communication procedures; programming languages, programming tools.

Literature

Compulsory:

U.A. Bakshi, A.V. Bakshi: Electronics Measurements And Instrumentation. Technical Publications, 2009.

Recommended:

Alan S Morris, Reza Langari: Measurement and Instrumentation.

Schedule (lecture):

1st week

Static characteristic.

2nd week

Electrodynamometer.

3rd week

Bridge Measurements. DC

4th week

Measurement of High Resistance.

5th week

Bridge Measurements. AC

6th week

Electronic Voltmeters, Ampermeters.

7th week

Mid-term test. Power measurement.

8th week

Frequency measurement, period measurement.

9th week

Signal generators, Function generators.

10th week

Digital to Analog Converter.

11th week

Analog to Digital Converter

12th week

Faults, protection tasks and principles. Protections.

13th week

Measurement by using PicoScope.

14th week

End-term test.

Schedule (laboratory):

1st week

Static characteristic. Examples.

2nd week

Electrodynamometer. Practice.

3rd week

Bridge Measurements. DC. Practice.

4th week

Measurement of High Resistance. Practice.

5th week

Bridge Measurements. AC. Practice.

6th week

Electronic Voltmeters, Ampermeters: measurement, practice. Practice.

7th week

Mid-term test. Power measurement. Practice.

8th week

Frequency measurement, period measurement. Practice. *9th week* Signal generators, Function generators. Practice *10th week* Digital to Analog Converter. Practice. *11th week* Analog to Digital Converter. Practice. *12th week* Faults, protection tasks and principles. Protections. *13th week* Measurement by using PicoScope. Practice. *14th week* **End-term test.**
Requirements: *- for a signature* Attendance at **lectures** is recommended, but not compulsory. Condition for sign obtaining is a successful (at least passed grade) write of two tests according to semester assessment timing. During the semester there are two tests: the mid-term test in the 7th week and the end-term test in the 14th week. Students' participation on the tests is mandatory. *- for a grade* The course ends in an **examination**. Sign receipt is a precondition for exam eligibility. Results of two tests are counted in the final grade by 60% weight. *-an offered grade:* It may be offered for students if the grades of the mid-term and end-term tests are at least satisfactory (3) for each one. The offered grade is the average of them.
Person responsible for course: Dr. Janos Arpad Kosa, assistant professor, PhD
Lecturer: Dr. Janos Arpad Kosa, assistant professor, PhD

Title of course: Electricity 1. **Code**: TTFBE1205	**ECTS Credit points:** 2

Type of teaching, contact hours

- lecture: 2 hours/week
- practice: -
- laboratory: -

Evaluation: exam

Workload (estimated), divided into contact hours:

- lecture: 28 hours
- practice: -
- laboratory: -
- home assignment: -
- preparation for the exam: 30 hours

Total: 58 hours

Year, semester: 1st year, 1st semester

Its prerequisite(s): -

Further courses built on it: Introduction to Measurements and Instrumentation (TTFBE1203), Electricity 2 (TTFBE1206, TTFBG1206), Electronics 1 (TTFBE1208)

Topics of course

Simple DC circuits: basic notions, basic circiut elements, Ohm's law, resistance, resistivity, electric power, passive and active two-poles, basic connections of passive two-poles, ideal and non-ideal active two-poles, transformation of generators, ideal and non-ideal measuring instruments.
Complex DC circuits: basic structural elements, transformation between wye-delta and delta-wye connections, bridge connection, Kirchhoff's laws, mesh analysis nodal analysis, linear superposition, Thevenin's, Norton's and Millmann's theorem, principle of compensation, reciprocal circuits.

Literature

Compulsory:

Charles K. Alexander, Matthew N.O. Sadiku – Fundamentals of Electric Circuits, The McGraw-Hill Companies, New York, 2009, ISBN 978–0–07–352955–4

Recommended:

Schedule:

1st week

Simple circuits, Ohm's law, electric power, passsive and active two-poles

2nd week

Analogies and equivalence of the models of active two-poles, measuring instruments

3rd week

Voltage and current dividers

4th week

Analysis of complex circuits: Kirchhoff's laws

5th week

Analysis of complex circuits: mesh analysis

6th week

Analysis of complex circuits: nodal analysis

7th week

Test

8th week

Delta-wye and wye-delta transformation

9th week

Bridge connection and its applications

10th week

The principle of linear superposition, Thevenin's theorem

11th week

Norton's theorem, Millmann's theorem

12th week

The principle of voltage and current compensation

13th week

Reciprocal circuits

14th week

Test

Requirements:

The semester ends in a written examination. The test consists of 10 questions, for which students must give free-text answers. The total score of the test is 100, and the grades are determined by the following rating:

0-49 % – fail (1)

50-62 % – pass (2)

63-75 % – satisfactory (3)

76-88 % – good (4)

89-100 % – excellent (5)

It is possible to obtain an offered exam grade. For this purpose the students write two mid-term tests during the semester (7th and 14th week) that are qualified at the level of scores only. If the result of each test is minimum 50 % then the average of the two tests provides the offered exam grade according to the above marking. If one of the tests is under 50 % then it is not possible to gain an exam grade, and the student must take the exam in the exam period.

Person responsible for course: Dr. Réka Trencsényi, assistant professor

Lecturer: Dr. Réka Trencsényi, assistant professor

Title of course: Electricity 1. **Code**: TTFBG1205	**ECTS Credit points:** 3
Type of teaching, contact hours - lecture: - - practice: 2 hours/week - laboratory: -	
Evaluation: practical grade	
Workload (estimated), divided into contact hours: - lecture: - - practice: 28 hours - laboratory: - - home assignment: 42 hours - preparation for the exam: - Total: 70 hours	
Year, semester: 1st year, 1st semester	
Its prerequisite(s): -	
Further courses built on it: Introduction to Measurements and Instrumentation (TTFBE1203), Electricity 2 (TTFBE1206, TTFBG1206), Electronics 1 (TTFBE1208)	

Topics of course

Simple DC circuits: basic notions, basic circiut elements, Ohm's law, resistance, resistivity, electric power, passive and active two-poles, basic connections of passive two-poles, ideal and non-ideal active two-poles, transformation of generators, ideal and non-ideal measuring instruments.
Complex DC circuits: basic structural elements, transformation between wye-delta and delta-wye connections, bridge connection, Kirchhoff's laws, mesh analysis nodal analysis, linear superposition, Thevenin's, Norton's and Millmann's theorem, principle of compensation, reciprocal circuits.

Literature

Compulsory:
Charles K. Alexander, Matthew N.O. Sadiku – Fundamentals of Electric Circuits, The McGraw-Hill Companies, New York, 2009, ISBN 978–0–07–352955–4

Recommended:

Schedule:

1st week
Simple circuits, Ohm's law, electric power, passive and active two-poles
2nd week
Analogies and equivalence of the models of active two-poles, measuring instruments
3rd week
Voltage and current dividers
4th week
Analysis of complex circuits: Kirchhoff's laws
5th week
Analysis of complex circuits: mesh analysis
6th week
Analysis of complex circuits: nodal analysis
7th week

Test

8th week

Delta-wye and wye-delta transformation

9th week

Bridge connection and its applications

10th week

The principle of linear superposition, Thevenin's theorem

11th week

Norton's theorem, Millmann's theorem

12th week

The principle of voltage and current compensation

13th week

Reciprocal circuits

14th week

Test

Requirements:

At the end of the semester the students obtain a practical grade, which is formed based on the average of two mid-term tests (7th and 14th week). Each test contains 2-3 calculational problems, and the total score of each test is 100. The practical grades are determined by the following rating:

0-49 % – fail (1)

50-62 % – pass (2)

63-75 % – satisfactory (3)

76-88 % – good (4)

89-100 % – excellent (5)

To acquire a valid practical grade, the students must reach at least 50 % of each mid-term test. In case of unsuccessful tests improvement possibility is ensured in the exam period.

Person responsible for course: Dr. Réka Trencsényi, assistant professor

Lecturer: Dr. Réka Trencsényi, assistant professor

Title of course: Electricity 2. **Code**: TTFBE1206	**ECTS Credit points:** 3
Type of teaching, contact hours - lecture: 3 hours/week - practice: - - laboratory: -	
Evaluation: exam	
Workload (estimated), divided into contact hours: - lecture: 42 hours - practice: - - laboratory: - - home assignment: - - preparation for the exam: 40 hours Total: 82 hours	
Year, semester: 1st year, 2nd semester	
Its prerequisite(s): Electricity 1 (TTFBE1205, TTFBG1205)	
Further courses built on it: Electricity 3 (TTFBE1207, TTFBG1207), Electronics 2 (TTFBE1209, TTFBG1209)	

Topics of course

Transient phenomena in RL and RC circuits. AC circuits, description of sinusoidal and triangle signals, calculation of linear and quadratic means. Summation of alternating quantities by means of mathematical and phasor method. Investigation of elementary AC circuits (resistive, capacitive, inductive). Serial and parallel RLC circuits, RLC resonances. Passive filters (low-pass, high-pass, band-pass, band-stop filters). Complex calculational method, analysis of complex circuits. Three-phase circuits. Active and passive four-poles, characteristics of four-poles. Description of magnetic field, magnetic flux, Ampere's law, Faraday's law. Magnetic circuits, reluctance, magnetic Ohm's law. Transformers.

Literature

Compulsory:

Charles K. Alexander, Matthew N.O. Sadiku – Fundamentals of Electric Circuits, The McGraw-Hill Companies, New York, 2009, ISBN 978–0–07–352955–4

Recommended:

Schedule:

1st week

Transient phenomena in RL and RC circuits

2nd week

AC circuits, sinusoidal and triangle signals, linear and quadratic means

3rd week

Summation of alternating quantities

4th week

Elementary AC circuits

5th week

Serial and parallel RLC circuits, resonances

6th week

Passive filters

7th week

Test

8th week

Complex calculational method, analysis of complex circuits

9th week

Three-phase circuits

10th week

Active and passive four-poles, characteristics of four-poles

11th week

Description of magnetic field, magnetic flux, Ampere's law, Faraday's law

12th week

Magnetic circuits, reluctance, magnetic Ohm's law

13th week

Transformers

14th week

Test

Requirements:

The semester ends in a written examination. The test consists of 10 questions, for which students must give free-text answers. The total score of the test is 100, and the grades are determined by the following rating:

0-49 % – fail (1)

50-62 % – pass (2)

63-75 % – satisfactory (3)

76-88 % – good (4)

89-100 % – excellent (5)

It is possible to obtain an offered exam grade. For this purpose the students write two mid-term tests during the semester (7th and 14th week) that are qualified at the level of scores only. If the result of each test is minimum 50 % then the average of the two tests provides the offered exam grade according to the above marking. If one of the tests is under 50 % then it is not possible to gain an exam grade, and the student must take the exam in the exam period.

Person responsible for course: Dr. Réka Trencsényi, assistant professor

Lecturer: Dr. Réka Trencsényi, assistant professor

Title of course: Electricity 2. **Code**: TTFBG1206	**ECTS Credit points:** 3

Type of teaching, contact hours
- lecture: -
- practice: 2 hours/week
- laboratory: -

Evaluation: practical grade

Workload (estimated), divided into contact hours:
- lecture: -
- practice: 28 hours
- laboratory: -
- home assignment: 42 hours
- preparation for the exam: -

Total: 70 hours

Year, semester: 1st year, 2nd semester

Its prerequisite(s): Electricity 1 (TTFBE1205, TTFBG1205)

Further courses built on it: Electricity 3 (TTFBE1207, TTFBG1207), Electronics 2 (TTFBE1209, TTFBG1209)

Topics of course

Transient phenomena in RL and RC circuits. AC circuits, description of sinusoidal and triangle signals, calculation of linear and quadratic means. Summation of alternating quantities by means of mathematical and phasor method. Investigation of elementary AC circuits (resistive, capacitive, inductive). Serial and parallel RLC circuits, RLC resonances. Passive filters (low-pass, high-pass, band-pass, band-stop filters). Complex calculational method, analysis of complex circuits. Three-phase circuits. Active and passive four-poles, characteristics of four-poles. Description of magnetic field, magnetic flux, Ampere's law, Faraday's law. Magnetic circuits, reluctance, magnetic Ohm's law. Transformers.

Literature

Compulsory:

Charles K. Alexander, Matthew N.O. Sadiku – Fundamentals of Electric Circuits, The McGraw-Hill Companies, New York, 2009, ISBN 978–0–07–352955–4

Recommended:

Schedule:

1st week

Transient phenomena in RL and RC circuits

2nd week

AC circuits, sinusoidal and triangle signals, linear and quadratic means

3rd week

Summation of alternating quantities

4th week

Elementary AC circuits

5th week

Serial and parallel RLC circuits, resonances

6th week

Passive filters *7th week* Test *8th week* Complex calculational method, analysis of complex circuits *9th week* Three-phase circuits *10th week* Active and passive four-poles, characteristics of four-poles *11th week* Description of magnetic field, magnetic flux, Ampere's law, Faraday's law *12th week* Magnetic circuits, reluctance, magnetic Ohm's law *13th week* Transformers *14th week* *Test*
Requirements: At the end of the semester the students obtain a practical grade, which is formed based on the average of two mid-term tests (7th and 14th week). Each test contains 2-3 calculational problems, and the total score of each test is 100. The practical grades are determined by the following rating: 0-49 % – fail (1) 50-62 % – pass (2) 63-75 % – satisfactory (3) 76-88 % – good (4) 89-100 % – excellent (5) To acquire a valid practical grade, the students must reach at least 50 % of each mid-term test. In case of unsuccessful tests improvement possibility is ensured in the exam period.
Person responsible for course: Dr. Réka Trencsényi, assistant professor
Lecturer: Dr. Réka Trencsényi, assistant professor

Title of course: Electricity 3. **Code**: TTFBE1207	**ECTS Credit points:** 2
Type of teaching, contact hours - lecture: 2 hours/week - practice: - - laboratory: -	
Evaluation: exam	
Workload (estimated), divided into contact hours: - lecture: 28 hours - practice: - - laboratory: - - home assignment: - - preparation for the exam: 30 hours Total: 58 hours	
Year, semester: 2nd year, 1st semester	
Its prerequisite(s): Electricity 2 .(TTFBE1206, TTFBG1206), Mathematics 2 (TTMBE0811, TTMBG0811)	
Further courses built on it: Basics of Circuit Simulation and Design (TTFBL1217), Electric Power Systems (TTFBE1216, TTFBG1216)	

Topics of course
Classification of signals and systems. Analysis of discrete and continuous time systems in the time domain. Analysis of discrete and continuous time signals in the frequency domain. Fourier and inverse Fourier transformation. Laplace and inverse Laplace transformation. Sample systems. Description of electromagnetic fields, Maxwell's equations. Interaction between electromagnetic field and medium. Transmission lines, telegraph equations. Special transmission lines, closing and fitting of transmission lines. Creation of electromagnetic waves. Propagation of electromagnetic waves.
Literature
Compulsory: Charles K. Alexander, Matthew N.O. Sadiku – Fundamentals of Electric Circuits, The McGraw-Hill Companies, New York, 2009, ISBN 978–0–07–352955–4 *Recommended:*

Schedule:

1st week

Classifiation of signals and systems

2nd week

Analysis of discrete and continuous time systems in the time domain

3rd week

Analysis of discrete and continuous time signals in the frequency domain

4th week

Fourier and inverse Fourier transformation

5th week

Laplace and inverse Laplace transformation

6th week

Sample systems

7th week

Test

8th week

Description of electromagnetic fields, Maxwell's equations

9th week

Interaction between electromagnetic field and medium

10th week

Transmission lines, telegraph equations

11th week

Special transmission lines, closing and fitting of transmission lines

12th week

Creation of electromagnetic waves

13th week

Propagation of electromagnetic waves

14th week

Test

Requirements:

The semester ends in a written examination. The test consists of 10 questions, for which students must give free-text answers. The total score of the test is 100, and the grades are determined by the following rating:

0-49 % – fail (1)

50-62 % – pass (2)

63-75 % – satisfactory (3)

76-88 % – good (4)

89-100 % – excellent (5)

It is possible to obtain an offered exam grade. For this purpose the students write two mid-term tests during the semester (7th and 14th week) that are qualified at the level of scores only. If the result of each test is minimum 50 % then the average of the two tests provides the offered exam grade according to the above marking. If one of the tests is under 50 % then it is not possible to gain an exam grade, and the student must take the exam in the exam period.

Person responsible for course: Dr. Réka Trencsényi, assistant professor

Lecturer: Dr. Réka Trencsényi, assistant professor

Title of course: Electricity 3. **Code**: TTFBG1217	**ECTS Credit points:** 1
Type of teaching, contact hours - lecture: 1 hour/week - practice: - - laboratory: -	
Evaluation: practical grade	
Workload (estimated), divided into contact hours: - lecture: - - practice: 14 hours - laboratory: - - home assignment: - - preparation for the exam: 42 hours Total: 56 hours	
Year, semester: 2nd year, 1st semester	
Its prerequisite(s): Electricity 2 (TTFBE1206, TTFBG1206), Mathematics 2 (TTMBE0811, TTMBG0811)	
Further courses built on it: Basics of Circuit Simulation and Design (TTFBL1217), Electric Power Systems (TTFBE1216, TTFBG1216)	

Topics of course

Classification of signals and systems. Analysis of discrete and continuous time systems in the time domain. Analysis of discrete and continuous time signals in the frequency domain. Fourier and inverse Fourier transformation. Laplace and inverse Laplace transformation. Sample systems. Description of electromagnetic fields, Maxwell's equations. Interaction between electromagnetic field and medium. Transmission lines, telegraph equations. Special transmission lines, closing and fitting of transmission lines. Creation of electromagnetic waves. Propagation of electromagnetic waves.

Literature

Compulsory:

Charles K. Alexander, Matthew N.O. Sadiku – Fundamentals of Electric Circuits, The McGraw-Hill Companies, New York, 2009, ISBN 978–0–07–352955–4

Recommended:

Schedule:

1st week

Classification of signals and systems

2nd week

Analysis of discrete and continuous time systems in the time domain

3rd week

Analysis of discrete and continuous time signals in the frequency domain

4th week

Fourier and inverse Fourier transformation

5th week

Laplace and inverse Laplace transformation

6th week

Sample systems *7^{th} week* Test *8^{th} week* Description of electromagnetic fields, Maxwell's equations *9^{th} week* Interaction between electromagnetic field and medium *10^{th} week* Transmission lines, telegraph equations *11^{th} week* Special transmission lines, closing and fitting of transmission lines *12^{th} week* Creation of electromagnetic waves *13^{th} week* Propagation of electromagnetic waves *14^{th} week* Test
Requirements: At the end of the semester the students obtain a practical grade, which is formed based on the average of two mid-term tests (7^{th} and 14^{th} week). Each test contains 2-3 calculational problems, and the total score of each test is 100. The practical grades are determined by the following rating: 0-49 % – fail (1) 50-62 % – pass (2) 63-75 % – satisfactory (3) 76-88 % – good (4) 89-100 % – excellent (5) To acquire a valid practical grade, the students must reach at least 50 % of each mid-term test. In case of unsuccessful tests improvement possibility is ensured in the exam period.
Person responsible for course: Dr. Réka Trencsényi, assistant professor
Lecturer: Dr. Réka Trencsényi, assistant professor

Title of course: Electronics 1. **Code**: **TTFBE1208**-EN	**ECTS Credit points:** 3

Type of teaching, contact hours
- lecture: 2 hours/week

Evaluation: exam

Workload (estimated), divided into contact hours:
- lecture: 28 hours
- practice: 0 hours
- laboratory: 0 hours
- home assignment: 28 hours
- preparation for the exam: 24

Total: 80 hours

Year, semester: 1st year, 2nd semester

Its prerequisite(s): Physics 1 TTFBE1101 ; Electricity 1 TTFBE1205

Further courses built on it: Electronics 2. TTFBE-1209, TTFBG1209

Topics of course

Lecture: Functions of electronic circuits. Electronic systems. Signals in electronic circuits and networks. General introduction to characterisation of linear amplifiers. The ideal model of operational amplifiers. Basics of inverting and noninverting amplifiers. Using operational amplifiers and their typical applications. Special applications of operational amplifiers: Basics of difference amplifiers, instrumentation amplifiers and their applications. Circuit models and types of semiconductor diodes. Simple applications of diodes. Physical operation of semiconductors 1.: PN diodes. (Phenomenological description). Datasheets of diodes. Physical operation of semiconductors 2.: Bipolar transistors. Models and characteristics of bipolar junction transistors; important parameters. Datasheets of BJTs. Basics of switch mode operation of BJTs. Models in switch operating mode. Simulation models of BJTs. Physical operation of semiconductors 3.: MOSFETs. Models, characteristics, parameters and applications. Power MOSFETs. MOSFET inverters. Datasheets of MOSFETs. Physical operation of semiconductors 4.: JFETs. Operation, characteristics, models, parameters. Comparison of transistor types.

Literature

Compulsory:
- Course materials

Recommended:
- S. Sedra and Kenneth C. Smith, Microelectronic circuit, 7th edition, Oxford University Press.

Schedule:

1st week

Summary of preliminary knowledge base: two port devices, two port networks, ideal and real generators, voltmeters and current meters. The most important network theorems.

2nd week

Functions of electrical circuit. Electrical systems.

3rd week

Signals in electrical circuits, networks. General introduction to characterisation of linear amplifiers.

