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Faculty of Electrical Engineering
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31 000 OSIJEK

Second Cycle Degree in Electrical Engineering (Master level)– Study Programme

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CONTENTS

1. INTRODUCTION

a) Rationale for founding the Faculty

Faculty of Electrical Engineering in Osijek was founded in 1978, but the university programme of electrical engineering has been carried out since 1990. During that period, the Faculty has developed into a respectable institution in material and staff terms, which is the basis for implementing study programmes at the highest level. During the previously mentioned period, the Faculty has been equipped with modern lecture rooms and staff offices, but what is more important it has equipped laboratories, which are of greatest importance in the modern education of students studying electrical and computer engineering.

Electrical engineering studies profiles in the field of technical sciences which educates experts and potential young scientists for a very important field of technological and the overall social development**.** Present–day improvements in techniques and technology are just the result of thorough research and development in the field of electrical and computer engineering.

Assessment of rationale with respect to labour market requirements - The labour market in Croatia shows that experts who complete their studies of electrical engineering find an employment easily so that there are hardly any unemployed engineers of the mentioned profile. Faculty of Electrical Engineering in Osijek is the only institution in the Eastern Croatia that educates professionals in the field of electrical engineering, and that makes the basis for future successful activities but also for employment of highly educated staff as well as development of both this region and Croatia in general. Some data from nearer, but also broader area, the European Union, the USA and other highly developed countries show that experts who complete the study programme of electrical engineering have great possibilities to find an employment due to the constant need for staff of this profile. Furthermore, trends of growth and development of electrical engineering, computer engineering, information and communication technologies as well as the impact of new technologies and services show that more experts of this profile will be needed. It is to be expected that this trend is going to be continued, which is the main reason for starting a study of this profile. Master level of electrical engineering and Bachelor level of electrical engineering will make a logically unified whole of education of engineers in the field of electrical engineering. Experts who successfully complete the Master level of electrical engineering, MSc in Electrical Engineering, will be able to confront complex research and development problems as well as the application of new technologies. Further social and economic development of modern society as well as Croatia is inconceivable without electrical engineering which is present in every segment of human life**.** Electrical engineering will undoubtedly remain the main initiator of the social development which will require highly educated experts who will be able to respond to the challenges of the new era. Highly educated experts in electrical engineering educated at the Faculty of Electrical Engineering in Osijek have found and will find their place at the labour market.

Connection with modern scientific ideas and/or skills based on them - The modern study of electrical engineering is based on the overall research and development in the field of natural and technical sciences but on new technologies as well. It is especially manifested in the development of electrical engineering and electronic industry which is supported by most recent ideas in the scientific field of electrical engineering. The initiator of the development and research in this field is the labour market, which supports further investment into science and research in the field of electrical engineering. Consequently, most recent scientific ideas have to be followed by research

and development at the Faculty, in the first place within the framework of different projects supported by the Ministry of Science, Education and Sports, through projects supported by the European Union and certainly through cooperation and projects with economy. Continuous and first-rate scientific work carried out at the Faculty will ensure outgoing experts of high quality in the scientific field of electrical engineering.

Comparability with programmes of other eminent foreign higher education institutions – The Master level of electrical engineering at the Faculty of Electrical Engineering in Osijek is based on study programmes of distinguished European universities. Furthermore, it can be compared with the second cycle programme of power engineering and the second cycle programme of telecommunications at TU Vienna, but also with the second cycle programme of electrical engineering and computer science at ETH Zurich. The common base is the study duration of two years during which students can acquire the minimum of 120 ECTS credits. The professional qualification awarded after the successful completion of second cycle studies is Master of Science in Electrical Engineering, indicating the field of specialisation in Power Engineering or Telecommunication and Computer Science**,** i.e. MSc in Power Engineering and MSc in Telecommunications (i.e. Master of Science in Electrical Engineering or Master of Science in Telecommunications at TU Vienna). Some advanced knowledge of the fundamental course units of specific fields and elective modules/course units where students can acquire some additional knowledge of a specific field represent the basis for this study.