4th week

The ideal model of operational amplifiers. Basics of inverting and noninverting amplifiers using operational amplifiers, and their most important applications.

5th week

Special applications of operational amplifiers: Basics of difference amplifiers, instrumentation amplifiers and their applications.

6th week

Circuit models and types of semiconductor diodes. Simple applications of diodes.

7th week

Physical operation of semiconductors 1.: PN diodes. (Phenomenological description). Datasheets of diodes.

8th week

Physical operation of semiconductors 2.: Bipolar transistors.

9th week

Models and characteristics of bipolar junction transistors. The most important parameters. Datasheets of BJTs.

10th week

Basics of switch mode operation of BJTs. Models in switch operating mode. Simulation models of BJTs.

11th week

Physical operation of semiconductors 3.: MOSFETs. Models, characteristics, parameters and applications.

12th week

Power MOSFETs. MOSFET inverters. Datasheets of MOSFETs.

13th week

Physical operation of semiconductors 4.: JFETs. Operation, characteristics, models, parameters.

14th week

Summary; comparison of transistor types.

Requirements:

- for a practice grade

- Signature requires writing the script tests with results of at least 50%.
  The correct solution of at least 50% of homework assignments.
- Knowledge of physical operation of devices: grade 2;
- In addition, knowledge of models of devices: grade 3;
- In addition, knowledge of application of models for basic calculations: grade 4;
- In addition, knowledge of applications of devices: grade 5.

If the score of any test is below 50, students can take a retake test in conformity with the EDUCATION AND EXAMINATION RULES AND REGULATIONS.

-an offered grade: --

Person responsible for course: Gyula Zilizi PhD, associate professor

Lecturer: Lajos Harasztosi engineer-lecturer

Title of course: Electronics 2. **Code**: **TTFBE1209**-EN	**ECTS Credit points:** 3

Type of teaching, contact hours

- Lecture: 3 hours/week

Evaluation: exam

Workload (estimated), divided into contact hours:

- lecture: 42
- practice: -
- laboratory: -
- home assignment: 20 hours
- preparation for the exam: 28 hours

Total: 90 hours

Year, semester: 2nd year, 1st semester

Its prerequisite(s): Electronics 1. TTFBE1208

Further courses built on it: Electronics 3., TTFBL1230-EN

Topics of course

Single stage amplifiers using discrete bipolar junction transistors and theire characteristics. Single stage amplifiers using FETs and theire characteristics. Simulation of the discret type amplifiers. Theory of feedback. The effects of feedback on amplifier characteristics. Negative feedback at operational amplifiers and single stage transistor amplifiers. Circuit basics of operation of logic gates. Logic gates families. Circuits of CMOS logics. Level shifters. Characteristics of real operational amplifiers. Effects of nonidealities on the inverting and noninverting amplifier stages. Circuitry of the operational amplifiers. Multistage amplifiers using transistors. Stability of feedback of multistage amplifiers. Frequency compensation of feedbacked amplifiers. Simulation models of operational amplifiers. Basic simulation on operational amplifiers. Output stages of linear amplifiers. Power amplifiers. Integrated power amplifiers. Cooling power semiconductor devices. Functional operational amplifier circuits I. Integrating differentiating circuits. Precision rectifiers. Functional operational amplifier circuits II. Comparators, limiters, log and exp amplifiers. Positive feedback. Oscillator and multivibrator circuits. Passive (R, L, C) circuit elements. Active filters. Linear power supplies. Stabilised power sources. Voltage reference circuits.

Literature

Compulsory: Course materials

Recommended:

S. Sedra and Kenneth C. Smith, Microelectronic circuit, 7th edition, Oxford University Press.

Schedule:

1st week

Single stage amplifiers using discrete bipolar junction transistors and their characteristics.

2nd week

Single stage amplifiers using FETs and their characteristics.

3rd week

Simulation of discrete type amplifiers.

4th week

Theory of feedback. The effects of feedback on amplifier characteristics. Negative feedback at operational amplifiers and single stage transistor amplifiers.

5th week

Circuit basics of operation of logic gates. Logic gates families. Circuits of CMOS logics. Level shifters.

6th week

Characteristics of real operational amplifiers. Effects of nonidealities on the inverting and noninverting amplifier stages. Circuitry of the operational amplifiers.

7th week

Multistage amplifiers using transistors. Stability of feedback of multistage amplifiers. Frequency compensation of feedbacked amplifiers.

8th week

Simulation models of operational amplifiers. Basic simulation on operational amplifiers.

9th week

Output stages of linear amplifiers. Power amplifiers. Integrated power amplifiers. Cooling power semiconductor devices.

10th week

Functional operational amplifier circuits I. Integrating differentiating circuits. Precision rectifiers.

11th week

Functional operational amplifier circuits II. Comparators, limiters, log and exp amplifiers.

12th week

Positive feedback. Oscillator and multivibrator circuits.

13th week

Passive (R, L, C) circuit elements. Active filters.

14th week

Linear power supplies. Stabilised power sources. Voltage reference circuits.

Requirements:

- Signature requires writing the script tests with results of at least 50%.
  The correct solution of at least 50% of homework assignments.
- Knowledge of basic operation of circuits: grade 2;
- In addition, knowledge of basic manually made calculations: grade 3;
- In addition, knowledge of more detailed calculation: grade 4;
- In addition, knowledge of applications of circuits: grade 5.

- No offered grade

Person responsible for course: Dr. Gyula Zilizi, associate professor, PhD

Lecturer: Harasztosi Lajos lecturer

Title of course: Electronics 2. **Code**: **TTFBG1209**-EN	**ECTS Credit points:** 3

Type of teaching, contact hours

- practice: 2 hours/week

Evaluation: exam

Workload (estimated), divided into contact hours:

- lecture: -
- practice: 28 hours
- laboratory: -
- home assignment: 28 hours
- preparation for the exam: -

Total: 56 hours

Year, semester: 2nd year, 1st semester

Its prerequisite(s): Electronics 1. TTFBE-1208

Further courses built on it: Electronics 3., TTFBL1230-EN

Topics of course

During the semester students will work with a computer simulation software. The topics covered are similar to the lecture:
Single stage amplifiers using discrete bipolar junction transistors and their characteristics. Single stage amplifiers using FETs and their characteristics. Simulation of the discrete type amplifiers. Theory of feedback. The effects of feedback on amplifier characteristics. Negative feedback at operational amplifiers and single stage transistor amplifiers. Circuit basics of operation of logic gates. Logic gates families. Circuits of CMOS logics. Level shifters. Characteristics of real operational amplifiers. Effects of nonidealities on the inverting and noninverting amplifier stages. Circuitry of the operational amplifiers. Multistage amplifiers using transistors. Stability of feedback of multistage amplifiers. Frequency compensation of feedbacked amplifiers. Simulation models of operational amplifiers. Basic simulation on operational amplifiers. Output stages of linear amplifiers. Power amplifiers. Integrated power amplifiers. Cooling power semiconductor devices. Functional operational amplifier circuits I. Integrating differentiating circuits. Precision rectifiers. Functional operational amplifier circuits II. Comparators, limiters, log and exp amplifiers. Positive feedback. Oscillator and multivibrator circuits. Passive (R, L, C) circuit elements. Active filters. Linear power supplies. Stabilised power sources. Voltage reference circuits.

Literature

Compulsory:

- Course materials

Recommended:

- S. Sedra and Kenneth C. Smith, Microelectronic circuit, 7th edition, Oxford University Press.

Schedule:

1st week

Simulating the operation of single stage amplifiers using discrete bipolar junction transistors.

2nd week

Simulating single stage amplifiers using FETs and their characteristics.

3rd week

Simulation of the discrete type amplifiers.

4th week

Calculating and simulating feedbacked amplifiers. Negative feedback at operational amplifiers and single stage transistor amplifiers.

5th week

Calculation and simulation of simple network to realise transfer functions using basic operational amplifier stages.

6th week

Characteristics of real operational amplifiers. Effects of nonidealities on the inverting and noninverting amplifier stages. Circuitry of the operational amplifiers.

7th week

Multistage amplifiers using transistors. Stability of feedback of multistage amplifiers. Frequency compensation of feedbacked amplifiers.

8th week

Simulation models of operational amplifiers. Basic simulation on operational amplifiers.

9th week

Output stages of linear amplifiers. Power amplifiers. Integrated power amplifiers. Cooling power semiconductor devices.

10th week

Functional operational amplifier circuits I. Integrating differentiating circuits. Precision rectifiers.

11th week

Functional operational amplifier circuits II. Comparators, limiters, log and exp amplifiers.

12th week

Positive feedback. Oscillator and multivibrator circuits.

13th week

Passive (R, L, C) circuit elements. Active filters.

14th week

Linear power supplies. Stabilised power sources. Voltage reference circuits.

Requirements:

- for a practice grade

- Correct solution of at least 50% of homework assignments.
  Knowledge of basic operation of circuits: Grade 2;
- Knowledge of basic calculations.
  Understanding different simulation types, working with them: Grade 3;
- Knowledge of more detailed calculations and simulations: Grade 4;
- Advanced simulations with parameter optimisation: Grade 5.

If the score of any test is below 50%, students can retake the test in conformity with the EDUCATION AND EXAMINATION RULES AND REGULATIONS.

- an offered grade: --

Person responsible for course: Dr. Gyula Zilizi, associate professor, PhD

Lecturer: Lajos Harasztosi, engineer-lecturer

Title of course: Electronics 3. **Code**: TTFBL1230-EN	**ECTS Credit points:** 3

Type of teaching, contact hours
- lecture: 2 hours/week, lab: 3 hours/week

Evaluation: exam

Workload (estimated), divided into contact hours:
- lecture: 28 hours
- practice: 0 hours
- laboratory: 42 hours
- home assignment: 28 hours
- preparation for the exam: 24

Total: 122 hours

Year, semester: 2nd year, 2nd semester

Its prerequisite(s): Electronics 2. TTFBE1209, TTFBG1209

Further courses built on it: -

Topics of course

Lecture: See at weekly description
Lab: Basic and intermediate level laboratory measurements

Literature

Compulsory:
- Course materials

Recommended:
- S. Sedra and Kenneth C. Smith, Microelectronic circuit, 7th edition, Oxford University Press.

Schedule:

1st week

Lecture: Nonlinear circuit function: multiplier, square-root, RMS measurements.
Lab: Introduction to use lab equipment.

2nd week

Lecture: AM, FM modulators, demodulators, mixers.
Lab: Semiconductor diodes and applications meas.

3rd week

Lecture: Electronics measurements and transmitter circuits.
Lab: Basic operational amplifier networks.

4th week

Lecture: Noises in electronical systems. Noise calculations.
Lab: Inverter network using BJT. CE amplifier using BJT.

5th week

Lecture: Nonideal amplifier characteristics. Nonlinearities, distortion.
Lab: Meas. of AC amplifier transfer characteristic.

6th week

Lecture: Powering electronic network. Grounding in electronics.
Lab: Test measurement 1.

7th week

Lecture: Circuit protection.
Lab: Summing operational amplifiers. Integrating and differentiating circuits.

8th week
Lecture: Analog switchers and their application.
Lab: Comparators and AC-DC circuits.

9th week
Lecture: Measurement principles of small current and voltage levels.
Lab: Measurements on power supplies.

10th week
Lecture: Data acquisition systems.
Lab: Filters, design and realisation.

11th week
Lecture: AD and DA converters.
Lab: Signal generators.

12th week
Lecture: RF and microwave basics.
Lab: Multipliers.

13th week
Lecture: RF and microwave circuit components.
Lab: Test measurement 2.

14th week
Lecture: Energy harvesting, power efficiency.
Lab: correction of lab notes (for students with incompleteness).

Requirements:

- for a practice grade

- Signature: students are required to complete all tests at least 50% level, and to solve at least 50% of the homework assignments.

For a laboratory grade:

- Ability to correctly measure all circuits in the lab: grade 2;
- In addition: Producing good lab notes: grade 3;
- In addition: Ability to make the calculations correctly: grade 4;
- In addition: Good skills in circuit simulation: grade 5.

If the score of any test is below 50, students can take a retake test in conformity with the EDUCATION AND EXAMINATION RULES AND REGULATIONS.

- an offered grade: --

Person responsible for course: László Oláh lecturer, PhD

Lecturer: Lajos Harasztosi engineer-lecturer

Title of course: Digital Electronics 1.
Code: **TTFBE1211**

ECTS Credit points: 3

Type of teaching, contact hours
- lecture: 3 hours/week

Evaluation: exam

Workload (estimated), divided into contact hours:
- lecture: 42
- practice: -
- laboratory: -
- home assignment: 28 hours
- preparation for the exam: 20

Total: 90 hours

Year, semester: 2nd year, 1st semester

Its prerequisite(s): Electronics 1. TTFBE1208

Further courses built on it: TTFBE1212 Digital Electronics 2.

Topics of course

Digital and analog quantities. Number systems, codes, code conversions. Logic gates. Boolean algebra, logic functions and logic networks. Logic simplification: algebraic method, Karnaugh Map minimization. Representing logic states with voltage levels. Logic circuits. Internal structure and characteristics of TTL and CMOS integrated circuits. Logic family interconnections. Driving external loads. Combinational logic analysis and design. Typical combinational circuits: encoders, decoders, multiplexers, demultiplexers, adders / subtractors, comparators, parity checkers / generators, multipliers. Synchronous and asynchronous sequential networks. Typical sequential networks: flip-flops, frequency dividers, counters, registers. Digital-to-Analog and Analog-to-Digital converters. Interfacing logic circuits to the outside world.

Literature

Compulsory:
- Thomas L. Floyd: Digital Fundamentals. 11th edition, Pearson 2015
- Horowitz P., Hill W.: The Art of Electronics. 3rd edition, Cambridge University Press 2016.

Recommended:
- Mano M. M., Ciletti M. D. Digital Design. 4th ed., Pearson-Prentice Hall, New Jersey, 2006.

Schedule:

1st week

Digital and analog quantities. Number systems, codes, code conversions.

2nd week

Logic gates. Boolean algebra, logic functions and logic networks.

3rd week

Logic simplification: algebraic method, Karnaugh Map minimization.

4th week

Combinational logic analysis and design 1.

5th week

Combinational logic analysis and design 2.

6th week

Midterm test.

7th week

Representing logic states with voltage levels. Logic circuits. Internal structure and characteristics of TTL and CMOS integrated circuits. Logic family interconnections. Driving external loads.

8th week

Encoders, decoders, code converters. Multiplexers (data selectors), demultiplexers.

9th week

Half and full adders, subtractors, comparators, parity checkers / generators, multipliers.

10th week

Synchronous and asynchronous sequential networks. Flip-flops. Frequency dividers, counters, registers, shift registers.

11th week

Mealy and Moore machines. Analysis and design of sequential networks. Finite state machine design.

12th week

End-term test

13th week

Digital-to-Analog and Analog-to-Digital converters. Interfacing logic circuits to the outside world.

14th week

Improvement test.

Consultation.

Requirements:

- for a signature

Attendance at **lectures** is recommended, but not compulsory. Condition for signature obtaining is a successful (at least passed grade) write of two tests according to semester assessment timing.

During the semester there are two tests: the midterm test in the 6th week and the end-term test in the 12th week. Students' participation on the tests is mandatory. There is an improvement test in the 14th week. Students have an opportunity to retake failed test(s).

- for a grade

The course ends in an **examination**. Signature receipt is a precondition for exam eligibility. Results of two tests are counted in the final grade by 60% weight.

The exam is in written form with test and essay questions.

0-50 % failed (1)
51-60 % pass (2)
61-70 % satisfactory (3)
71- 80 % good (4)
81-100% excellent (5)

- an offered grade:

It may be offered for students if the grades of the midterm and end-term tests are at least satisfactory (3) for each one. The offered grade is the average of them.

Person responsible for course: Dr. Gyula Zilizi, associate professor, PhD

Lecturer: Dr. Gyula Zilizi, associate professor, PhD; Dr. Sandor Misak, associate professor, PhD

Title of course: Digital Electronics 2. **Code**: **TTFBE1222**	**ECTS Credit points:** 6

Type of teaching, contact hours

- lecture: 2 hours/week
- laboratory: 3 hours/week

Evaluation: term grade

Workload (estimated), divided into contact hours:

- lecture: 28
- practice: -
- laboratory: 42
- home assignment: 28 hours
- preparation for the laboratory: 28

Total: 126 hours

Year, semester: 2nd year, 2nd semester

Its prerequisite(s): TTFBE1211 Digital Electronics 1.

Further courses built on it: TTFBE1311 Programmable Logic Devices
TTFBE1321 Industrial Process Control

Topics of course

Fundamentals of semiconductor-based memories (RAM, ROM memories). Structure, operation, instruction set of microprocessors. Basics of microcontrollers. Basics of standard serial and parallel communication protocols. Programmable logic devices (CPLD, FPGA). Structure and application of hardware description languages.

Literature

Compulsory:

- Thomas L. Floyd: Digital Fundamentals. 11th edition, Pearson 2015
- Kleitz W.: Digital Electronics: A Practical Approach with VHDL. 9th ed., Pearson, 2011.

Recommended:

- Tokheim R. L.: Digital Electronics: Principles and Applications. 8th ed., McGraw-Hill Education, 2013.
- Mano M. M., Ciletti M. D. Digital Design. 4th ed., Pearson-Prentice Hall, New Jersey, 2006.

Schedule:

1st week

Fundamentals of semiconductor-based memories 1.: RAM memories.

2nd week

Fundamentals of semiconductor-based memories 2.: ROM memories.

3rd week

Special types of memories. Memory hierarchy. Cloud storage. Memory expansion.

4th week

Structure, operation, instruction set of microprocessors.

5th week

Basics of microcontrollers. Microchip (Atmel) 8 bit microcontrollers. Arduino environment.

6th week

Bus basics. Basics of standard serial and parallel communication protocols: PCI, SCSI, USB, RS232, RS485, I2C, SPI.

7th week

Midterm test.

8th week

Programmable logic devices: SPLD, CPLD, FPGA.

9th week

The basic hardware synthesis design flow. Introduction to the Lattice Diamond software package. Introduction to the TinyFPGA-UD1 development board: pin layout, capabilities, connection to the Lattice Diamond software suite.

10th week

Brief overview of hardware description languages. Fundamentals of the VHDL hardware description language. Basic constructs, syntax, essential datatypes.

11th week

Usage of libraries with emphasis on the IEEE libraries for logic types and arithmetic operations. Synthesis of basic logic gates. Synthesis of more complex logic: encoders, decoders, multiplexers and demultiplexers. Synthesis using minterms and maxterms.

12th week

Review of storage elements used in digital design: latches and flip-flops. Introduction to new constructs in VHDL for storage implementation. Overview of sequential logic: state memory, output and next state logic. State encoding. Implementation of counters (up, down, one-hot) as special state machines in VHDL.

13th week

End-term test

14th week

Improvement test.

Consultation.

Requirements:

- for a signature

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

During the semester there are two theoretical tests: the midterm test in the 7th week and the end-term test in the 13th week. Students' participation on the tests is mandatory. There is an improvement test in the 14th week. Students have an opportunity to retake failed test(s).

Attendance at **laboratories** is compulsory.

During the semester there are two laboratory tests: the midterm test in the 6th week (microcontroller programming in Arduino environment) and the end-term test in the 13th week (FPGA programming). Students' participation on the tests is mandatory. There is an improvement test in the 14th week. Students have an opportunity to retake failed test(s).

Students receive homework in the lecture and laboratory courses with defined submission deadline.

Condition for signature obtaining is:

- submission of homework assignment (theory, laboratory).
- successful (at least passed grade) write of two theoretical tests according to semester assessment timing;
- at least passed grades on two laboratory tests.

- for a grade

Term grade is calculated as a weighted sum of submitted homework and all test grades:

term_grade = 0.1·(lab_hw_grade + theory_hw_grade) + 0.2·(lab_test1_grade + lab_test2_grade + theory_test1_grade + theory_test2_grade), where term_grade is a term grade, lab_hw_grade is a laboratory homework assignment grade, theory_hw_grade is a theory homework assignment grade, lab_test1_grade is a laboratory test1 grade, lab_test2_grade is a laboratory test2 grade, theory_test1_grade is a theory test1 grade, theory_test2_grade is a theory test2 grade. - *an offered grade:* —
Person responsible for course: Dr. Gyula Zilizi, associate professor, PhD
Lecturer: Dr. Gyula Zilizi, associate professor, PhD; Dr. Sandor Misak, associate professor, PhD

Title of course: Electrotechnology **Code**: TTFBE1223-EN	**ECTS Credit points:** 3

Type of teaching, contact hours
- lecture: 1 hour / week
- practice: -
- laboratory: 2 hours/week

Evaluation: term mark

Workload (estimated), divided into contact hours:
- lecture: 14 hours
- practice: 28 hours
- laboratory: -
- home assignment: 28 hours
- preparation for the exam: -

Total: 70 hours

Year, semester: 2nd year, 1st semester

Its prerequisite(s): TTFBE12076-EN Electricity 2., TTFBE1113-EN Materials Science for Electrical Engineering

Further courses built on it: -

Topics of course

Generation of electrical energy. Basic structure and components of electrical energy systems. Cables, switchgears and other components. Installation of electrical power systems. Basics of transformers and electrical rotating machines. Overvoltage and overcurrent. Protective devices: circuit breaker, fuse, surge protection. DC systems: photovoltaic panel, DC motor, batteries.

Literature

Compulsory:
- Course materials

Recommended:
- Theodore Wildi: Electrical Machines, Drives, and Power Systems, Prentice Hall.
- Casazza J., Delea F.: Understanding Electric Power Systems: An Overview of the Technology and the Marketplace, Wiley, 2010.
- Electrical Installation Guide by Schneider Electric (http://www.electrical-installation.org/enwiki/Main_Page)

Schedule for practice:

1st week

Lecture: Introduction, course requirements, Electricity, energy, history of electrical energy.

2nd week

Lecture: Production of electrical energy.

Laboratory, 1st measurement: Basic electricity measurements (resistance of conductors, temperature dependence of resistors, Kirchoff’s laws, transients, unknown four-pole, measurement devices for electrical power systems).

3rd week

Lecture: Building installations.

4th week

Lecture: Cables.

Laboratory, 2nd measurement: Installation techniques (basic circuits, types of cables, types of electrical bonds, bonding components, junction boxes).

5th week

Lecture: Switchgears.

6th week

Lecture: Installation techniques.

Laboratory, 3rd measurement: Electrical machines (Transformer: open-circuit, drop, loaded state; Rotating-machines: power measurement, start-up transient).

7th week

Lecture: Transformers.

8th week

Lecture: Electrical rotating machines.

Laboratory, 4th measurement: Electrical rotating machines (soft-start, rotation direction, wye-delta connection, frequency converter).

9th week

Lecture: Operation of electrical rotating machines.

10th week

Lecture: Protection devices.

Laboratory, 5th measurement: Protection devices (circuit breakers: structure, characteristics, RCD: structure, tripping current; fuse: structure, types; over-voltage protection: varistor.

11th week

Lecture: Protection devices.

12th week

Lecture: DC systems.

Laboratory, 6th measurement: DC power systems (photovoltaics: I-V characteristics, temperature dependence, short-circuit current; DC motor: characteristics.

13th week

Lecture: DC systems.

14th week

Lecture: Pre-exam grading test.

Laboratory, 7th measurement: DC power systems (Secondary batteries: I-V curve, capacity measurement, capacity dependence on discharge current).

Requirements:

- for a term grade

Participation at **laboratory classes** is compulsory. A student must attend the laboratory 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 cannot make up any practice with another group. Attendance at laboratory classes will be recorded by the laboratory leader. Being late is equivalent with an absence. In case of further absences, a medical certificate needs to be presented. Missed laboratory 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 laboratory class. Active participation is evaluated by the teacher in every class. If a student's behaviour or conduct does not 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.

Preparation for measurement will be checked. The student has to complete 7 measurements (4 hours / measurement). Measurement reports have to be submitted. Grading is based on the measurement activity and reports.

During the semester there are two tests based on the lecture and practical part: the mid-term test in the 7th week and the end-term test in the 14th week. Students have to sit for the tests. Tests are in written form with short and long essay questions.

Grades:

0-50 % failed (1)

51-62 % pass (2)

63-75 % satisfactory (3)

76- 87 % good (4)

88-100% excellent (5).

Based on the result of these two tests and averaging of laboratory grades a term mark will be given.

Person responsible for course: Árpád Rácz, assistant lecturer, PhD

Lecturer: Árpád Rácz assistant lecturer

Title of course: Basics of technical drawing **Code**: TTFBL1227-EN	**ECTS Credit points:** 3

Type of teaching, contact hours
- lecture: -
- practice: -
- laboratory: 3 hours/week

Evaluation: signature and grade for laboratory work

Workload (estimated), divided into contact hours:
- lecture: -
- practice: -
- laboratory: 42 hours
- home assignment: 48 hours
- preparation for the exam: -

Total: 90 hours

Year, semester: 2nd year, 1st semester

Its prerequisite(s): TTFBE1209-EN Electronics 2., TTFBE1223-EN Electrotechnology

Further courses built on it: -

Topics of course

The base of circuits simulation, and the SPICE parameters of basic electronic components. Basic electronic symbols of the circuit diagram. Creating a simple electronic schematic. Editing libraries of symbols of electronic components. Elements of PCB (Printed Circuit Board) and useful methods of planning PCB. The trait of the proper footprint of an electronic component. To view recommended standards of footprint. Creating a simple PCB. Editing libraries of footprints of electronic components. Generating of files for manufacturing of PCB. Introduction to drawing of mechanical objects. Basics of plan and design the electrical engineering for machines and plant systems.

Literature

Compulsory:

User manuals of the used CAD software

Schedule:

1st week

Items of SPICE based circuit simulation, syntactic rules.

2nd week

Behavior analysis of simple circuits.

3rd week

Behavior analysis of circuits based on operational amplifier.

4th week

Behavior analysis of a complex circuits in class all by oneself.

5th week

Basic methods and symbols of to draw circuit diagram.

6th week

The structure of library of symbols of circut elements. Creating bill of materials (BOM) list.

7th week

Elements of PCB and basic methods of planning PCB.

8th week
Naming conventions of footprint of components. Creating a footprint.

9th week
Generate documents for manufacture of PCB.

10th week
Planning of PCB in class all by oneself.

11th week
Basic elements of technical drawing.

12th week
Creating technical drawing of a simple mechanical item.

13th week
Drawing of a simple technical drawing in class all by oneself.

14th week
In class test.

Requirements:

- for a signature

Participation at laboratory works is compulsory. A student must attend the laboratory works 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 laboratory works will be recorded by the laboratory work leader. Being late is equivalent with an absence. In case of further absences, a medical certificate needs to be presented. Missed laboratory works should be made up for at a later date, to be discussed with the tutor. Students are required to bring the reports to each laboratory works. 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.

Grading System

The grade is computed as arithmetic mean of the solutions of homeworks and the class test.

Person responsible for course: Zsolt Szabó

Lecturer: Lajos Harasztosi, Zsolt Szabó, Ádám Kardos

Title of course: Microelectronics **Code**: TTFBE1225	**ECTS Credit points:** 3

Type of teaching, contact hours
- lecture: 2 hours/week
- practice: -
- laboratory: -

Evaluation: exam

Workload (estimated), divided into contact hours:
- lecture: 28 hours
- practice: -
- laboratory: -
- home assignment: 42 hours
- preparation for the exam: 20 hours

Total: 90 hours

Year, semester: 2nd year, 2nd semester

Its prerequisite(s): TTFBE1103 Materials Science for Electrical Engineering

Further courses built on it: TTFBE1221 Electronic Technology, TTFBE1314 Nanoelectronics and Nanotechnology, TTFBE1315/TTFBG1315 Photonics

Topics of course

Main parameters of passive and functional microelectronics materials, electron-hole processes, contacts, interfacial processes. Linear and non-linear electron processes. Electrical space effects, p-n junction, heterojunctions, bipolar transistors. FET transistors. Passive and active integrated elements, memory structures. CCD, image formation structures. Basic elements of optoelectronics. Integrated optical elements, nanostructures. Directions and limits of microelectronics development.

Literature

Compulsory:

– Sze S.M., Ng K.K.: Physics of Semiconductor Devices, Wiley and Sons, 2007.
– Sedra A.S., Smith K.C.: Microelectronic Circuits, Oxford University Press, 6th ed., 2009.

Recommended:

– Razavi B.: Fundamentals of Microelectronics. Wiley, 2nd ed., 2014.
– Jaeger R.C., Blalock T.N.: Microelectronic Circuit Design. McGraw-Hill, 2nd ed., 2011.
– Fonstad C.G.: Microelectronic Devices and Circuits. McGraw-Hill, 2006 electronic edition, 2006.

Schedule:

1st week

Formation of microelectronics: main mile stones, present and future. Microelectronics materials: systematization of semiconductors, dielectrics and metals according to basic parameters and applications.

2nd week

Energy band of semiconductors and dielectrics, Fermi-level, contact potential. Seebeck and Peltier effects, devices.

3rd week

Electron (intrinsic and extrinsic) conductivity of semiconductors, compensation, concentration of charge carriers, temperature dependence, hot electrons. Continuity equation, majority and minority charge carriers, their role in device operation.

4th week

Non-linear electron phenomena, devices. Gunn-effect, Hall-effect, magnetic resistance, devices.

5th week

Metal-semiconductor junction, Schottky diode. Band diagram of p-n junction, characteristics, space charge regions, capacity. Bipolar transistor.

6th week

Field effect. FET types. MESFET, MOSFET, structure, characteristics, operation.

7th week

Mid-term test. Heterojunction. Main types and applications

8th week

ROM, EPROM, DRAM, CMOS elements: structure, operation, parameters. Integrated circuits.

9th week

Semiconductor optics, non-equilibrium processes, generation and recombination. Photoresistor, optocoupler, integrated optical elements.

10th week

Polarization of dielectrics, ferroelectricity. Piezo-, pyroeffects, parameters, devices.

11th week

Secondary storage devices: flash memory, magnetic memory (HDD structure), optical memory (CD-R, CD-RW, DVD carriers), main parameters.

12th week

Sensors. Solar cells. Types, parameters, applications.

13th week

Size reduction: possibilities and conditions. Size-confined, quantum effects. Application in photosensors and light sources.

14th week

End-term test. Elements of nanoelectronics: Coulomb transistor, plasmonics, nanophotonics. Spintronics elements.

Requirements:

- for a signature

Attendance at **lectures** is recommended, but not compulsory. Condition for sign obtaining is a successful (at least passed grade) write of two tests according to semester assessment timing.

During the semester there are two tests: the mid-term test in the 7th week and the end-term test in the 14th week. Students' participation on the tests is mandatory.

- for a grade

The course ends in an **examination**. Sign receipt is a precondition for exam eligibility. Results of two tests are counted in the final grade by 60% weight.

-an offered grade:

It may be offered for students if the grades of the mid-term and end-term tests are at least satisfactory (3) for each one. The offered grade is the average of them.

Person responsible for course: Dr. Sándor Misák, associate professor, PhD
Lecturer: Dr. Sándor Misák, associate professor, PhD

Title of course: Electrical Power Systems **Code**: TTFBE1216-EN	**ECTS Credit points:** 3

Type of teaching, contact hours
- lecture: 2 hours/week
- practice: -
- laboratory: -

Evaluation: exam

Workload (estimated), divided into contact hours:
- lecture: 28 hours
- practice: -
- laboratory: -
- home assignment: 10 hours
- preparation for the exam: 52 hours

Total: 90 hours

Year, semester: 2nd year, 2nd semester

Its prerequisite(s): TTFBE1207-EN

Further courses built on it: -

Topics of course

Theory: General structure of electric power systems, generation, transmission and distribution of electrical energy. One and three phase systems. Renewable energy sources. HVDC transmission. Electrical energy storage. Fundamentals of power engineering. Indoor and outdoor switching gears. Earthing systems. Physiological effects of magnetic and electric fields, electric shock. Over-voltage and ESD protection. The concept of power quality and Smart Grids.
Practical: Equivalent one-phase circuit, generator, transformer, power transmission line, distribution lines. Three-phase short circuit. Low voltage safety. Sizing of conductors.

Literature

Compulsory:
- Theodore Wildi: Electrical Machines, Drives, and Power Systems, Prentice Hall
- Massimo Mitolo: Electrical Safety of Low Voltage Systems, McGraw-Hill, 2009.
- Electrical Installation Guide by Schneider Electric (available on the Web)
- Course materials

Recommended:
- Casazza J., Delea F.: Understanding Electric Power Systems: An Overview of the Technology and the Marketplace, Wiley, 2010.

Schedule for lecture:

1st week

Introduction to Electrical Power Systems

2nd week

Electric power generation

3rd week

Renewable energy sources

4th week

Transmission and distribution of electrical energy

5th week
HVDC-transmission
6th week
Electrical energy storage
7th week
The cost of electricity
8th week
Indoor and outdoor switching gears
9th week
Electrical safety of low voltage systems
10th week
Electrical safety of low voltage systems
11th week
Over-voltage protection
12th week
ESD protection
13th week
Power quality
14th week
Concept of Smart Grid

Requirements:
- for a lecture grade
Attendance at **lectures** is recommended, but not compulsory.

The course ends in an **examination**. The requirement for examination is having pass (2) or better practical mark.

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 table:

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 two theoretical test during the semester is at least satisfactory (3) and the average of the mid-term and end-term tests is at least satisfactory (3). The offered grade is the average of the theoretical test. Taking these tests is not mandatory.

Person responsible for course: Dr. János Árpád Kósa, senior lecturer, PhD

Lecturer: Dr. János Árpád Kósa, senior lecturer, PhD, Árpád Rácz assistant lecturer

Title of course: Electrical Power Systems **Code**: TTFBG1216-EN	**ECTS Credit points:** 2

Type of teaching, contact hours
- lecture: -
- practice: 2 hours/week
- laboratory: -

Evaluation: exam

Workload (estimated), divided into contact hours:
- lecture: -
- practice: 28 hours
- laboratory: -
- home assignment: 32 hours
- preparation for the exam: -

Total: 60 hours

Year, semester: 2nd year, 2nd semester

Its prerequisite(s): TTFBE1207-EN

Further courses built on it: -

Topics of course

Theory: General structure of electric power systems, generation, transmission and distribution of electrical energy. One and three phase systems. Renewable energy sources. HVDC transmission. Electrical energy storage. Fundamentals of power engineering. Indoor and outdoor switching gears. Earthing systems. Physiological effects of magnetic and electric fields, electric shock. Over-voltage and ESD protection. The concept of power quality and Smart Grids.
Practical: Equivalent one-phase circuit, generator, transformer, power transmission line, distribution lines. Three-phase short circuit. Low voltage safety. Sizing of conductors.

Literature

Compulsory:
- Course materials

Recommended:
- Theodore Wildi: Electrical Machines, Drives, and Power Systems, Prentice Hall
- Massimo Mitolo: Electrical Safety of Low Voltage Systems, McGraw-Hill, 2009.
- Electrical Installation Guide by Schneider Electric (available on the Web)
- Casazza J., Delea F.: Understanding Electric Power Systems: An Overview of the Technology and the Marketplace, Wiley, 2010.

Schedule for practice:

1st week

Overview of symmetric three-phase systems

2nd week

Stability parameters for electrical power systems

3rd week

Impedance calculation

4th week

Impedance calculation

5th week
Calculation symmetric components
6th week
Calculation of equivalent reactance
7th week
Test 1.
8th week
Calculation of three-phase short circuit
9th week
Calculation of three-phase short circuit
10th week
Calculation of low voltage safety systems
11th week
Calculation of voltage drop
12th week
Sizing of conductors
13th week
Sizing of conductors
14th week
Test 2.

Requirements:
- for a practical grade
Participation at **practice classes** 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 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 based on the practical part: the mid-term test in the 8th week and the end-term test in the 15th week. Students have to sit for the tests. Based on the result of these two tests a practical mark will be given.

Person responsible for course: Dr. János Árpád Kósa, senior lecturer, PhD

Lecturer: Dr. János Árpád Kósa, senior lecturer, PhD, Árpád Rácz assistant lecturer

Title of course: Automation and Control Engineering 1.
Code: TTFBE1218

ECTS Credit points: 3

Type of teaching, contact hours
lecture: 2 hours/week

Evaluation: exam

Workload (estimated), divided into contact hours:
- lecture: 30 hours
- practice: -
- laboratory: -
- home assignment: 30 hours
- preparation for the exam: 30 hours

Total: 90 hours

Year, semester: 2nd year, 2nd semester

Its prerequisite(s): TTFBE1202 Programming 2, TTMBE0812 Mathematics 3, TTMBG0812 Mathematics 3

Further courses built on it: - TTFBE1219 Automation and Control Engineering 2, TTFBG1219 Automation and Control Engineering 2

Topics of course

Basic notions, closed loop control, open loop control, structure, requirements, examples. Description of continuous-time linear elements and systems: differential equation, state space representation, weighting function, unit step response, transfer function, frequency function. Block-scheme Algebra, Equivalent Block Manipulations. State space, state trajectory, solution of the state equations in the complex frequency domain and in the time domain. Own motion, excited motion, stability. State transformations. Controllability and observability, the Kalman decomposition into four sub-systems. The theorem of state-feedback. Transfer characteristics of typical basic and complex blocks. Transfer characteristics of the closed loop control. Resultant transfer functions, type number of the regulation, follow-up control and disturbance elimination. Stability examination, Nyquist stability criterion. Structural and conditional stability. Right pole compensation. Quality characteristics of closed loop control systems, their appraisals on the basis of frequency features. Planning of the closed loop control system, requirements and methods. Planning of serial P, PD, PI and PID regulator to proportional process. Planning of serial P and PD regulator to integrating process. Planning of 2-type regulation to proportional process. Planning of PI and PID regulator to integrating process. Regulation of a process with double integrating effect using PD regulator. Regulation of process with dead time, ideal dead time using I regulator, proportional process with dead time using PI and PID regulator. Application of Smith predictor. Disturbance compensation and cascade regulators. Experimental setting of regulators using oscillation (Ziegler-Nichols method) and on the basis of unit step response (Oppelt method). Tuning of regulators with 'own method' using proportional first order dead time approximation, and first order integrating approximation.

Literature

Compulsory:
- Laszlo Keviczky, Ruth Bars, …: Control Engineering, Szechenyi University Press, Gyor, 2011.

Recommended:
- Franklin, Powell, Emami-Naeini: Feedback Control of Dynamic Systems, Pearson 2014

Schedule:

1st week: Basic notions, closed loop control, open loop control, structure, requirements, examples.

2nd week: Block-scheme Algebra, Equivalent Block Manipulations. State space, state trajectory, solution of the state equations in the complex frequency domain and in the time domain.

3rd week: State transformations. Controllability and observability, the Kalman decomposition into four sub-systems. The theorem of state- feedback.

4th week: Transfer characteristics of typical and complex basic blocks.

5th week: Transfer characteristics of the closed loop control. Resultant transfer functions, type number of the regulation, follow-up control and disturbance elimination. Stability examination, Nyquist stability criterion.

6th week: Structural and conditional stability. Right pole compensation. Quality characteristics of closed loop control systems, their appraisals on the basis of frequency features.

7th week: Planning of the closed loop control system, requirements and methods. Planning of serial P, PD, PI and PID regulator to proportional process.

8th week: Planning of serial P and PD regulator to integrating process. Planning of 2-type regulation to proportional process.

9th week: Planning of PI and PID regulator to integrating process. Regulation of a process with double integrating effect using PD regulator.

10th week: Regulation of process with dead time, ideal dead time using I regulator, proportional process with dead time using PI and PID regulator. Application of Smith predictor.

11th week: Disturbance compensation and cascade regulators.

12th week: Experimental setting of regulators using oscillation (Ziegler-Nichols method) and on the basis of unit step response (Oppelt method).

13th week: Test

14th week: Tuning of regulators with 'own method' using proportional first order dead time approximation, and first order integrating approximation. Test2

Requirements:

Students have to complete test based on the knowledge of computer practices. On test students have to create and apply MATLAB program and simulation. Condition of fulfilment of practical course: successful test. Students cannot take an exam without successful test.

Person responsible for course: Dr. Gabor Katona, associate professor

Lecturer: Dr. Eniko Kosane Kalave, engineer teacher

Title of course: Automation and Control Engineering 1. **Code**: TTFBG1218	**ECTS Credit points:** 2

Type of teaching, contact hours

- practice: 2 hours/week

Evaluation: practical grade

Workload (estimated), divided into contact hours:

- lecture: -
- practice: 20 hours
- laboratory: -
- home assignment: 20 hours
- preparation for the practical grade: 20 hours

Total: 60 hours

Year, semester: 2nd year, 2nd semester

Its prerequisite(s): TTFBE1202 Programming 2, TTMBE0812 Mathematics 3, TTMBG0812 Mathematics 3

Further courses built on it: - TTFBE1219 Automation and Control Engineering 2, TTFBG1219 Automation and Control Engineering 2

Topics of course

Description of continuous time linear elements and systems: differential equation, state space representation, weighting function, unit step response, transfer function, frequency function. Own motion, excited motion, stability. Examination in the state space. State controllability, observability, output controllability. Transfer characteristics of typical basic and complex blocks. Examination of closed loop control. Stability. Quality characteristics of closed loop control systems, their appraisals on the basis of frequency features. Planning, programming and simulation of serial P, PD, PI and PID regulator to proportional process. Planning of serial P and PD regulator to integrating process. Planning of 2-type regulation to proportional process. Planning of PI and PID regulator to integrating process. Regulation of a process with double integrating effect using PD regulator. Regulation of process with dead time. Application of Smith predictor. Planning of cascade regulators. Experimental setting of regulators using oscillation (Ziegler-Nichols method) and on the basis of unit step response (Oppelt method). Computer based laboratory practices applying MATLAB/SIMULINK program.

Literature

Compulsory:

- Laszlo Keviczky, Ruth Bars, …: Control Engineering, Szechenyi University Press, Gyor, 2011.

Recommended:

- Franklin, Powell, Emami-Naeini: Feedback Control of Dynamic Systems, Pearson 2014.

Schedule:

1st week: Description of continuous time linear elements and systems: differential equation, state space representation, weighting function, unit step response, transfer function, frequency function.

2nd week: Own motion, excited motion, stability.

3rd week: Examination in the state space. State controllability, observability, output controllability.

4th week: Transfer characteristics of typical basic and complex blocks.

5th week: Examination of closed loop control. Stability.

6th week: Quality characteristics of closed loop control systems, their appraisals on the basis of frequency features. *7th week:* Planning, programming and simulation of serial P, PD, PI and PID regulator to proportional process. *8th week:* Planning of serial P and PD regulator to integrating process. Planning of 2-type regulation to proportional process. *9th week:* Planning of PI and PID regulator to integrating process. Regulation of a process with double integrating effect using PD regulator. *10th week:* Regulation of process with dead time. Application of Smith predictor. *11th week:* Planning of cascade regulators. *12th week:* Experimental setting of regulators using oscillation (Ziegler-Nichols method) and on the basis of unit step response (Oppelt method). *13th week:* Test1. *14th week:* Test2.
Requirements: Students have to complete test based on the knowledge of computer practices. On test students have to create and apply MATLAB program and simulation. Condition of fulfilment of practical course: successful test. Students cannot take an exam without successful test.
Person responsible for course: Dr. Gabor Katona, associate professor
Lecturer: Dr. Eniko Kosane Kalave, engineer teacher

Title of course: Electronic technology **Code**: TTFBE1221-EN	**ECTS Credit points:** 3

Type of teaching, contact hours
- lecture: 2 hours/week
- practice: -
- laboratory: -

Evaluation: exam

Workload (estimated), divided into contact hours:
- lecture: 28 hours
- practice: -
- laboratory: -
- home assignment: 28 hours
- preparation for the exam: 34 hours

Total: 90 hours

Year, semester: 3rd year, 1st semester

Its prerequisite(s): TTFBE1225-EN

Further courses built on it: -

Topics of course

The main materials for electronics, their classification, and properties. Metals, semiconductors and dielectric material. Crystalline and amorphous materials. Band structures, optical and electrical conductivity. P-n junction. Main types of semiconductors and their technology. Si and Ge, organic semiconductors, their main properties, and parameters. Vacuum technology and basic elements. Thin layer technology, main deposition techniques: evaporation, deposition. Investigation of thin layers. The technology of single crystals, amorphous materials. The technology of Si and GaAs from the bottom to the top. Diffusion, implantation and another lithography. The technology of active and passive elements, diodes, transistors, circuits. The technology of optoelectronic elements and devices: light sources and solar cells. SMT and THM technology of PCB. Quality, reliability. Some peculiar applications: sensors, memory elements, functional electronics, mechatronics. Trends in the development of micro- and nanotechnology. At the laboratory, students deal with thin film technology, thin film measurements, lithography, design, and fabrication of PCBs.

Literature

Compulsory:

1. Sze S.M. and Ng K.K. Physics of Semiconductor Devices. Wiley and Sons, 2006.
2. Sedra A.S., Smith K.C.: Microelectronic Circuits. Oxford Series in Electrical & Computer Engineering, 5th edition, Oxford University Press Inc., U.S. 2004.
3. Nalwa H.S. Nanostructured Materials and Nanotechnology. Elsevier, 2002.

Schedule:

1st week

The main materials for electronics, their classification, and properties.

2nd week

Metals, semiconductors and dielectric material. Crystalline and amorphous materials.

3rd week

Band structures, optical and electrical conductivity

4th week

P-n junction. Main types of semiconductors and their technology. Si and Ge, organic semiconductors, their main properties, and parameters.

5th week

The technology of single crystals, amorphous materials. The technology of Si and GaAs from the bottom to the top.

6th week

Vacuum technology and basic elements.

7th week

Thin layer technology, main deposition techniques: evaporation, deposition.

8th week

Investigation of thin layers.

9th week

Diffusion, implantation and another lithography

10th week

Dielectric layers. The technology of SiO2 and SiN technológiája. Integrated circuits.

11th week

SMT and THM technology of PCB. Quality, reliability.

12th week

The technology of optoelectronic elements and devices: light sources and solar cells.

13th week

Some peculiar applications: sensors, memory elements, functional electronics, mechatronics.

14th week

Trends in the development of micro- and nanotechnology.

Requirements:

- for a signature

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

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.

- for a grade

The course ends in an **examination**. Based on the examination, the exam grade is calculated as a:

- 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 table:

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 mid-term and end-term tests is at least satisfactory (3). The offered grade is the average of them.

Person responsible for course: Dr. István Csarnovics, assistant professor, PhD
Lecturer: Dr. István Csarnovics, assistant professor, PhD

Title of course: Electronic technology, laboratory work **Code**: TTFBL1221 -EN	**ECTS Credit points:** 2

Type of teaching, contact hours
- lecture: -
- practice: -
- laboratory: 2 hours/week

Evaluation: signature and grade for laboratory work

Workload (estimated), divided into contact hours:
- lecture: -
- practice: -
- laboratory: 28 hours
- home assignment: 32 hours
- preparation for the exam: -

Total: 60 hours

Year, semester: 3rd year, 1st semester

Its prerequisite(s): TTFBE1225-EN

Further courses built on it: -

Topics of course

The main materials for electronics, their classification, and properties. Metals, semiconductors and dielectric material. Crystalline and amorphous materials. Band structures, optical and electrical conductivity. P-n junction. Main types of semiconductors and their technology. Si and Ge, organic semiconductors, their main properties, and parameters. Vacuum technology and basic elements. Thin layer technology, main deposition techniques: evaporation, deposition. Investigation of thin layers. The technology of single crystals, amorphous materials. The technology of Si and GaAs from the bottom to the top. Diffusion, implantation and another lithography. The technology of active and passive elements, diodes, transistors, circuits. The technology of optoelectronic elements and devices: light sources and solar cells. SMT and THM technology of PCB. Quality, reliability. Some peculiar applications: sensors, memory elements, functional electronics, mechatronics. Trends in the development of micro- and nanotechnology. At the laboratory, students deal with thin film technology, thin film measurements, lithography, design, and fabrication of PCBs.

Literature

Compulsory:

1. Sze S.M. and Ng K.K. Physics of Semiconductor Devices. Wiley and Sons, 2006.
2. Sedra A.S., Smith K.C.: Microelectronic Circuits. Oxford Series in Electrical & Computer Engineering, 5th edition, Oxford University Press Inc., U.S. 2004.
3. Nalwa H.S. Nanostructured Materials and Nanotechnology. Elsevier, 2002.

Schedule:

1st week

Information about the laboratory work, accident prevention.

2nd week

Design and construction of printed circuit board.

3rd week

Design and construction of printed circuit board.

4th week

Thick layer technology. Creation of thick layers.

5th week

Thick layer technology. Creation of thick layers.

6th week

Vacuum technology. Thin layer technology: vacuum evaporation.

7th week

Vacuum technology. Thin layer technology: vacuum evaporation.

8th week

Investigation of the created thin layers.

9th week

Investigation of the created thin layers.

10th week

Soldering of the elements into the created printed circuit board.

11th week

Soldering of the elements into the created printed circuit board.

12th week

Visiting the National Instruments factory.

13th week

Evaluation of the experimental results and fabrication of the report.

14th week

The presentation of the report of the experimental results.

Requirements:

- for a signature

Participation at laboratory works is compulsory. A student must attend the laboratory works 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 laboratory works will be recorded by the laboratory work leader. Being late is equivalent with an absence. In case of further absences, a medical certificate needs to be presented. Missed laboratory works should be made up for at a later date, to be discussed with the tutor. Students are required to bring the reports to each laboratory works. 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 five designing reports** as a scheduled minimum on a sufficient level.

- for a grade

The course ends with a presentation of the report of the experimental results and with a grade for it. Based on the average of the grades of the designing tasks, the grade is calculated as an average of them:

- the average grade of the five designing tasks

The grade for the tasks is given according to the following table:

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 task is below 60, students can take a retake the report in conformity with the EDUCATION AND EXAMINATION RULES AND REGULATIONS.

Person responsible for course: Dr. István Csarnovics, assistant professor, PhD

Lecturer: Dr. István Csarnovics, assistant professor, PhD

Title of course: Automation and Control Engineering 2. **Code**: TTFBE1219	**ECTS Credit points:** 3

Type of teaching, contact hours

- lectures: 2 hours/week

Evaluation: exam

Workload (estimated), divided into contact hours:

- lecture: 30 hours
- practice: -
- laboratory: -
- home assignment: 30 hours
- preparation for the exam: 30 hours

Total: 90 hours

Year, semester: 3rd year, 1st semester

Its prerequisite(s): TTFBE1218 Automation and Control Engineering 1, TTFBG1218 Automation and Control Engineering 1

Further courses built on it: -

Topics of course

Basic notions of nonlinear systems, linearization in working point. Case study: temperature control and its modelling. Handling of static nonlinearities, nonlinearity of furnace, equal percentile valve. Typical nonlinearities and their effect. Describing function. Describing functions of some typical nonlinearities. Application of describing function for stability examination, limit cycle. Decreasing of insensitivity band of servo motors, position setting, tachometer feedback. Integrating windup and its elimination, gradient restriction, Foxboro regulator. Standing regulators, improvement their working using feedback. Time proportional regulators. Neural network. Fuzzy logic. Basic notions of sampled data control systems. Choice of sampling time. Mathematical description of sampled signals. Z-transformation. Description of the sampled elements in the time domain and z operator domain. Impulse transfer function. Determination of impulse transfer functions of typical elements. Stability examination of sampled data control systems. Frequency functions of discrete elements. Relation between the continuous and discrete frequency functions. Approximation in low frequency. Discrete PID compensating algorithms. PID regulator planning in the frequency domain. Planning examples. Examples for the planning of discrete PID regulators. Dead-Beat controllers. Internal Model Control (IMC) structure. Smith predictor. Youla controller. Planning examples. State variable description of sampled data control systems. Programming of regulators.

Literature

Compulsory:

- Laszlo Keviczky, Ruth Bars, …: Control Engineering, Szechenyi University Press, Gyor, 2011.

Recommended:

- Franklin, Powell, Emami-Naeini: Feedback Control of Dynamic Systems, Pearson 2014

Schedule:

1st week: Basic notions of nonlinear systems, linearization in working point. Case study: temperature control and its modelling.

2nd week: Handling of static nonlinearities, nonlinearity of furnace, equal percentile valve.

3rd week: Typical nonlinearities and their effect. Describing function. Describing functions of some typical nonlinearities. Application of describing function for stability examination, limit cycle.

4th week: Decreasing of insensitivity band of servo motors, position setting, tachometer feedback.

5th week: Integrating windup and its elimination, gradient restriction, Foxboro regulator.

6th week: Standing regulators, improvement their working using feedback. Time proportional regulators. Neural network. Fuzzy logic.

7th week: Basic notions of sampled data control systems. Choice of sampling time. Mathematical description of sampled signals. Z-transformation.

8th week: Description of the sampled elements in the time domain and z operator domain. Impulse transfer function. Determination of impulse transfer functions of typical elements. Stability examination of sampled data control systems.

9th week: Discrete PID compensating algorithms. PID regulator planning in the frequency domain.

10th week: Examples for the planning of discrete PID regulators. Dead-Beat controllers.

11th week: Internal Model Control (IMC) structure. Smith predictor. Youla controller.

12th week: State variable description of sampled data control systems.

13th week: Test

14th week: Programming of regulators. Test2

Requirements:

Students have to complete test based on the knowledge of computer practices. On test students have to create and apply MATLAB program and simulation. Condition of fulfilment of practical course: successful test. Students cannot take an exam without successful test.

Person responsible for course: Dr. Gabor Katona, associate professor

Lecturer: Dr. Eniko Kosane Kalave, engineer teacher

Title of course: Automation and Control Engineering 2. **Code**: TTFBG1219	**ECTS Credit points:** 2

Type of teaching, contact hours

- practice: 2 hours/week

Evaluation: practical grade

Workload (estimated), divided into contact hours:

- lecture: -
- practice: 20 hours
- laboratory: -
- home assignment: 20 hours
- preparation for the practical grade: 20 hours

Total: 60 hours

Year, semester: 3rd year, 1st semester

Its prerequisite(s): TTFBE1218 Automation and Control Engineering 1., TTFBG1218 Automation and Control Engineering 1.

Further courses built on it: -

Topics of course

Case study: temperature control and its modelling. Typical nonlinearities and their effect. Application of describing function for stability examination, limit cycle. Position setting, tachometer feedback. Integrating windup and its elimination, gradient restriction, Foxboro regulator. Standing regulators, improvement their working using feedback. Time proportional regulators. Description of sampled data signals. Z-transformation, inverse z transformation. Impulse transfer function. Determination of impulse transfer functions of typical elements. Frequency functions of sampled elements. Relation between the continuous and discrete frequency functions. Approximation in low frequency. Discrete PID compensating algorithms. PID regulator design in the frequency domain. Planning examples. Design of Dead-Beat controllers. Internal Model Control (IMC) structure. Smith predictor. Youla controller. Planning examples. State variable description of sampled data control systems. Planning examples. Computer based laboratory practices applying MATLAB/SIMULINK program.

Literature

Compulsory:

- Laszlo Keviczky, Ruth Bars, …: Control Engineering, Szechenyi University Press, Gyor, 2011.

Recommended:

- Franklin, Powell, Emami-Naeini: Feedback Control of Dynamic Systems, Pearson 2014

Schedule:

1st week: Case study: temperature control and its modelling.

2nd week: Typical nonlinearities and their effect.

3rd week: Application of describing function for stability examination, limit cycle.

4th week: Position setting, tachometer feedback.

5th week: Integrating windup and its elimination, gradient restriction, Foxboro regulator.

6th week: Standing regulators, improvement their working using feedback. Time proportional regulators.

7th week: Description of sampled data signals. Z-transformation, inverse z transformation.

8th week: Impulse transfer function. Determination of impulse transfer functions of typical elements. Frequency functions of sampled elements. Relation between the continuous and discrete frequency functions. Approximation in low frequency.

9th week: Discrete PID compensating algorithms. PID regulator design in the frequency domain. Planning examples.

10th week: Design of Dead-Beat controllers.

11th week: Internal Model Control (IMC) structure. Smith predictor. Youla controller. Planning examples.

12th week: State variable description of sampled data control systems. Planning examples.

13th week: Test1.

14th week: Test2. Programming of regulators.

Requirements:

Students have to complete test based on the knowledge of computer practices. On test students have to create and apply MATLAB program and simulation. Condition of fulfilment of practical course: successful test. Students cannot take an exam without successful test.

Person responsible for course: Dr. Gabor Katona, associate professor

Lecturer: Dr. Eniko Kosane Kalave, engineer teacher

Title of course: Telecommunication and infocommunication **Code**: TTFBE1214	**ECTS Credit points:** 3

Type of teaching, contact hours
- lecture: 2 hours/week
- practice: -
- laboratory: -

Evaluation:

Workload (estimated), divided into contact hours:
- lecture: 28 hours
- practice: -
- laboratory: -
- home assignment: 42 hours
- preparation for the exam: 20 hours

Total: 90 hours

Year, semester: 2nd year, 1st semester

Its prerequisite(s): TTFBE1207 Electricity 3.

Further courses built on it: -

Topics of course

Historical Review of Wired and Wireless Telecommunication Technologies, Digital Signal Processing, Computer Networks and Protocols, Satellite Communication and Location, Cellular Telephone networks. (GSM, 3G, LTE), modulation techniques, source and channel encoding, high frequency networks and metering technology. Wave propagation, antennas., measurement methods

Literature

Compulsory:
- digitally available materials on moodle

Recommended:
- Telecommunication,. Géher Károly, Műszaki Könyvkiadó, 2000
- Computer networks, David J. Wetherall, Andrew S. Tanenbaum, Panem Kft 2013

Schedule:

1st week

The development of telecommunication and information transfer technologies, their soci-al role, everyday examples. Presentation of the subject's requirements and structure.

2nd week

Wired Telecommunication Technologies. Historical overview of initial forms of tele-communications, wireline telegraphs, and analog telephone networks. The structure, ele-ments and technological parameters of circuit-switched networks.

3rd week

Digital speech transmission in telephony. Sampling and nonlinear quantization of the speech signal. Theoretical transmission capacity of the communication channel, Shanon's theorem. Frequency and time division multiple access techniques.

4th week

Wireless communication. The formation and history of radio communication. Analog Modulation Techniques (AM, FM). Antenna types, simple antennas. Electromagnetic field of the antenna. The electromagnetic spectrum. Specificity of radio waves.

5th week

GSM phone system. The development of mobile telecommunications. The cellular (cell principle) communication. Access technologies (FDMA, TDMA, FDD) Elements of the GSM network (BST, BSC, VLR, HLR, MSc, Auc). GSM services.

6th week

Computer Networks. Structure of packet-switched networks (PS). Network Layers and Protocols. The most important protocols used in digital data transmission and speech transmission. TCP / IP, UDP, RTC, RTP.

7th week

3G and LTE The history and goals of the development of mobile communications techno-logies. Further developments in GSM (HSDD, PSD), EDGE. CDMA is multiple access technology. Presentation of the elements of the 3G network. Elements of the LTE stan-dard, OFDMA. Network Services, Data Transmission.

8th week

Structure of Multimedia Conference Systems, H323 protocol. Transmission of signals in analog and digital telephony, the structure of SIP. Forwarding your voice over a computer network (VoIP, Skypee). Devices for Internet access at home: aDSL, Cable Displays, Op-tical Cable)

9th week

Satellite communication, speech and data transfer capabilities. The classification of satel-lite tracking (LEO, MEO, GEO) and their peculiarities. Satellite positioning GNSS systems, structure of the GPS system, understanding NMEA messages. Areas of applica-tion.

10th week

The structure of the digital communication channel: Source Encoding, Channel Encoding, Modulation, Blending, Filtering. Digital Modulation Techniques (ASK, PSK, QAM). Ef-fects of the signal-to-channel channel, The receiving side of the communication channel.

11th week

High Frequency (RF) Circuit Elements. Active and Passive Circuit Elements, Characteri-zation of transmission lines, Wave Resistance, Standing Voltage, Impedance Transforma-tion, Schmindt Diagram.

12th week

High Frequency Measurement Techniques. Power Meter, Signal Generator, Vector Signal Generator, Spectrum Analyzer, Vector Spectrum Analyzer, Network Analyzer.

13th week

Local and personal wireless network devices. The ISM band. WiFi standards and commu-nication techniques, Bluetooth based communication. UWB communicati-on.

14th week

Radio Frequency Identification Systems (RFID). Internet of Things solutions and oppor-tunities. Summary.

Requirements:

- for a signature

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

Participation at **laboratory classes** is compulsory.

- for a grade

The course ends in an **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 table:

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

Person responsible for course: Dr. Szabó István

Lecturer: Dr. Szabó István

Title of course: Telecommunication and infocommunication **Code**: TTFBL1214	**ECTS Credit points:** 1
Type of teaching, contact hours - lecture: - - practice: - - laboratory: 1 hours/week	
Evaluation:	
Workload (estimated), divided into contact hours: - lecture: - - practice: - laboratory: 14 hours - home assignment: 14 hours - preparation for the exam: 2 hours Total: 30 hours	
Year, semester: 2nd year, 1st semester	
Its prerequisite(s): TTFBE1207 Electricity 3.	
Further courses built on it: -	

Topics of course

Analogue and Digital Modulation Procedures RF Measurement Technology: Use of a Signal Generator, Spectrum Analyzer and Circuit Analyzer. Measurement of RF transmitter receivers. Digital data transfer techniques, satellite positioning systems

Literature

Compulsory:

- digitally available materials on moodle

Recommended:

- Telecommunication,. Géher Károly, Műszaki Könyvkiadó, 2000
- Computer networks, David J. Wetherall, Andrew S. Tanenbaum, Panem Kft 2013

Schedule:

1st week

Accident prevention education. Presentation of the subject's requirements and structure. Assignment and preparation of measurements. Understanding the safety and technical aspects of laboratory work. Acquiring information about regular work.

2nd week

Implementation and testing of amplitude modulation and demodulation using an educati-onal kit. Oscilloscopic measurements. spectrum analysis. DSBSC modulation and de-modulation implementation.

Learn about modulation circuits, modulation depth, mixer vibration. Demodulation of AM signals. Can connect simple circuit elements, test oscilloscope operation, determine frequency duration

3rd week

Implementation of frequency modulation and demodulation. Understanding the frequency modulating circuits and the steps of demodulation. Testing the FM Transmitter Properties.

4th week

Acquire the handling rutine of measuring instruments. Investigating factors affecting spectral resolution and sensitivity. Realization of simple circuit measurement.

Learn about the use of RF signal generator and spectrum analyzer. Learn how to use set-tings and modes. Simple signal generation and spectral analysis. Passive filter testing. Production and testing of modulated sig-nals.

5th week

TX transmitter module test: Measure the local oscillator (LO) signal. Testing the mixing circuit. Measurement of the filter circuit characteristics. Compilation and examination of the total transmitter.

6th week

RX Unit Testing. Low noise preamp, filter, mixer, local oscillator, filter, end amplifier. Testing and then compiling the receiver unit and running the RX / TX module together for the entire transmission chain.

Implement a measurement process for a complete RF transmitter / receiver unit, study the transmission of modulated signals.

7th week

Understanding the operation of the network analyser, knowing the conditions required for performing authentic measurement, and understanding the measurement results. Use a network analyzer. Learn how to use the circuit monitor. Measuring RF Modules: Examining Distributor and Filter Circuits.

8th week

Testing transmission lines using a network analyzer. Testing of the impendance matching for different transmission line sections. Antenna Testing. Interpretation of the measurements made using the network based on the theoretical knowledge of the transmission lines. Define matching conditions.

9th week

Use RFID systems with an instruction module.

10th week

Introduction of the LabVIEW RF modul components. Simulation of RF transmission chain using LabVIEW. Examination of AM and FM modulation schemas.

11th week

Simulation of RF digital channel operation with LabVIEW. Knowing the elements of the required RF module, compiling data transfer chains, distortion and noise simulation, BER measurements.

12th week

Implementing Bluetooth communication with an embedded device. Testing serial data at different speeds. Learn and study the use of programming and hardware components for bluetooth based data transfer.

13th week

RF module programming as a low power consumption thermometer. Understand the prog-ramming environment, modify and test the application. Measuring energy con-sumption.

14th week

Receiving and processing GPS data. Read location, time and speed data.

Requirements:

- for a signature

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

Participation at **laboratory classes** is compulsory.

- for a grade
The course ends in an **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 table:

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

Person responsible for course: Dr. Szabó István

Lecturer: Dr. Szabó István

Title of course: Labour Protection and Safety Technology **Code**: TTFBE1220	**ECTS Credit points:** 2
Type of teaching, contact hours - lecture: 2 hours/week - practice: - - laboratory: -	
Evaluation: exam	
Workload (estimated), divided into contact hours: - lecture: 28 hours - practice: - - laboratory: - - home assignment: - - preparation for the exam: 32 hours Total: 60 hours	
Year, semester: 3rd year, 1st semester	
Its prerequisite(s): TTFBE1223 Electrotechnology, TTFBE1216 Electric Power Systems	
Further courses built on it: -	

Topics of course

General labour protection: Legal, administrative, organizational and management questions of labour protection. Healthy and safe working environment. Protection against electric shock: Electric shock. Establishment of protection against electric shock. Protections against direct contacts. Protections against indirect contacts. Combined protections against direct and indirect contacts. Application of protection against electric shock. Fire protection. Lightning protection.

Literature

Compulsory:

United Nations International Labour Organization Encyclopaedia of Occupational Health and Safety, Volume I-III.

Recommended:

Schedule:

1st week

Notion, tasks and tools of labour protection. Legal, administrative, organizational questions of labour protection. The law of labour protection.

2nd week

The healthy and safe working environment.

3rd week

Industrial medicine, fundamentals of occupational physiology. Protective equipment, occupational safety, accident analysis.

4th week

Risk assessment. Recognition of hazard sources. Safety reviews. Labour protection education, documentation. Safety technology of machines and devices.

5th week

Notion of chemical safety, basic notions relating to dangerous substances, wastes, physical, chemical, fire-protection classification of dangerous substances.

6th week

Environmental risks and environmental safety.

7th week First mid-term test. *8th week* Physiological effects of electric shock, first aid in case of electric shock. *9th week* Protection methods against electric shock. *10th week* Protection methods against electric shock. *11th week* Protection methods against electric shock. *12th week* Fire protection: basic notions, flammable materials, technologies, fire-protection of buildings, machines, devices, fire-fighting. National fire safety regulations. *13th week* Lightning protection. *14th week* Second mid-term test.
Requirements: In the framework of the lecture the students have the possibility to get an offered grade. Prerequisite of this is to write two mid-term tests with accomplishment of at least satisfactory level. The exam is a written test. The grades are determined by the following rating: 0-49 % – fail (1) 50-62 % – pass (2) 63-75 % – satisfactory (3) 76-88 % – good (4) 89-100 % – excellent (5)
Person responsible for course: Dr. Réka Trencsényi, assistant professor
Lecturer: János Kosa, assistant professor

Title of course: Programmable logical devices **Code**: TTFBE1311-EN	**ECTS Credit points:** 1
Type of teaching, contact hours - lecture: 1 hours/week - practice: - - laboratory: -	
Evaluation: exam	
Workload (estimated), divided into contact hours: - lecture: 14 hours - practice: - - laboratory: - - home assignment: - - preparation for the exam: 16 hours Total: 30 hours	
Year, semester: 3rd year, 1st semester	
Its prerequisite(s): TTFBE1222-EN Digital Electronics 2., TTFBE1201-EN Programming 1.	
Further courses built on it: -	

Topics of course

Basics of VHDL (**V**HSIC **H**ardware **D**escription **L**anguage, VHSIC - Very High Speed Integrated Circuit). The steps of hierarchical design. Timing and synchronisation. Communication busses, SPI, I2C, UART. Microprocessor in FPGA.

Literature

- Pong P. Chu, FPGA Prototyping by VHDL Examples: Xilinx Spartan-3 Version, ISBN:978-0-470-18531-5
- Clive Maxfield, The Design Warrior's Guide to FPGAs. Devices, Tools and Flows, ISBN:0750676043
- Steve Kilts, Advanced FPGA Design: Architecture, Implementation, and Optimization, ISBN: 978-0-470-05437-6

Schedule:

1st week

Basic of VHDL. Counter, registers, timing. Hierarchical design.

2nd week

SPI bus

3rd week

I2C bus

4th week

UART

5th week

Microprocessor in FPGA environment

6th week

Work with microprocessor 1.

7th week

Work with microprocessor 2.

8th week

Work with microprocessor 3.

9th week

Temperature sensor readout

10th week

Fault tolerance communication

11th week

Communication with the microprocessor implemented in FPGA card

12th week

Communication with the microprocessor implemented in FPGA card

13th week

Summary, discussion of questions emerging during the semester.

14th week

Summary, discussion of questions emerging during the semester.

Requirements:

The course exam is a written examination. In the exam theoretical questions and practical problems must be answered and solved in 100 minutes. The evaluation of the exam occurs based on the following grading:

0–59 % → 1,

60–69 % → 2,

70–79 % → 3,

80–89 % → 4,

90–100 % → 5

Person responsible for course: Dr. Balázs Ujvári, assistant professor, PhD

Lecturer: Dr. Balázs Ujvári, assistant professor, PhD

Title of course: Programmable logical devices **Code**: TTFBE1311-EN	**ECTS Credit points:** 4

Type of teaching, contact hours
- lecture: -
- practice: -
- laboratory: 3 hours/week

Evaluation: signature + grade for written tests

Workload (estimated), divided into contact hours:
- lecture:-
- practice: -
- laboratory: 42 hours
- home assignment: 58 hours
- preparation for the exam: 20 hours

Total: 120 hours

Year, semester: 3rd year, 1st semester

Its prerequisite(s): TTFBE1222-EN Digital Electronics 2., TTFBE1201-EN Programming 1.

Further courses built on it: -

Topics of course

Basics of VHDL (**V**HSIC **H**ardware **D**escription **L**anguage, VHSIC - Very High Speed Integrated Circuit). The steps of hierarchical design. Timing and synchronisation. Communication busses, SPI, I2C, UART. Microprocessor in FPGA.

Literature

- Pong P. Chu, FPGA Prototyping by VHDL Examples: Xilinx Spartan-3 Version, ISBN:978-0-470-18531-5
- Clive Maxfield, The Design Warrior's Guide to FPGAs. Devices, Tools and Flows, ISBN:0750676043
- Steve Kilts, Advanced FPGA Design: Architecture, Implementation, and Optimization, ISBN: 978-0-470-05437-6

Schedule:

1st week

Basic of VHDL. Counter, registers, timing. Hierarchical design.

2nd week

SPI bus

3rd week

I2C bus

4th week

UART

5th week

Microprocessor in FPGA environment

6th week

Work with microprocessor 1.

7th week

Work with microprocessor 2.

8th week

Work with microprocessor 3. *9th week* Temperature sensor readout *10th week* Fault tolerance communication *11th week* Communication with the microprocessor implemented in FPGA card *12th week* Communication with the microprocessor implemented in FPGA card *13th week* Summary, discussion of questions emerging during the semester. *14th week* Summary, discussion of questions emerging during the semester.
Requirements: *The course test is a written examination. Practical problems and coding questions must be answered and solved in 100 minutes. The evaluation of the exam occurs based on the following grading:* *0–59 % → 1,* *60–69 % → 2,* *70–79 % → 3,* *80–89 % → 4,* *90–100 % → 5*
Person responsible for course: Dr. Balázs Ujvári, assistant professor, PhD
Lecturer: Dr. Balázs Ujvári, assistant professor, PhD

Title of course: Applications of Embedded systems (project)
Code: TTFBE1312

ECTS Credit points: 1

Type of teaching, contact hours
- lecture: 1 hours/week
- practice: -
- laboratory: -

Evaluation: grade for lab. report

Workload (estimated), divided into contact hours:
- lecture: 14 hours
- practice: -
- laboratory: -
- home assignment: 16
- preparation for the exam: -

Total: 30 hours

Year, semester: 3rd year, 1st semester

Its prerequisite(s): TTFBL1213

Further courses built on it: -

Topics of course

Understanding the LabVIEW project structure. CompactRIO industrial instrumentation hardware and software components. Install LabVIEW to use this tool. Various options for using the device (Scan, FPGA, and mixed mode). Using analog and digital out / inputs, special modules, PWM, encoder, etc. use. Timed Program Structure and Use of Industry Measurements, Video Camera and Image Processing Functions. Hardware and software elements of ARDUINO (GENUINO) embedded microcontroller device. Install the programming environment to use the tool. Using Processing, Connectivity, Programming in LabVIEW Environment. Analogue and digital out / inputs, use of PWM, programming basics.

Literature

E-learning interface of the UD Physics Institute (moodle.phys.unideb.hu)

Schedule:

1st week

Presentation of the LabVIEW project structure. CompactRIO industrial instrumentation hardware and software components

2nd week

Installation of the programming and running environment to use the tool

3rd week

Various options for using the device (Scan, FPGA, and mixed mode)

4th week

Use analogue outputs / inputs

5th week

Digital Outputs / Inputs, Special Modules, PWM, Encoder use, etc.

6th week

Special program structures on cRIO

7th week

Timed Program Structure and Usage

8th week

Presentation of the capabilities of digital camera and image processing functions *9th week* Hardware and software elements of ARDUINO (GENUINO) embedded microcontroller device *10th week* Installation of the programming and running environment to use the tool *11th week* Use Processing software and it's connectivity options *12th week* Use analogue and digital out / inputs. *13th week* PWM usage, basics of programming *14th week* Closing test (test assignment + programming assignment)
Requirements: *- for a grade* Attendance at **lectures** is recommended, but not compulsory. During the semester you will be able to write a tutorial on the exam, and to solve the project work on both platforms (an optional list or an independent idea). After the completion of the final exam at least 75% of the project work, the student may attend the project work. The group of up to 2 people in the project work should also be required to use the manual for use of the program. • 75% completion of classroom work: sufficient • a program completed during project work is in operation but responds to questions posed during the presentation, the structure of the program and the user guide are difficult to understand: medium • The program completed during the project work is functioning satisfactorily, and the program's structure, user interface and operating instructions are well-answered: good • a program that is completed during the presentation of project work works, responds to the questions positively, the structure of the program is well-traced, its user interface and user's guide are consistent and easy to understand: excellent
Person responsible for course: Dr. Csaba Cserh áti, associate professor, PhD
Lecturer: Dr. Csaba Cserháti, associate professor, PhD, Dr. Bence Partditka assistant professor, János Tomán assistant lecturer

Title of course: Applications of Embedded systems (project) **Code**: TTFBL1312	**ECTS Credit points**: 2

Type of teaching, contact hours
- lecture: 0 hours/week
- practice: -
- laboratory: 3 hours/week

Evaluation: grade for laboratory report

Workload (estimated), divided into contact hours:
- lecture: -
- practice: -
- laboratory: 42 hours
- home assignment: 40 hours
- preparation for the exam: -

Total: 82 hours

Year, semester: 3rd year, 1st semester

Its prerequisite(s): TTFBL1312

Further courses built on it: -

Topics of course

Understanding the LabVIEW project structure. CompactRIO industrial instrumentation hardware and software components. Install LabVIEW to use this tool. Various options for using the device (Scan, FPGA, and mixed mode). Using analog and digital out / inputs, special modules, PWM, encoder, etc. use. Timed Program Structure and Use of Industry Measurements, Video Camera and Image Processing Functions. Hardware and software elements of ARDUINO (GENUINO) embedded microcontroller device. Install the programming environment to use the tool. Using Processing, Connectivity, Programming in LabVIEW Environment. Analogue and digital out / inputs, use of PWM, programming basics.

Literature

E-learning interface of the UD Physics Institute (moodle.phys.unideb.hu)

Schedule:

1st week Introduction to the project work max.

Creating groups of max. 2 students, selecting projects (one by one). Presentation of the LabVIEW project structure. CompactRIO industrial instrumentation hardware and software components.

2nd week

Project work, consultation.

3rd week

Project work, consultation.

4th week

Project work, consultation.

5th week

Project work, consultation.

6th week Project work, consultation. *7th week* Project work, consultation. *8th week* Project work, consultation. *9th week* Project work, consultation. *10th week* Project work, consultation. *11th week* Project work, consultation. *12th week* Project work, consultation. *13th week* Project work, consultation. *14th week* Presentation of the Project work
Requirements: *- for a grade* Attendance at **laboratory practices** is compulsory. During the semester, each project will be solved for each project (optional or self-contained). The project work will be evaluated for at least 75% of the final exam closing the theoretical course. The project work is presented as a presentation of the group with a maximum of 2 people, which must be accompanied by the manual for use of the program besides the program. • The completed program works, its handling is not clear, the documentation is incomplete: sufficient • a program completed during project work is in operation but responds to questions posed during the presentation, the structure of the program and the user guide are difficult to understand: medium • The program completed during the project work is functioning satisfactorily, and the program's structure, user interface and operating instructions are well-answered: good • a program that is completed during the presentation of the project work, its handling is user-friendly, responds to the questions positively, the structure of the program is well-traced, its user interface and user's guide are consistent and easy to understand: excellent
Person responsible for course: Dr. Csaba Cserháti, associate professor, PhD
Lecturer: Dr. Csaba Cserháti, associate professor, PhD, Dr. Bence Partditka assistant professor, János Tomán assistant lecturer

Title of course: Digital Signal Processing **Code**: TTFBL1316	**ECTS Credit points:** 1

Type of teaching, contact hours
- lecture: 1 hours/week
- practice: -
- laboratory: -

Evaluation:

Workload (estimated), divided into contact hours:
- lecture: -
- practice: -
- laboratory: 14 hours
- home assignment: - 16 hours
- preparation for the exam: -

Total: 30 hours

Year, semester: 3rd year, 1st semester

Its prerequisite(s): TTFBE1207 Electricity 3.

Further courses built on it: -

Topics of course

Properties of the analog and digital signal processing systems, Digitalisation and sampling process. Signal generation and processing. Properties of digital filters (FIR, IIR). Fast Fourier Transformation – signals in the frequency and time domains. The architecture and programming of DSP processors. Harward architecture. Programing techniques, optimized filter algorithms and FFT. DSP programming using data flow methods.

Applications of digital signal processing and signal processors. Digital signal processing method: sampling and quantization, filter algorithms (FIR, IIR) and their implementation, Spatial characterization of signal frequencies. Fourier Transform Type, Fast Fourier Transform Transformation Implementation. Structure and type of signal processing processors. DSP processors architecture and instructions set. Addressing modes, interrupt system, peripherals management. Programming Techniques.

Literature

Compulsory:
- digitally available materials on moodle.

Recommended:
- The Scientist & Engineer's Guide to Digital Signal Processing, Steven W. Smith, California Technical Publishing
  A Simple Approach to Digital Signal Processing, Craig Marven, Gillian Ewers, Willey

Schedule:

1st week

Basic characterization of digital signal processing and signal processors. Digital and analog signal processing methods. Features of DSP Processors, Application Areas, Benefits and Drawbacks. The Harward architecture

2nd week

Number representation, fixed-point, fractional and floating-point numbers. DSP processor families, their application areas and features. Selecting the DSP processor that matches the application.

3rd week

Digital Signal Filtering, Digital Filter Algorithms (FIR, IIR Filters). Linear phase filters. to select the appropriate filter type for the application

4th week

Examining signals in frequency spectrum using the Fourier transform. Fourier Transforms Family (Fourier Line, Fourier Transform, Discrete Fourier Transform, Discrete Fourier Transform) and Properties.

5th week

Real-time signal processing with DSP processor. .Filtering algorithm is an efficient implementation with a DSP processor. ALU and mul-tiplier units. MAC operation, addressing modes, cycle management, implementation of a delay chain.

6th week

Real-time Fourier transform using DPS processor. Fast Fourier Transform Algorithm (FFT). Implementation of the calculation process, decimation and hardware with bit-reverzed addressing.

7th week

DSP processor for real-time encoding and compression. Transmission of digital signals. Realization of speech encoding using Vocoder, Wave-form en-coding.

8th week

Transformation based encoders for real-time image compression. Introduction to coding Techniques for Picture and Video Signals. JPEG, MPEG encoding.

9th week

DSP Processor Programming Techniques, DSP processor interruption system. Memory map, translation and linking process. As-sembler and C code const-ruction.

10th week

Use of internal peripherals. Timing and sampling circuits. Generate output PWM signals .

11th week

Signal Processing Methods in the time domain: Moving averages, standard deviation, RMS estimation, statistical characterization.

12th week

Practical applications of filtering algorithms. Design of digital filters, parametristaion

13th week

Applications of the Fourier transform. Selecting a window function and averaging methods.

14th week

Summarize the procedures and methods familiar with the exercises and the lecture.

Requirements:

- for a signature

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

Participation at **practice classes** is compulsory.

- for a grade

The theoretical part ends in an exam. The grade is given based on the theoretical test result and the result of the practical application based on the accompanying practice..

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 practice problem results is given according to the following table:

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:* -
Based on the excellent solution of the practice problems and homework assignments.

Person responsible for course: Dr. Szabó István

Lecturer: Dr. Szabó István

Title of course: Digital Signal Processing
Code: TTFBE1316

ECTS Credit points: 2

Type of teaching, contact hours
- lecture: 1 hours/week
- practice: -
- laboratory: -

Evaluation:

Workload (estimated), divided into contact hours:
- lecture: - 14 hours
- practice: -
- laboratory: -
- home assignment: 16 hours
- preparation for the exam: 30 hours

Total: 60 hours

Year, semester: 3nd year, 1st semester

Its prerequisite(s): TTFBE1207 Electricity 3.

Further courses built on it: -

Topics of course

Characterisation of Digital and Analog Signal Processing Systems, Digitization and Sampling Process. Generate and process signals. Characterisation of digital filters (FIR, IIR). Fast Fourier Transform - signals in frequency and time domain. Architecture and programming of DSP processors. Harward architecture. Programming Techniques, Optimized Filter Algorithms, and FFT.

Fields of application of digital signal processing and signal processors. Digital signal processing method: sampling and quantization, filter algorithms (FIR, IIR) and their implementation, Spatial characterization of signal frequencies. The Fourier Transform Type, the implementation of the Fast Fourier Transform. Solve complex signal processing tasks.

Literature

Compulsory:
- digitally available materials on moodle.

Recommended:
- The Scientist & Engineer's Guide to Digital Signal Processing, Steven W. Smith, California Technical Publishing
  A Simple Approach to Digital Signal Processing, Craig Marven, Gillian Ewers, Willey

Schedule:

1st week

Dataflow Programming (LabVIEW) as a basic tool. Generate and display digital signals. Learn how to use the programming environment appropriately. Learn about the charac-teristics of sampled signals.

2nd week

Handling standard digital signals, using a hardware tool, managing channel data, learning data formats. Monaural and Stereo audio (wav file), laoding, playback and saving

3rd week

Using a digital filter. Selecting and parameterizing a filter type, displaying the effect of filtering. Parametrization and application techniques for digital filters.

4th week

Signals in frequency space with Fourier transformation, Window selection, effect of transformation parameters. Application of Fourier Transform Algorithms.

5th week

Learning DSP processor programming tools. DSP Processor Programming Methods. Use Code Composer Studio to compile and test a project.

6th week

Practical demonstration of DSP processor operation. Programming DSP Processors. Investigating the implementation of a filter algorithm using the DSP processor.

7th week

Project work solving and time domain signal processing problem: Processing noisy ECG signals, determining heart rate 1.

8th week

Project work filters and time-based signal processing. Signal Processing Project Problem: Processing noisy ECG signals, determining heart rate 2.

9th week

Learn about managing hardware digitizing tools in different environments. Collecting and displaying signals in a hardware environment (sound card, USB device, DPS porcessor system)

10th week

Realization of signal transformation and frequency based analysis of characteristics. Sound Recognition and Classification Project: Recognition of Coins sound 1

11th week

Sound Recognition and Classification Project: Recognition of Coins sound 2.

12th week

Telecommunication application of signal processing method. Realization of a digital modulation scheme.

13th week

Control theory example : Implementing a PID controller in a hardware environment

14th week

Final practice, demonstration of skills, evaluation of project results.

Requirements:

- for a signature

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

Participation at **practice classes** is compulsory.

- for a grade

The theoretical part ends in an test. The grade is given based on the test result and the result of the accompanying practice.

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 practice problem results is given according to the following table:

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: -

Person responsible for course: Dr. Szabó István

Lecturer: Dr. Szabó István

Title of course: Nanotechnology and nanoelectronics **Code**: TTFBE1103-EN	**ECTS Credit points**: 4

Type of teaching, contact hours
- lecture: 2 hours/week
- practice: 1 hours/week
- laboratory: -

Evaluation: exam

Workload (estimated), divided into contact hours:
- lecture: 28 hours
- practice: 14 hours
- laboratory: -
- home assignment: 42 hours
- preparation for the exam: 36 hours

Total: 120 hours

Year, semester: 3rd year, 2nd semester

Its prerequisite(s): TTFBE1225-EN, TTFBE1221-EN

Further courses built on it: -

Topics of course

The history of nanotechnology. Electrical, optical and mechanical properties on the nanoscale. From micro to nano. Size effects. Main types of nanostructured materials. Research and production at the nanoscale. Basic elements of the nanotechnology: fullerenes, carbon nanotubes, graphene, metals, ceramics, Nanoporous materials. Preparation of nanostructured materials: bottom up and top down technology. Investigation of nanostructured materials: SEM, EDS, TEM, XPS, SIMS/SNMS, AFM, SPM, IR, Raman, XRD, UV Vis. Physical properties of nanostructured materials: surface, surface energy, particle size, and shape. Magnetic, optical and electrical properties of nanostructured materials. Application of nanostructured materials: data storage, sensors, biology, solar cells, photovoltaic. The spectra of electrons in nanostructured materials. Superlattices, materials, and technology. Quantum structures: light sources and detectors. Nanostructured materials and catalysis. Elements of plasmonics. Devices of micro and nanoelectronics, their properties, parameters and technology and application. Organic nanostructured materials, bio-nanotechnology. Self-organizing at the nanoscale. Molecular electronics.

Literature

Compulsory:

1. Gabor L. Hornyak, H.F. Tibbals, Joydeep Dutta, John J. Moore, Introduction to Nanoscience and Nanotechnology, CRS Press, 2008
2. M.A. Herman, Semiconductor superlattices, Academie Verlag, Berlin, 1986.

Schedule:

1st week

The history of nanotechnology. Electrical, optical and mechanical properties on the nanoscale. From micro to nano. Size effects. Main types of nanostructured materials. Research and production at the nanoscale.

2nd week

Basic elements of the nanotechnology: fullerenes, carbon nanotubes, graphene, metals, ceramics, Nanoporous materials.

3rd week

Preparation of nanostructured materials: bottom-up technology.

4th week

Preparation of nanostructured materials: top-down technology.

5th week

Investigation of nanostructured materials: SEM, EDS, TEM, XPS, SIMS/SNMS.

6th week

Investigation of nanostructured materials: AFM, SPM, IR, Raman, XRD, UV VIS.

7th week

Physical properties of nanostructured materials: surface, surface energy, particle size and shape

8th week

Magnetic, optical and electrical properties of nanostructured materials.

9th week

Application of nanostructured materials: data storage, sensors, biology

10th week

Application of nanostructured materials: solar cells, photovoltaic.

11th week

The spectra of electrons in nanostructured materials. Superlattices, materials, and technology.

12th week

Quantum structures: light sources and detectors. Nanostructured materials and catalysis.

13th week

Elements of plasmonics. Devices of micro and nanoelectronics, their properties, parameters and technology and application.

14th week

Organic nanostructured materials, bio-nanotechnology. Self-organizing at the nanoscale. Molecular electronics. Trends in the development of photonics.

Requirements:

- for a signature

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

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

- for a grade

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

- 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 table:

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 of the mid-term and end-term tests is at least satisfactory (3). The offered grade is the average of them.
Person responsible for course: Dr. István Csarnovics, assistant professor, PhD
Lecturer: Dr. István Csarnovics, assistant professor, PhD

Title of course: Photonics **Code**: TTFBE1315-EN	**ECTS Credit points:** 3

Type of teaching, contact hours
- lecture: 2 hours/week
- practice: -
- laboratory: -

Evaluation: exam

Workload (estimated), divided into contact hours:
- lecture: 28 hours
- practice: -
- laboratory: -
- home assignment: 28 hours
- preparation for the exam: 34 hours

Total: 90 hours

Year, semester: 3rd year, 2nd semester

Its prerequisite(s): TTFBE1225-EN, TTFBE1221-EN

Further courses built on it: -

Topics of course

Photometry. Electromagnetic waves. Geometrical optics: absorption, reflection, transmission, reflection, polarization. Optical elements: mirrors, filters, lenses, prisms. Materials for Photonics, their parameters, and possible applications. Interference and diffraction. Active and passive materials for photonics and their technology. Light sources: physical basis, types, and application. LED and lasers. Photodetectors, photo resistance, photodiodes, transistor. Active optical devices and their properties: modulators, converters, bistable elements. LCD elements, projector. Monitors and displays. Optical data storage: materials and elements, technologies and properties and parameters. Holography: materials and technology. Optoelectronic devices: optoelectronic switching element, CCD, and solar cells. Optical fibers, optical waveguides, optical sensors. Integrated optics: materials, devices and their application. Plasmonic elements: physical basis, materials, and applications.

Literature

Compulsory:

1. Sze S.M. and Ng K.K. Physics of Semiconductor Devices. Wiley and Sons, 2006.
2. Sedra A.S., Smith K.C.: Microelectronic Circuits. Oxford Series in Electrical & Computer Engineering, 5th edition, Oxford University Press Inc., U.S. 2004.
3. Nalwa H.S. Nanostructured Materials and Nanotechnology. Elsevier, 2002.

Schedule:

1st week

Introduction to photonics. Electromagnetic waves. Wave and particle nature of the light.

2nd week

Geometrical optics: absorption, transmission, reflection, and polarization. Lenses, prisms, polarization. Materials, parameters, and application.

3rd week

Interference, diffraction, optical elements and their application.

4th week

Light sources. Lasers. Semiconductor laser diodes. Materials and application.

5th week

Photodetectors. Spectrometers. Materials and application

6th week

Optical mirrors, windows, filters. Materials, technology, and application

7th week

Active optical devices and their parameters.

8th week

LCD elements. Displays. Luminescence displays.

9th week

Optical data storage: elements, materials, technology, and parameters.

10th week

Holography. Materials, technology, and application.

11th week

Optoelectronic elements, optical switches, solar cells.

12th week

Integrated optics and their elements: lenses, waveguides, interferometers, sensors.

13th week

Plasmonics and its elements. Materials, technology, and application.

14th week

Trends in the development of photonics.

Requirements:

- for a signature

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

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.

- for a grade

The course ends in an **examination**. Based on the examination, the exam grade is calculated as a:

-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 table:

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 mid-term and end-term tests is at least satisfactory (3). The offered grade is the average of them.

Person responsible for course: Dr. István Csarnovics, assistant professor, PhD

Lecturer: Dr. István Csarnovics, assistant professor, PhD

Title of course: Photonics, laboratory work **Code**: TTFBL1315 -EN	**ECTS Credit points:** 2

Type of teaching, contact hours
- lecture: -
- practice: -
- laboratory: 2 hours/week

Evaluation: signature and grade for laboratory work

Workload (estimated), divided into contact hours:
- lecture: -
- practice: -
- laboratory: 28 hours
- home assignment: 32 hours
- preparation for the exam: -

Total: 60 hours

Year, semester: 3rd year, 2nd semester

Its prerequisite(s): TTFBE1225-EN, TTFBE1221-EN

Further courses built on it: -

Topics of course

Photometry. Electromagnetic waves. Geometrical optics: absorption, reflection, transmission, reflection, polarization. Optical elements: mirrors, filters, lenses, prisms. Materials for Photonics, their parameters, and possible applications. Interference and diffraction. Active and passive materials for photonics and their technology. Light sources: physical basis, types, and application. LED and lasers. Photodetectors, photo resistance, photodiodes, transistor. Active optical devices and their properties: modulators, converters, bistable elements. LCD elements, projector. Monitors and displays. Optical data storage: materials and elements, technologies and properties and parameters. Holography: materials and technology. Optoelectronic devices: optoelectronic switching element, CCD, and solar cells. Optical fibers, optical waveguides, optical sensors. Integrated optics: materials, devices and their application. Plasmonic elements: physical basis, materials, and applications.

Literature

Compulsory:

1. Sze S.M. and Ng K.K. Physics of Semiconductor Devices. Wiley and Sons, 2006.
2. Sedra A.S., Smith K.C.: Microelectronic Circuits. Oxford Series in Electrical & Computer Engineering, 5th edition, Oxford University Press Inc., U.S. 2004.
3. Nalwa H.S. Nanostructured Materials and Nanotechnology. Elsevier, 2002.

Schedule:

1st week

Investigation of different light sources: halogen, cathode, LED, lasers. The intensity and spectral distribution.

2nd week

Investigation of different light sources: halogen, cathode, LED, lasers. The intensity and spectral distribution.

3rd week

Investigation of optical filters: neutral, interference, spectral and antireflection coating.

4th week

Investigation of optical filters: neutral, interference, spectral and antireflection coating.

5th week

Investigation of optical waveguides and its parameters.

6th week

Investigation of optical waveguides and its parameters.

7th week

Optical data storage: materials, recording, and parameters. Sensitivity and affectivity.

8th week

Optical data storage: materials, recording, and parameters. Sensitivity and affectivity.

9th week

Investigation of properties of a solar cell.

10th week

Investigation of properties of a solar cell.

11th week

Investigation of properties of a solar cell.

12th week

Investigation of properties of a solar cell.

13th week

Evaluation of the experimental results and fabrication of the report.

14th week

The presentation of the report of the experimental results.

Requirements:

- for a signature

Participation at laboratory works is compulsory. A student must attend the laboratory works 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 laboratory works will be recorded by the laboratory work leader. Being late is equivalent with an absence. In case of further absences, a medical certificate needs to be presented. Missed laboratory works should be made up for at a later date, to be discussed with the tutor. Students are required to bring the reports to each laboratory works. 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 six designing reports** as a scheduled minimum on a sufficient level.

- for a grade

The course ends with a presentation of the report of the experimental results and with a grade for it. Based on the average of the grades of the designing tasks, the grade is calculated as an average of them:

- the average grade of the six designing tasks

The grade for the tasks is given according to the following table:

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 task is below 60, students can take a retake the report in conformity with the EDUCATION AND EXAMINATION RULES AND REGULATIONS.

Person responsible for course: Dr. István Csarnovics, assistant professor, PhD

Lecturer: Dr. István Csarnovics, assistant professor, PhD

Title of course: Technical image processing **Code**: TTFBE1313	**ECTS Credit points**: 2
Type of teaching, contact hours - lecture: 1 hours/week - practice: - - laboratory: 2 hours/week	
Evaluation: grade for lab. report	
Workload (estimated), divided into contact hours: - lecture: 14 hours - practice: - - laboratory: 28 hours - home assignment: 40 hours - preparation for the exam: - Total: 82 hours	
Year, semester: ?	
Its prerequisite(s): TTFBL1213	
Further courses built on it: -	

Topics of course

The fundamentals of the theory of vision. Introduction to digital images: sampling, quantization, restoration. Introduction to image processing: arithmetic operations. Image repair procedures: point and spatial transformations, luminance code transformations, linear and nonlinear coordinate transformations, convolutions, correlations, filters. Image Enhancement in Frequency Range, Fourier Transform, Filtering in Fourier Space. Image processing on morphological basis, segmentation. Image Transformations (Fourier, Hough, Radon). Form recognition, statistical and synthetic pattern recognition, texture analysis.

Literature

E-learning interface of the UD Physics Institute (moodle.phys.unideb.hu)

Schedule:

1st week

Introduction to digital images: sampling, quantization LabVIEW image processing options, image scanning from a file, image display options.

2nd week

Introduction to image processing: Arithmetic Operations, Event-driven Programming Structure; Making and using ROI.

3rd week

Image enhancement procedures: point transformations, histogram, luminance code transformations; making and using a mask; state machine programming structure.

4th week

Image enhancement procedures: linear and nonlinear coordinate transformations, cummulative histogram; Use cluster variables during programming.

5th week

Convolution: Low and High Pass Filters, Correlation, Pattern Recognition, Camera Usage.

6th week

Image Enhancement in Frequency Range, Fourier Transform, Filtering in Fourier Space.

7th week

Image processing on morphological basis, segmentation.

8th week

Image Transformations (Hough, Radon), Hough Transformation Implementation.

9th week

Component checking: Coordinate systems, pattern recognition.

10th week

Closing test (test assignment + programming assignment).

11th week

Project work, consultation.

12th week

Project work, consultation.

13th week

Project work, consultation.

14th week

Presentation of project work.

Requirements:

- for a grade

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

During the semester the student will be asked to write a written exam and a project work solution (optional or optional). After the completion of the final exam at least 75% of the project work, the student may attend the project work. The project work is presented as a presentation of the group with a maximum of 2 students, which must be accompanied by the manual for use of the program besides the program.

• 75% completion of classroom work: sufficient

• the program completed during project work is in operation and its use is cumbersome; during the presentation the student responds to the questions asked, the structure of the program and the instruction manual are incomplete: medium

• The program completed during the project work is functioning satisfactorily, and the program's structure, user interface and operating instructions are well-answered: good

• a program that is completed during the presentation of project work works, responds to the questions positively, the structure of the program is well-traced, its user interface and user's guide are consistent and easy to understand: excellent

Person responsible for course: Dr. Csaba Cserh áti, associate professor, PhD

Lecturer: Dr. Csaba Cserháti, associate professor, PhD, Dr. Bence Partditka assistant professor, János Tomán assistant lecturer

Title of course: Industrial process control **Code**: TTFBE1321	**ECTS Credit points:** 4

Type of teaching, contact hours
- lecture: 3 hours/week
- practice: -
- laboratory: -

Evaluation: term mark

Workload (estimated), divided into contact hours:
- lecture: 42 hours
- practice: -
- laboratory: -
- home assignment: 56 hours
- preparation for the exam: 22 hours

Total: 120 hours

Year, semester: 3rd year, 1st semester

Its prerequisite(s): TTFBE1222 Digital Electronics 2., TTFBE1201 Programming 1., TTFBE1223 Electrotechnology

Further courses built on it: TTFBL1301 Individual Laboratory, TTFBG1302 Diploma Thesis, TFBE1521, TTFBE1522 Industrial Supervisory and Control Systems 1., 2.

Topics of course

Basic concepts of control engineering. Control systems. Technological process groups. Development of automation devices and systems. Structure, classification, operating model of PLCs. Modular and compact PLC systems. PLC programming, programming languages. Characteristics, types of variables, instructions, functions, function blocks in textual and graphic PLC languages according to IEC61131-3 standard. Set of elements in ladder diagram, instruction list, function block diagram programming languages. Structured text as a high-level programming language in control system programming. Basics of sequential function chart (SFC) design, set of elements in SFC language. Program development aspects. Possibilities of programming and program portability. High-reliability PLCs and their characteristics: self-test, methods of fault recognition and fault deletion. Concept and structure of distributed control systems. PLC field and sensor buses. Viewpoints of design, methods and steps of design. Tasks of PLC system installation, presentation of a few specific PLC families. Human-machine interface (HMI) devices. Supervisory control and data acquisition (SCADA) systems.

Literature

Compulsory:
- Rehg J.A., Sartori G.J.: Programmable logic controllers. Pearson, 2nd ed., 2013.
- Bryan L.A., Bryan E.A.: Programmable Controllers. Theory and Implementation. Marletta: Industrial Text Company (2nd ed.), 1997.
- Manufacturers' PLC, HMI manuals, PLC programming manuals.

Recommended:
- Hackworth J.R., Hackworth F.D, Jr.: Programmable logic controllers: Programming methods and applications. Delhi: Pearson Education, 2004.
- Bolton W.: Programmable logic controllers. New Delhi: Newnes (Elsevier), 2008.

– Parr E.A.: Programmable Controllers. An Engineer's Guide. Amsterdam: Newnes (Elsevier, 3rd ed.), 2003.
– Petruzella F.D.: Programmable logic controllers. New York: McGraw-Hill, 4th ed., 2011.

Schedule:

1st week

Basic concepts of control engineering. Control systems. Technological process groups. Development of automation devices and systems.

2nd week

Functional structure, classification, operating model of PLCs. Modular and compact PLC systems.

3rd week

Structure of PLC hardware I.: byte- and word-based PLCs, microprocessor-based PLC hardware structure.

4th week

Structure of PLC hardware II.: digital input and output units.

5th week

Structure of PLC hardware III.: analog input and output modules, special PLC modules.

6th week
Mid-term test.
IEC 61131-3 standard directives regarding structure of PLC projects. Programming languages and their peculiarities according to IEC 61131-3 standard.

7th week

Set of elements in ladder diagram, instruction list and function block programming language.

8th week

Structured text as a high-level programming language in control system programming. Basics of sequential function chart (SFC) design, set of elements in SFC language.

9th week

Program development aspects. Possibilities of programming and program portability.

10th week

Industrial control networks. Ethernet network. PLC field bus systems.

11th week

Modbus, Profibus, Canopenbus communication.

12th week

Viewpoints of PLC selection, hardware selection, problems of system performance, environmental conditions, operation requirements.

13th week
End-term test.
Enhancement of PLC system reliability.

14th week
Improvement retest.
Human-machine interface (HMI) devices. Supervisory control and data acquisition (SCADA) systems. Concept and structure of distributed control systems.

Requirements:

- for a signature

Attendance at **lectures** is recommended, but not compulsory. Condition for sign obtaining is a successful (at least passed grade) write of two tests according to semester assessment timing. During the semester there are two tests: the mid-term test in the 6th week and the end-term test in the 13th week. Students' participation on the tests is mandatory. There is an improvement test in the 14th week. Students have an opportunity to retake failed test(s). - *for a grade* The course ends in an **examination**. Signature receipt is a precondition for exam eligibility. Results of two tests are counted in the final grade by 60% weight. -*an offered grade:* It may be offered for students if the grades of the mid-term and end-term tests are at least satisfactory (3) for each one. The offered grade is the average of them.
Person responsible for course: Dr. Sándor Misák, associate professor, PhD
Lecturer: Dr. Sándor Misák, associate professor, PhD

Title of course: Industrial process control **Code**: TTFBL1321	**ECTS Credit points:** 2

Type of teaching, contact hours
- lecture: -
- practice: -
- laboratory: 2 hours/week

Evaluation: term mark

Workload (estimated), divided into contact hours:
- lecture: -
- practice: -
- laboratory: 28 hours
- home assignment: 28 hours
- preparation for the exam: 4 hours

Total: 60 hours

Year, semester: 3rd year, 1st semester

Its prerequisite(s): TTFBE1222 Digital Electronics 2., TTFBE1201 Programming 1., TTFBE1223 Electrotechnology

Further courses built on it: TTFBL1301 Individual Laboratory, TTFBG1302 Diploma Thesis, TFBE1521, TTFBE1522 Industrial Supervisory and Control Systems 1., 2.

Topics of course

Basic concepts of control engineering. Control systems. Technological process groups. Development of automation devices and systems. Structure, classification, operating model of PLCs. Modular and compact PLC systems. PLC programming, programming languages. Characteristics, types of variables, instructions, functions, function blocks in textual and graphic PLC languages according to IEC61131-3 standard. Set of elements in ladder diagram, instruction list, function block diagram programming languages. Structured text as a high-level programming language in control system programming. Basics of sequential function chart (SFC) design, set of elements in SFC language. Program development aspects. Possibilities of programming and program portability. High-reliability PLCs and their characteristics: self-test, methods of fault recognition and fault deletion. Concept and structure of distributed control systems. PLC field and sensor buses. Viewpoints of design, methods and steps of design. Tasks of PLC system installation, presentation of a few specific PLC families. Human-machine interface (HMI) devices. Supervisory control and data acquisition (SCADA) systems.

Literature

Compulsory:

– Rehg J.A., Sartori G.J.: Programmable logic controllers. Pearson, 2nd ed., 2013.
– Bryan L.A., Bryan E.A.: Programmable Controllers. Theory and Implementation. Marletta: Industrial Text Company (2nd ed.), 1997.
– Manufacturers' PLC, HMI manuals, PLC programming manuals.

Recommended:

– Hackworth J.R., Hackworth F.D, Jr.: Programmable logic controllers: Programming methods and applications. Delhi: Pearson Education, 2004.
– Bolton W.: Programmable logic controllers. New Delhi: Newnes (Elsevier), 2008.
– Parr E.A.: Programmable Controllers. An Engineer's Guide. Amsterdam: Newnes (Elsevier, 3rd ed.), 2003.

– Petruzella F.D.: Programmable logic controllers. New York: McGraw-Hill, 4th ed., 2011.

Schedule:

1st week

EasySoft PRO 6 programming environment elements, structure and functions. Ladder diagram programming language elements.

2nd week

Programming of timers and counters.

3rd week

Arithmetic, jump instructions. Processing of analog signals.

4th week

Complex problem solution in EasySoft Pro 6 programming environment

5th week

XSoft-CoDeSys programming, simulation environment. Introduction with ladder diagram elements by simple problem solution.

6th week

Function block diagram (FBD) language elements. Programming in FBD language.

7th week

Structured text (ST) language elements. Programming in ST language.

8th week

Instruction list (IL) language elements. Programming in IL language.

9th week

Sequential function chart (SFC) language elements. Programming in SFC language.

10th week

Modular PLC program development in CoDeSys programming environment. Introduction with continuous function chart (CFC) language, acquirement of CFC language techniques.

11th week

Complex problem solution in CoDeSys programming environment.

12th week

Selection of proper PLC platform, PLC configuration composing, steps of program upload to real PLC. Examples on field buses implementation.

13th week

Reliable PLC configurations. HMI usage in PLC projects.

14th week

End-term test.

Complex programming problem solution in computer (PLC) class.

Requirements:

- for a signature

Attendance at **laboratories** is compulsory. Condition for sign obtaining is a submission of homework assignment.

Semester finishes by an end-term test where students solve a complex automation problem in computer (PLC) class. Students’ participation on the test is mandatory.

- for a grade

The course ends in a practical **examination**. Signature receipt is a precondition for exam eligibility. - *an offered grade:* —
Person responsible for course: Dr. Sándor Misák, associate professor, PhD
Lecturer: Dr. Sándor Misák, associate professor, PhD

Title of course: Electrical Switchgears **Code**: TTFBE1323	**ECTS Credit points:** 3

Type of teaching, contact hours
- lecture: 2 hours/week
- practice: -
- laboratory: -

Evaluation: exam

Workload (estimated), divided into contact hours:
- lecture: 28 hours
- practice: -
- laboratory: -
- home assignment: 42
- preparation for the exam: 20 hours

Total: 90 hours

Year, semester: 3rd year, 6th semester

Its prerequisite(s): TTFBE1216 Electrical Power Systems

Further courses built on it:

Topics of course

To show the role of switching gears in electrical power distribution networks, first of all in area of electrical applications in buildings and through some industrial examples.
Summary on switching gears which operate power electronics equipment, electrical machines and drive. Classification on the basis of current and voltage stress. Switching-off phenomena in ideal case. One- and two-frequency fly-back voltage interpretation.
Operational and overload current heating. Short-circuit heating. Electrodynamic force effect.
Relays: structure, parameters, application. Disconnectors: structure, parameters, application.
Circuit breakers: structure, parameters, application. Fuses: structure, parameters, application.
Switches, contactors: structure, parameters, application. Utilization categories. Motor-protective devices: structure, parameters, application. Solis-state relays. Electromagnets. Overload and electric shock.

Literature

Recommended:

Badri Ram, D.N. Vishwakarma, ‘Power system protection and switchgear’ , Tata McGraw – Hill Publishing Company Limited, New Delhi.
C.L Wadhwa, ‘ Electrical power systems’ , New Age International Limited.
Sunil S. Rao, ‘Switchgear and Protection’, Khanna Publishers, New Delhi.

Stefányi I., Szandtner K.: Villamos kapcsolókészülékek. Műegyetemi Kiadó, Budapest, 2002. Nívódíjas egyetemi jegyzet.
Koller L.: Kisfeszültségű kapcsolókészülékek. Műegyetemi Kiadó, Budapest, 2006
Horváth-Csernátony-Hoffer: Nagyfeszültségű technika. Tankönyvkiadó, Budapest, 1986

Schedule:

1st week
Task of switch gears

2nd week
Break-down in air

3rd week
Break-down in liquid insulator

4th week
Break-down in solid insulator
5th week
Switch gears in energy system
6th week
Relay
7th week
Fuses
8th week
Switches and contactors
9th week
Disconnectors
10th week
Circuit breaker at low voltage
11th week
Circuit breaker at high voltage
12th week
Selectivity between gears
13th week
Protection of transformer
14th week
Application of superconductors as protection, Test

Requirements:
The semester ends in a written examination. The test consists of 10 questions, for which students must give free-text answers. The total score of the test is 100, and the grades are determined by the following rating:

0-49 % – fail (1)

50-62 % – pass (2)

63-75 % – satisfactory (3)

76-88 % – good (4)

89-100 % – excellent (5)

Exam grade can be obtained by writing two mid-term tests. To acquire a valid exam grade, students must reach at least 50% of the total scores of each mid-term test. In case of unsuccessful tests, improvement possibility is ensured in the exam period.

Person responsible for course: Dr. Janos Arpad Kosa, assistant professor

Lecturer: Dr. Janos Arpad Kosa, assistant professor

Title of course: Electrical Switchgears Practical **Code**: TTFBG1323	**ECTS Credit points:** 1
Type of teaching, contact hours - lecture: - - practice: - 1 hours/week - laboratory: -	
Evaluation: exam, practical grade	
Workload (estimated), divided into contact hours: - lecture: - - practice: 14 hours - laboratory: - - home assignment: 14 - preparation for the exam: 2 hours Total: 30 hours	
Year, semester: 3rd year, 6th semester	
Its prerequisite(s): TTFBE1216 Electrical Power Systems	
Further courses built on it:	

Topics of course

To know the switching transients, switch-on processes, the electric arc.

To show the role of switching gears in electrical power distribution networks, first of all in area of electrical applications in buildings and through some industrial examples. Summary on switching gears which operate power electronics equipment, electrical machines and drive. Classification on the basis of current and voltage stress. Switching-off phenomena in ideal case. One- and two-frequency fly-back voltage interpretation. Operational and overload current heating. Short-circuit heating. Electrodynamic force effect. Relays: structure, parameters, application. Disconnectors: structure, parameters, application. Circuit breakers: structure, parameters, application. Fuses: structure, parameters, application. Switches, contactors: structure, parameters, application. Utilization categories. Motor-protective devices: structure, parameters, application. Solis-state relays. Electromagnets. Overload and electric shock.

Literature

Recommended: Badri Ram , D.N.Vishwakarma, ‘Power system protection and switchgear’ , Tata McGraw –Hill Publishing Company Limited, New Delhi.
C.L Wadhwa , ‘ Electrical power systems’ , New Age International Limited.
Sunil S. Rao, ‘Switchgear and Protection’, Khanna Publishers, New Delhi.

Stefányi I., Szandtner K.: Villamos kapcsolókészülékek. Műegyetemi Kiadó, Budapest, 2002. Nívódíjas egyetemi jegyzet.
Koller L.: Kisfeszültségű kapcsolókészülékek. Műegyetemi Kiadó, Budapest, 2006
Horváth-Csernátony-Hoffer: Nagyfeszültségű technika. Tankönyvkiadó, Budapest, 1986
Németh-Horváth: Nagyfeszültségű szigeteléstechnika. Tankönyvkiadó, Budapest, 1986

Schedule:

1st week

Switch-on of serial RL and RC circuit

2nd week

Switch-on of serial RLC circuit at DC and AC voltage

3rd week

Switch-on in three phase system

4th week

Electrical arc

5th week

Switch-off of DC

6th week

Switch-off of AC

7th week

Calculation and choice of fuses

8th week

Switches and contactors in the practise

9th week

Choice of disconnector

10th week

Choice of circuit breaker at low voltage

11th week

Choice of circuit breaker at high voltage

12th week

Selectivity between gears

13th week

Protection of transformer

14th week

Application of superconductors as protection, Test

Requirements:
The semester ends in a written examination. The test consists of 10 questions, for which students must give free-text answers. The total score of the test is 100, and the grades are determined by the following rating:

0-49 % – fail (1)

50-62 % – pass (2)

63-75 % – satisfactory (3)

76-88 % – good (4)

89-100 % – excellent (5)

Exam grade can be obtained by writing two mid-term tests. To acquire a valid exam grade, students must reach at least 50% of the total scores of each mid-term test. In case of unsuccessful tests, improvement possibility is ensured in the exam period.

Person responsible for course: Dr. Janos Arpad Kosa, assistant professor

Lecturer: Dr. Janos Arpad Kosa, assistant professor

Title of course: Electric Machines and Drives
Code: TTFBE1324

ECTS Credit points: 3

Type of teaching, contact hours
- lecture: 2 hours/week
- practice: -
- laboratory: -

Evaluation: exam

Workload (estimated), divided into contact hours:
- lecture: 28 hours
- practice: -
- laboratory: -
- home assignment: 28 hours
- preparation for the exam: 20 hours

Total: 76 hours

Year, semester: 3rd year, 6th semester

Its prerequisite(s): TTFBE1216-EN Electrical Power Systems

Further courses built on it:

Topics of course

magnetic materials, magnetic circuits, ideal transformer, real transformer, equivalent circuit of the transformer, three phase transformers, construction of transformers; DC commutator machines, structure, equivalent circuit, equations of DC machines, concept of armature reaction and it's compensation, torque characteristic curves of DC motors; the basic mechanic concepts of driving systems, speed and position control in DC driving systems; AC machines, alternators, the structure of multiphase windings, the rotating magnetic field, synchronous motors, equivalent circuit, simplified equivalent circuit, circle diagram, torque and mechanical power of synchronous machines, compensation of reactive power, brushless DC motors; principle of operation and structure of asynchronous machines, the concept of the slip, equivalent circuit, power balance, torque characteristic curve, circle diagram, speed control of asynchronous machines, concepts of scalar and vector controls, single phase asynchronous motors, operation of asynchronous machines; stepping motors, taxonomy, structure and operation, driving circuits.

Literature

Compulsory:

Dieter Gerling: Electrical Machines, Springer Verlag (2015)

moodle.phys. unideb.hu/electric machines and drives

Recommended:

Stephen J.Chapman: Electric Machinery Fundamentals, Mc Graw Hill (2005)

John Hindmarsch and Alasdair Renfrew: Electrical Machines and Drive Systems, (Third edition), Newnes (2002)

Theodore Wildi: Electric Machines and Power Systems, (Fifth edition), Prentice Hall (2002)

Valery Vodovozov: Electric Drive Systems and Operation, Bookboon,com (2002)

Schedule:

1st week

Physical basics, magnetic field, magnetic materials, simple magnetic cirsuits

2nd week

The principle of single phase transformers, the structure and operation of transformers, equivalent circuit, the basic considerations of transformer design.

3rd week

Three-phase transformers, special transformers (welding transformers, autotransformers, toroidal transformers)

4th week

DC commutator machines, principles of operation, structure, equivalent circuit, basic equations, excitation modes, torque characteristic curves, armature reaction and it's compensation, universal machines.

5th week

The mechanical basics of electric drives. Equations of rotary motion, the stability analysis of electric drives, design of drives with maximum angular acceleration.

6th week

Speed and position control in DC electric drive systems, feedback loops, controller and power circuits

7th week

Principles of AC machines, multiphase windings, alternators, generation of rotary magnetic field

8th week

The structure and operation of synchronous machines, equivalent circuit, simplified equivalant circuit and current vector diagram, mechanical power and torque of synchronous machines.

9th week

The operation of synchronous machines. The role of synchronous machines in the compensation of reactive power. Structure and operation of brushless DC motors.

10th week

The asynchronous machines, principles of operation, structure, taxonomy. The concept of the slip, equivalent circuit, power balance.

11th week

Torque-angular velocity characteristic curve and circle diagram of asynchronous machines. Operation character and application of asynchronous motors.

12th week

Speed control modes of asynchronous motors (slip, number of poles, frequency), concepts of scalar and vector controls.

13th week

Single phase asynchronous motors, structure, principle of operation, torque-angular velocity characteristic curve, typical starter solutions.

14th week

Stepping motors, basic structures, principles of operation, driver and interface circuits, applications.

Requirements:

- for a signature

Attendance at **lectures** is recommended, but not compulsory. Condition for sign obtaining is a successful (at least passed grade) solution of computer assisted home works..

- for a grade

The course ends in an **examination**.

Grades:

0-50% 1

51-62%	2
63-75%	3
76-87%	4
88-100%	5

Person responsible for course: Dr. Lajos Daróczi, associate professor, PhD

Lecturer: Dr. Lajos Daróczi, associate professor, PhD

Title of course: Electric Machines and Drives Laboratory Practice **Code**: TTFBL1324	**ECTS Credit points:** 2

Type of teaching, contact hours

- lecture:
- practice: -
- laboratory: 2 hours/week -

Evaluation: grade

Workload (estimated), divided into contact hours:

- lecture:
- practice: -
- laboratory: -28 hours
- home assignment: 28 hours
- preparation for the exam:

Total: 48 hours

Year, semester: 3rd year, 6th semester

Its prerequisite(s): TTFBE1216-EN Electrical Power Systems

Further courses built on it:

Topics of course

study of ferromagnetic materials and magnetic circuits

measurements on transformer

measurements on DC machines (induced voltage, excitation modes, torque characteristics)

DC servo drive

synchronous machine and brushless DC machine

asynchronous motors (squirrel cage, slip ring, single phase) basic operation, Dahlander winding, star to delta switching, slip control, torque characteristics

Literature

Compulsory:

Dieter Gerling: Electrical Machines, Springer Verlag (2015)

moodle.phys. unideb.hu/electric machines and drives

Recommended:

Stephen J.Chapman: Electric Machinery Fundamentals, Mc Graw Hill (2005)

John Hindmarsch and Alasdair Renfrew: Electrical Machines and Drive Systems, (Third edition), Newnes (2002)

Theodore Wildi: Electric Machines and Power Systems, (Fifth edition), Prentice Hall (2002)

Valery Vodovozov: Electric Drive Systems and Operation, Bookboon,com (2002)

Schedule:

1st week

Measurement of magnetic properties of ferromagnetic materials

2nd week

Measurement of magnetic induction and magnetic forces in a simple magnetic circuit

3rd week

Measurements on single phase transformer, determination of the parameters in the equivalent circuit, determination of losses and drop

4th week

Measurements on three phase transformer. Investigation of the effects of asymmetric load.

5th week

Measurements on DC commutator motor. Measurement of induced voltage, measurement of torque.

6th week

Measurement of moment of inertia and retarding (frictional) torque.

7th week

Investigation of DC commutator motor servo system, setting the optimal control parameters

8th week

Measurements on squirrel cage motor. Determination of torque characteristic curve, calculation of parameters in the equivalent circuit, construction of current vector diagram

9th week

Measurements on slip-ring motor. Measurement of torque characteristic curves at different rotor resistance values.

10th week

Measurements on ventilator with inverter drive. Determination of pressure ratio, pumping speed, and efficiency. Comparison of inverter and throttle control.

11th week

Basic operation modes of squirrel cage motors: reversion, change the number of pole pairs (Dahlander winding), decreasing the start current (star to delta switch)

12th week

Investigation of single phase squirrel cage motor. Measurement of torque characteristic curve, using of starter capacitor and current relay, capacitor motor

13th week

Measurements on a BLDC motor. Investigation of the driving circuit. Torque measurements

14th week

Measurements on stepping motors. Full and half step rotation, investigation of driving circuits, determination of breakdown torque

Requirements:

- *for a signature*

Attendance at **lectures** is compulsory

- *for a grade*

The reports of the measurements and the control tests are evaluated and graded. The final grade is calculated from the average value of the partial grades.

Grades:

0-50% 1

51-62% 2 63-75% 3 76-87% 4 88-100% 5
Person responsible for course: Dr. Lajos Daróczi, associate professor, PhD
Lecturer: Dr. Lajos Daróczi, associate professor, PhD

Title of course: Power Electronics **Code**: TTFBE1325	**ECTS Credit points:** 3

Type of teaching, contact hours
- lecture: 2 hours/week
- practice: -
- laboratory: -

Evaluation: exam

Workload (estimated), divided into contact hours:
- lecture: 30 hours
- practice: -
- laboratory: -
- home assignment: 30 hours
- preparation for the exam: 30 hours

Total: 90 hours

Year, semester: 4th year, 1st semester

Its prerequisite(s): TTFBL1230 Electronics 3., TTFBE1225 Microelectronics

Further courses built on it: -

Topics of course

Scope of power electronics. Classification of power electronics equipment. Areas of application of power electronics. Power semiconductor devices. Uncontrolled multilayer semiconductor devices. Power semiconductor devices. Thyristor, triac, Light Activated SCR, Gate Turn Off Thyristor, BJT, Static Induction Thyristor, MOS controlled thyristor. AC-DC Converters, rectifiers. Classification. Half-wave rectifier with RC load, with RL load. Half-wave controlled rectifier, one pulse converter. Controlled Half-Wave Rectifier with R-L-E Load. Full-wave controlled converter with center-tapped transformer. Calculation. Full-wave bridge rectifier both without and with filter. AC-DC Converters, rectifiers. Three-phase bridge rectifier. Calculation. AC Voltage Controllers. Variable speed AC motor drive (block diagram and operation). Using power electronics, energy conservation in motor driven pump and compressor systems. Cycloconverter. Illumination control circuit and its working. AC Voltage Controllers. Phase-control type. Phase half-wave control type. On-off control type. Three-phase ACVCs. DC-DC converters. Step-down chopper. RLE load connected to step-down chopper (buck-converter). DC-DC converters. Step-up chopper (boost-converter). Buck-boost (polarity change) converter Four quadrant choppers, circuit diagram and operation. DC-AC converters, inverters. Types of inverters. Half-bridge inverter. Bridge inverter. DC-AC converters, inverters. Three phase inverters and their conduction strategies.

Literature

Compulsory:
-R. S. Ananda Murthy, V. Nattarasu: Power Electronics, Sanguine Technical Publishers, Bangalore, India, 2005.
Recommended:
-Ned Mohan, Tore M. Undeland, William P. Robbins: Power Electronics, John Wiley and Sons Inc., 2003.

Schedule:

1st week: Scope of power electronics. Classification of power electronics equipment. Areas of application of power electronics. Power semiconductor devices. Uncontrolled multilayer semiconductor devices.

2nd week: Power semiconductor devices. Thyristor, triac, Light Activated SCR, Gate Turn Off Thyristor, BJT, Static Induction Thyristor, MOS controlled thyristor.
3rd week: AC-DC Converters, rectifiers. Classification. Half-wave rectifier with RC load, with RL load. Half-wave controlled rectifier, one pulse converter. Controlled Half-Wave Rectifier with R-L-E Load. Full-wave controlled converter with center-tapped transformer. Calculation. Full-wave bridge rectifier both without and with filter.
4th week: AC-DC Converters, rectifiers. Three-phase bridge rectifier. Calculation.
5th week: AC Voltage Controllers. Variable speed AC motor drive (block diagram and operation). Using power electronics, energy conservation in motor driven pump and compressor systems. Cycloconverter. Illumination control circuit and its working.

6th week: AC Voltage Controllers. Phase-control type. Phase half-wave control type. On-off control type. Three-phase ACVCs.

7th week: DC-DC converters. Step-down chopper. RLE load connected to step-down chopper (buck-converter).

8th week: DC-DC converters. Step-down chopper. RLE load connected to step-down chopper (buck-converter).

9th week: DC-AC converters, inverters. Types of inverters. Half-bridge inverter. Bridge inverter.

10th week: DC-AC converters, inverters. Three phase inverters and their conduction strategies.

11th week: Test

12th week: -

13th week: -

14th week: -

Requirements:
Students have to complete a test, take an exam.

Person responsible for course: Dr. Lajos Daroczi, associate professor

Lecturer: Dr. Eniko Kosane Kalave, engineer teacher

Title of course: Electricity Grid and Operations **Code**: TTFBE1331	**ECTS Credit points:** 4

Type of teaching, contact hours
- lecture: 3 hours/week
- practice: -
- laboratory: -

Evaluation: exam

Workload (estimated), divided into contact hours:
- lecture: 42 hours
- practice: -
- laboratory: -
- home assignment: 28 hours
- preparation for the exam: 50 hours

Total: 120 hours

Year, semester: 3rd year, 5th semester

Its prerequisite(s): TTFBE1216 Electrical Power Systems

Further courses built on it:

Topics of course

Cooperation between electricity systems. European systems, organizations. Transmission and distribution electricity grid in Hungary. Power lines in the electricity system. Substations, primary and secondary systems, protections, automation systems. Regulation of electricity systems. Legal and environmental issues of electricity system. The qualitative requirements of the electricity service, voltage quality. Quality and reliability of the energy system. System states, transitions. Faults, protection tasks and principles.

Literature

Compulsory:

Kirtley, James, Introduction to Electric Power Systems, Spring 2007.

Sedra A.S., Smith K.C.: Badri Ram , D.N.Vishwakarma, ‘Power system protection and switchgear’ , Tata McGraw –Hill Publishing Company Limited, New Delhi.

Recommended:

-C.L Wadhwa , ‘ Electrical power systems’ , New Age International Limited.

- Sunil S. Rao, ‘Switchgear and Protection’, Khanna Publishers, New Delhi.

Schedule:

1st week

The role of electric power, general structure of the power system.

2nd week

Analysis of three-phase symmetrical systems.

3rd week

Asymmetrical operation of the network.

4th week

Star point earthing methods.

5th week

Network operations

6th week

Power lines in the elect.ricity system.

7th week

Mid-term test. Requirements of power supply quality.

8th week

Control of power systems. Regulation of electricity systems.

9th week

Calculation of voltage drop in case of radial supply. Reactive power compensation. Calculation of power losses.

10th week

Quality and reliability of the energy system.

11th week

Concept of smart grids (network elements, operation, control). Smart metering. Demand-side management. Grid effects of e-mobility. Overview.

12th week

Faults, protection tasks and principles. Protections.

13th week

HVDC.

14th week

End-term test. Energy systems in the future.

Requirements:

- for a signature

Attendance at **lectures** is recommended, but not compulsory. Condition for sign obtaining is a successful (at least passed grade) write of two tests according to semester assessment timing.

During the semester there are two tests: the mid-term test in the 7th week and the end-term test in the 14th week. Students' participation on the tests is mandatory.

- for a grade

The course ends in an **examination**. Sign receipt is a precondition for exam eligibility. Results of two tests are counted in the final grade by 60% weight.

-an offered grade:

It may be offered for students if the grades of the mid-term and end-term tests are at least satisfactory (3) for each one. The offered grade is the average of them.

Person responsible for course: Dr. Janos Arpad Kosa, assistant professor, PhD

Lecturer: Dr. Janos Arpad Kosa, assistant professor, PhD

Title of course: Electricity Grid and Operations **Code**: TTFBG1331	**ECTS Credit points:** 2

Type of teaching, contact hours

- lecture: -
- practice: - 2 hours/week
- laboratory: -

Evaluation: exam

Workload (estimated), divided into contact hours:

- lecture: 28 hours
- practice: -
- laboratory: -
- home assignment: 22 hours
- preparation for the exam: 10 hours

Total: 60 hours

Year, semester: 3rd year, 5th semester

Its prerequisite(s): TTFBE1216 Electrical Power Systems

Further courses built on it:

Topics of course

Cooperation between electricity systems. European systems, organizations. Transmission and distribution electricity grid in Hungary. Power lines in the electricity system. Substations, primary and secondary systems, protections, automation systems. Regulation of electricity systems. Legal and environmental issues of electricity system. The qualitative requirements of the electricity service, voltage quality. Quality and reliability of the energy system. System states, transitions. Faults, protection tasks and principles.

Literature

Compulsory:

Kirtley, James, Introduction to Electric Power Systems, Spring 2007

Sedra A.S., Smith K.C.: Badri Ram , D.N.Vishwakarma, ‘Power system protection and switchgear’ , Tata McGraw –Hill Publishing Company Limited, New Delhi.

Recommended:

-C.L Wadhwa , ‘ Electrical power systems’ , New Age International Limited.

- Sunil S. Rao, ‘Switchgear and Protection’, Khanna Publishers, New Delhi.

Schedule:

1st week

The role of electric power, general structure of the power system. Examples, overview.

2nd week

Analysis of three-phase symmetrical systems. Examples.

3rd week

Asymmetrical operation of the network. Examples.

4th week

Star point earthing methods. Examples.

5th week

Network operations. Examples.

6th week

Power lines in the elect.ricity system. Examples.

7th week

Mid-term test. Requirements of power supply quality. Examples.

8th week

Control of power systems. Regulation of electricity systems.

9th week

Calculation of voltage drop in case of radial supply. Reactive power compensation. Calculation of power losses. Examples.

10th week

Quality and reliability of the energy system. Examples.

11th week

Concept of smart grids (network elements, operation, control). Smart metering. Demand-side management. Grid effects of e-mobility. Overview.

12th week

Faults, protection tasks and principles. Protections. Examples.

13th week

HVDC.

14th week

End-term test. Energy systems in the future. Overview.

Requirements:

- for a signature

Attendance at **lectures** is recommended, but not compulsory. Condition for sign obtaining is a successful (at least passed grade) write of two tests according to semester assessment timing.

During the semester there are two tests: the mid-term test in the 7th week and the end-term test in the 14th week. Students' participation on the tests is mandatory.

- for a grade

The course ends in an **examination**. Sign receipt is a precondition for exam eligibility. Results of two tests are counted in the final grade by 60% weight.

-an offered grade:

It may be offered for students if the grades of the mid-term and end-term tests are at least satisfactory (3) for each one. The offered grade is the average of them.

Person responsible for course: Dr. Janos Arpad Kosa, assistant professor, PhD

Lecturer: Dr. Janos Arpad Kosa, assistant professor, PhD

Title of course: IoT solutions for electrical power systems **Code**: TTFBE1332-EN	**ECTS Credit points:** 2

Type of teaching, contact hours
- lecture: 2 hours/week
- practice: -
- laboratory: -

Evaluation: exam

Workload (estimated), divided into contact hours:
- lecture: 28 hours
- practice: -
- laboratory: -
- home assignment: 10 hours
- preparation for the exam: 22 hours

Total: 60 hours

Year, semester: 3rd year, 5th semester

Its prerequisite(s): TTFBE1222-EN Digital Electronics 2., TTFBE1201-EN Programming 1., TTFBE1216-EN Electrical Power Systems

Further courses built on it: -

Topics of course

Overview of IoT technologies. Indicators of electrical power quality. Electrical power quality standards. Sensors for measuring electrical parameters, power measurement, measurement of quality parameters. Architecture of measurement/data acquisition systems, possible hardware components. Data collection, data transmission and data processing solutions. Application of ICT in electrical power systems, demand control, smart-metering, smart-grid. Building energy systems, building energy management. Security issues of IoT systems.

Literature

Compulsory:
- Course materials

Recommended:
- Theodore Wildi: Electrical Machines, Drives, and Power Systems, Prentice Hall
- Casazza J., Delea F.: Understanding Electric Power Systems: An Overview of the Technology and the Marketplace, Wiley, 2010.

Schedule for lecture:

1st week

Overview of IoT technologies.

2nd week

Indicators of electrical power quality.

3rd week

Electrical power quality standards.

4th week

Sensors for measuring electrical parameters, power measurement, measurement of quality parameters.

5th week

Architecture of measurement/data acquisition systems, possible hardware components.

6th week

Architecture of measurement/data acquisition systems, possible hardware components.

7th week

Data collection, data transmission and data processing solutions.

8th week

Data collection, data transmission and data processing solutions.

9th week

Application of ICT in electrical power systems, demand control, smart-metering, smart-grid.

10th week

Application of ICT in electrical power systems, demand control, smart-metering, smart-grid.

11th week

Building energy systems, building energy management.

12th week

Building energy systems, building energy management.

13th week

Security issues of IoT systems.

14th week

Summary

Requirements:

- for a lecture grade

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

The course ends in an **examination**. The requirement for examination is having pass (2) or better practical mark.

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 table:

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 for outstanding performance during the practical part.

Person responsible for course: Dr. István Szabó, associate professor, PhD

Lecturer: Dr. István Szabó, associate professor, PhD, Árpád Rácz assistant lecturer

Title of course: Electrical Switchgears **Code**: TTFBE1323	**ECTS Credit points:** 3

Type of teaching, contact hours
- lecture: 2 hours/week
- practice: -
- laboratory: -

Evaluation: exam

Workload (estimated), divided into contact hours:
- lecture: 28 hours
- practice: -
- laboratory: -
- home assignment: 42
- preparation for the exam: 20 hours

Total: 90 hours

Year, semester: 3rd year, 6th semester

Its prerequisite(s): TTFBE1216-EN Electrical Power Systems

Further courses built on it:

Topics of course

To show the role of switching gears in electrical power distribution networks, first of all in area of electrical applications in buildings and through some industrial examples.
Summary on switching gears which operate power electronics equipment, electrical machines and drive. Classification on the basis of current and voltage stress. Switching-off phenomena in ideal case. One- and two-frequency fly-back voltage interpretation.
Operational and overload current heating. Short-circuit heating. Electrodynamic force effect.
Relays: structure, parameters, application. Disconnectors: structure, parameters, application.
Circuit breakers: structure, parameters, application. Fuses: structure, parameters, application.
Switches, contactors: structure, parameters, application. Utilization categories. Motor-protective devices: structure, parameters, application. Solis-state relays. Electromagnets. Overload and electric shock.

Literature

Recommended:

Badri Ram, D.N.Vishwakarma, ‘Power system protection and switchgear’ , Tata McGraw – Hill Publishing Company Limited, New Delhi.
C.L Wadhwa, ‘ Electrical power systems’ , New Age International Limited.
Sunil S. Rao, ‘Switchgear and Protection’, Khanna Publishers, New Delhi.

Stefányi I., Szandtner K.: Villamos kapcsolókészülékek. Műegyetemi Kiadó, Budapest, 2002. Nívódíjas egyetemi jegyzet.
Koller L.: Kisfeszültségű kapcsolókészülékek. Műegyetemi Kiadó, Budapest, 2006
Horváth-Csernátony-Hoffer: Nagyfeszültségű technika. Tankönyvkiadó, Budapest, 1986

Schedule:

1st week

Task of switch gears

2nd week

Break-down in air

3rd week

Break-down in liquid insulator

4th week
Break-down in solid insulator
5th week
Switch gears in energy system
6th week
Relay
7th week
Fuses
8th week
Switches and contactors
9th week
Disconnectors
10th week
Circuit breaker at low voltage
11th week
Circuit breaker at high voltage
12th week
Selectivity between gears
13th week
Protection of transformer
14th week
Application of superconductors as protection, Test

Requirements:
The semester ends in a written examination. The test consists of 10 questions, for which students must give free-text answers. The total score of the test is 100, and the grades are determined by the following rating:

0-49 % – fail (1)

50-62 % – pass (2)

63-75 % – satisfactory (3)

76-88 % – good (4)

89-100 % – excellent (5)

Exam grade can be obtained by writing two mid-term tests. To acquire a valid exam grade, students must reach at least 50% of the total scores of each mid-term test. In case of unsuccessful tests, improvement possibility is ensured in the exam period.

Person responsible for course: Dr. Janos Arpad Kosa, assistant professor

Lecturer: Dr. Janos Arpad Kosa, assistant professor

Title of course: Electrical Switchgears Practical **Code**: TTFBG1323	**ECTS Credit points:** 1
Type of teaching, contact hours - lecture: - - practice: - 1 hours/week - laboratory: -	
Evaluation: exam, practical grade	
Workload (estimated), divided into contact hours: - lecture: - - practice: 14 hours - laboratory: - - home assignment: 14 - preparation for the exam: 2 hours Total: 30 hours	
Year, semester: 3rd year, 6th semester	
Its prerequisite(s): TTFBE1216-EN Electrical Power Systems	
Further courses built on it:	

Topics of course

To know the switching transients, switch-on processes, the electric arc.

To show the role of switching gears in electrical power distribution networks, first of all in area of electrical applications in buildings and through some industrial examples. Summary on switching gears which operate power electronics equipment, electrical machines and drive. Classification on the basis of current and voltage stress. Switching-off phenomena in ideal case. One- and two-frequency fly-back voltage interpretation. Operational and overload current heating. Short-circuit heating. Electrodynamic force effect. Relays: structure, parameters, application. Disconnectors: structure, parameters, application. Circuit breakers: structure, parameters, application. Fuses: structure, parameters, application. Switches, contactors: structure, parameters, application. Utilization categories. Motor-protective devices: structure, parameters, application. Solis-state relays. Electromagnets. Overload and electric shock.

Literature

Recommended:
Badri Ram , D.N.Vishwakarma, ‘Power system protection and switchgear’ , Tata McGraw –Hill Publishing Company Limited, New Delhi.
C.L Wadhwa , ‘ Electrical power systems’ , New Age International Limited.
Sunil S. Rao, ‘Switchgear and Protection’, Khanna Publishers, New Delhi.

Stefányi I., Szandtner K.: Villamos kapcsolókészülékek. Műegyetemi Kiadó, Budapest, 2002. Nívódíjas egyetemi jegyzet.
Koller L.: Kisfeszültségű kapcsolókészülékek. Műegyetemi Kiadó, Budapest, 2006
Horváth-Csernátony-Hoffer: Nagyfeszültségű technika. Tankönyvkiadó, Budapest, 1986
Németh-Horváth: Nagyfeszültségű szigeteléstechnika. Tankönyvkiadó, Budapest, 1986

Schedule:

1st week

Switch-on of serial RL and RC circuit

2nd week

Switch-on of serial RLC circuit at DC and AC voltage

3rd week

Switch-on in three phase system

4th week

Electrical arc

5th week

Switch-off of DC

6th week

Switch-off of AC

7th week

Calculation and choice of fuses

8th week

Switches and contactors in the practise

9th week

Choice of disconnector

10th week

Choice of circuit breaker at low voltage

11th week

Choice of circuit breaker at high voltage

12th week

Selectivity between gears

13th week

Protection of transformer

14th week

Application of superconductors as protection, Test

Requirements:
The semester ends in a written examination. The test consists of 10 questions, for which students must give free-text answers. The total score of the test is 100, and the grades are determined by the following rating:

0-49 % – fail (1)

50-62 % – pass (2)

63-75 % – satisfactory (3)

76-88 % – good (4)

89-100 % – excellent (5)

Exam grade can be obtained by writing two mid-term tests. To acquire a valid exam grade, students must reach at least 50% of the total scores of each mid-term test. In case of unsuccessful tests, improvement possibility is ensured in the exam period.

Person responsible for course: Dr. Janos Arpad Kosa, assistant professor

Lecturer: Dr. Janos Arpad Kosa, assistant professor

Title of course: Electric Machines and Drives **Code**: TTFBE1324	**ECTS Credit points:** 3

Type of teaching, contact hours
- lecture: 2 hours/week
- practice: -
- laboratory: -

Evaluation: exam

Workload (estimated), divided into contact hours:
- lecture: 28 hours
- practice: -
- laboratory: -
- home assignment: 28 hours
- preparation for the exam: 20 hours

Total: 76 hours

Year, semester: 3rd year, 6th semester

Its prerequisite(s): TTFBE1216-EN Electrical Power Systems

Further courses built on it:

Topics of course

magnetic materials, magnetic circuits, ideal transformer, real transformer, equivalent circuit of the transformer, three phase transformers, construction of transformers; DC commutator machines, structure, equivalent circuit, equations of DC machines, concept of armature reaction and it's compensation, torque characteristic curves of DC motors; the basic mechanic concepts of driving systems, speed and position control in DC driving systems; AC machines, alternators, the structure of multiphase windings, the rotating magnetic field, synchronous motors, equivalent circuit, simplified equivalent circuit, circle diagram, torque and mechanical power of synchronous machines, compensation of reactive power, brushless DC motors; principle of operation and structure of asynchronous machines, the concept of the slip, equivalent circuit, power balance, torque characteristic curve, circle diagram, speed control of asynchronous machines, concepts of scalar and vector controls, single phase asynchronous motors, operation of asynchronous machines; stepping motors, taxonomy, structure and operation, driving circuits.

Literature

Compulsory:

Dieter Gerling: Electrical Machines, Springer Verlag (2015)

moodle.phys. unideb.hu/electric machines and drives

Recommended:

Stephen J.Chapman: Electric Machinery Fundamentals, Mc Graw Hill (2005)

John Hindmarsch and Alasdair Renfrew: Electrical Machines and Drive Systems, (Third edition), Newnes (2002)

Theodore Wildi: Electric Machines and Power Systems, (Fifth edition), Prentice Hall (2002)

Valery Vodovozov: Electric Drive Systems and Operation, Bookboon,com (2002)

Schedule:

1st week

Physical basics, magnetic field, magnetic materials, simple magnetic cirsuits

2nd week

The principle of single phase transformers, the structure and operation of transformers, equivalent circuit, the basic considerations of transformer design.

3rd week

Three-phase transformers, special transformers (welding transformers, autotransformers, toroidal transformers)

4th week

DC commutator machines, principles of operation, structure, equivalent circuit, basic equations, excitation modes, torque characteristic curves, armature reaction and it's compensation, universal machines.

5th week

The mechanical basics of electric drives. Equations of rotary motion, the stability analysis of electric drives, design of drives with maximum angular acceleration.

6th week

Speed and position control in DC electric drive systems, feedback loops, controller and power circuits

7th week

Principles of AC machines, multiphase windings, alternators, generation of rotary magnetic field

8th week

The structure and operation of synchronous machines, equivalent circuit, simplified equivalant circuit and current vector diagram, mechanical power and torque of synchronous machines.

9th week

The operation of synchronous machines. The role of synchronous machines in the compensation of reactive power. Structure and operation of brushless DC motors.

10th week

The asynchronous machines, principles of operation, structure, taxonomy. The concept of the slip, equivalent circuit, power balance.

11th week

Torque-angular velocity characteristic curve and circle diagram of asynchronous machines. Operation character and application of asynchronous motors.

12th week

Speed control modes of asynchronous motors (slip, number of poles, frequency), concepts of scalar and vector controls.

13th week

Single phase asynchronous motors, structure, principle of operation, torque-angular velocity characteristic curve, typical starter solutions.

14th week

Stepping motors, basic structures, principles of operation, driver and interface circuits, applications.

Requirements:

- for a signature

Attendance at **lectures** is recommended, but not compulsory. Condition for sign obtaining is a successful (at least passed grade) solution of computer assisted home works..

- for a grade

The course ends in an **examination**.

Grades:

0-50% 1

51-62%	2
63-75%	3
76-87%	4
88-100%	5

Person responsible for course: Dr. Lajos Daróczi, associate professor, PhD

Lecturer: Dr. Lajos Daróczi, associate professor, PhD

Title of course: Electric Machines and Drives Laboratory Practice **Code**: TTFBL1324	**ECTS Credit points:** 2

Type of teaching, contact hours
- lecture:
- practice: -
- laboratory: 2 hours/week -

Evaluation: grade

Workload (estimated), divided into contact hours:
- lecture:
- practice: -
- laboratory: -28 hours
- home assignment: 28 hours
- preparation for the exam:

Total: 48 hours

Year, semester: 3rd year, 6th semester

Its prerequisite(s): TTFBE1216-EN Electrical Power Systems

Further courses built on it:

Topics of course

study of ferromagnetic materials and magnetic circuits

measurements on transformer

measurements on DC machines (induced voltage, excitation modes, torque characteristics)

DC servo drive

synchronous machine and brushless DC machine

asynchronous motors (squirrel cage, slip ring, single phase) basic operation, Dahlander winding, star to delta switching, slip control, torque characteristics

Literature

Compulsory:

Dieter Gerling: Electrical Machines, Springer Verlag (2015)

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Recommended:

Stephen J.Chapman: Electric Machinery Fundamentals, Mc Graw Hill (2005)

John Hindmarsch and Alasdair Renfrew: Electrical Machines and Drive Systems, (Third edition), Newnes (2002)

Theodore Wildi: Electric Machines and Power Systems, (Fifth edition), Prentice Hall (2002)

Valery Vodovozov: Electric Drive Systems and Operation, Bookboon,com (2002)

Schedule:

1st week
Measurement of magnetic properties of ferromagnetic materials

2nd week
Measurement of magnetic induction and magnetic forces in a simple magnetic circuit

3rd week

Measurements on single phase transformer, determination of the parameters in the equivalent circuit, determination of losses and drop

4th week

Measurements on three phase transformer. Investigation of the effects of asymmetric load.

5th week

Measurements on DC commutator motor. Measurement of induced voltage, measurement of torque.

6th week

Measurement of moment of inertia and retarding (frictional) torque.

7th week

Investigation of DC commutator motor servo system, setting the optimal control parameters

8th week

Measurements on squirrel cage motor. Determination of torque characteristic curve, calculation of parameters in the equivalent circuit, construction of current vector diagram

9th week

Measurements on slip-ring motor. Measurement of torque characteristic curves at different rotor resistance values.

10th week

Measurements on ventilator with inverter drive. Determination of pressure ratio, pumping speed, and efficiency. Comparison of inverter and throttle control.

11th week

Basic operation modes of squirrel cage motors: reversion, change the number of pole pairs (Dahlander winding), decreasing the start current (star to delta switch)

12th week

Investigation of single phase squirrel cage motor. Measurement of torque characteristic curve, using of starter capacitor and current relay, capacitor motor

13th week

Measurements on a BLDC motor. Investigation of the driving circuit. Torque measurements

14th week

Measurements on stepping motors. Full and half step rotation, investigation of driving circuits, determination of breakdown torque

Requirements:

- *for a signature*

Attendance at **lectures** is compulsory

- *for a grade*

The reports of the measurements and the control tests are evaluated and graded. The final grade is calculated from the average value of the partial grades.

Grades:

0-50% 1

51-62% 2 63-75% 3 76-87% 4 88-100% 5
Person responsible for course: Dr. Lajos Daróczi, associate professor, PhD
Lecturer: Dr. Lajos Daróczi, associate professor, PhD

Title of course: Renewable energy systems **Code**: TTFBE1335-EN	**ECTS Credit points:** 3

Type of teaching, contact hours
- lecture: 2 hours/week
- practice: -
- laboratory: -

Evaluation: exam

Workload (estimated), divided into contact hours:
- lecture: 22 hours
- practice: -
- laboratory: -
- home assignment: 26
- preparation for the exam: 42 hours

Total: 90 hours

Year, semester: 4th year, 7th semester

Its prerequisite(s): TTFBE1102-EN Physics 2., TTFBE1216-EN Electrical Power Systems

Further courses built on it: -

Topics of course

Overview of renewable energy sources. Types and operation of solar cells. Maximum-power-point-tracking. Hydro power plants and pumped-hydro energy storage. Electrical machines in wind power plants. Electrical energy production from geothermal energy. Biomass heat power plants. Production of biogas and hydrogen. Operation of fuel cells. Effect of renewables on the electrical power networks. Storage electrical energy.

Literature

Compulsory:
- Course materials

Recommended:
- Muhammad H. Rashid - Electric Renewable Energy Systems, ISBN: 978-0-12-804448-3
- Gilbert M. Masters - Renewable and Efficient Electric Power Systems, 2nd Edition, ISBN: 978-1-118-63350-2
- Ahmad Hemami - Electricity and Electronics for Renewable Energy Technology: An Introduction, 2017, CRC Press, ISBN 9781138892996

Schedule for lecture:

1st week

Overview of renewable energy sources.

2nd week

Types and operation of solar cells

3rd week

PV systems

4th week

Hydro power plants and pumped-hydro energy storage.

5th week

Electrical machines in wind power plants.

6th week
Biomass heat power plants.
7th week
Biogas and hydrogen. Operation of fuel cells
8th week
Effect of renewables on the electrical power networks
9th week
Effect of renewables on the electrical power networks
10th week
Storage electrical energy.
11th week
Summary, consultation.
12th week
N/A
13th week
N/A
14th week
N/A

Requirements:
- for a lecture grade
Attendance at **lectures** is recommended, but not compulsory.

The course ends in an **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 table:

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 two theoretical test during the semester is at least satisfactory (3) and the average of the mid-term and end-term tests is at least satisfactory (3). The offered grade is the average of the theoretical test. Taking these tests is not mandatory.

Person responsible for course: Dr. Gábor Katona senior lecturer, PhD

Lecturer: Dr. Gábor Katona senior lecturer, PhD, Árpád Rácz assistant lecturer