b) Experience in the implementation of equivalent or similar programmes

Faculty of Electrical Engineering in Osijek has been educating engineers in the field of electrical engineering for many years. In the new curriculum and study programme of the undergraduate studies, which was accepted in 2003, engineers in the scientific field of electrical engineering are educated at the Faculty of Electrical Engineering. Students can choose one of the three following branches: Power Engineering**,** Automation and Computer Engineering in Process Control, and Computer Engineering and Telecommunications**.** Furthermore, postgraduate studies programme of electrical engineering is carried out at the Faculty of Electrical Engineering with the following branches: Power Engineering, Telecommunications and Computer Science. On account of the mentioned studies, the Faculty of Electrical Engineering has acquired valuable experience in the education of experts in the scientific field of electrical engineering. Former studies of electrical engineering represent the foundation for the new First cycle study programme in electrical engineering that will, together with the Second cycle and the Third cycle study programme**,** create a continuing educational cycle from the Bachelor to the Master and finally to the doctoral degree. In this way, the Faculty of Electrical Engineering will encircle the education of experts in the scientific field of electrical engineering.

c) Partners not in the higher education system, who are interested in starting the study of this profile

Faculty of Electrical Engineering in Osijek has gained many partners in economy and public sector that are very interested in continuation and further development of their partnership with the Faculty. In the first place it is the partner company, Siemens that bases its branch–office on engineers in the field of electrical and computer engineering that are educated at the Faculty of Electrical Engineering in Osijek. Siemens plans further development and extension

as well as employment of a considerable number of new personnel from the field of electrical and computer engineering. Other significant companies cooperating with the Faculty of Electrical Engineering are Croatian National Grid Company (Hrvatska elektroprivreda), Croatian telecommunications (THT), VIPNet as well as other companies interested in the study of such profile.

d) Faculty overtness towards mobility of students

Within the scope of the Master level of electrical engineering, students from other universities/faculties will be given an opportunity to study particular courses/modules or even whole semesters at the Faculty of Electrical Engineering in Osijek. Studying at other higher education institutions will be made available to our own students. Candidates that have completed the adequate degree at some other related technical and natural science faculties will be enabled to enrol in the Master level study programme of electrical engineering at the Faculty of Electrical Engineering in Osijek. A high level of students' mobility will be enabled in this way. Mobility of students as well as the teaching staff will be regulated on the basis of a partnership agreement between different universities/faculties. Coordination and agreeing of particular arrangements will be executed by ECTS coordinators of partnership institutions.

2. PRELIMINARIES

2.1. *Study programme*:

Second cycle degree in electrical engineering.

2.2. *Institution*:

J. J. Strossmayer University of Osijek, Faculty of Electrical Engineering Osijek in co-operation with other institutions of the University (faculties, departments)

2.3. *Duration of study*:

Master level study programme in electrical engineering would take **2 years** and a student should acquire a minimum of **120 ECTS credits**.

2.4. *Entry requirements*:

Prior to their enrolment in the second cycle degree study programme in electrical engineering applicants should successfully complete the first cycle degree study programme in electrical or computer engineering. It would also be possible for applicants who graduated from other relative engineering and natural science study programmes majoring in mathematics and/or computer science to enter the second cycle, taking a compulsory course unit or module enhancing fundamental courses in electrical and computer engineering indispensable to a successful continuation of the study programme, whereby first cycle courses would be acknowledged as electives. In this way a high level of student mobility within natural science study programmes majoring in mathematics and/or computer science and engineering would be obtained.

2.6. *Qualification attributes or competencies computer engineering graduates would achieve and positions they would be qualified for:*

Upon graduation from the Faculty of Electrical Engineering in Osijek MSc degree holders in electrical engineering would acquire knowledge and skills in mathematics, physics, science and engineering that should be applied to electrical engineering, in order to be able to successfully conceptualise engineering models. MSc degree holders in EE would learn how to identify, formulate, survey electronic and print literature and solve complex engineering tasks, whereby they would draw important conclusions applying first of all basic mathematical principles and engineering sciences. In addition, they would learn how to design solutions to complex engineering tasks, as well as systems, components and processes corresponding to specific demands, paying special attention to public health care, security, cultural and social values, and environment protection. MSc degree holders in CE would be able to investigate complex problems, including experimental design, data analysis and interpretation, as well as synthesis of all information by creating effective judgement. Furthermore, MSc degree holders in EE would be able to create, select and apply respective techniques, resources and modern engineering tools, including prediction and modelling, to complex engineering activities, understanding at the same time limits such tools might have.

Depending on the branch they would like to specialise in, second cycle degree holders (MSc) in electrical engineering would acquire the necessary knowledge and abilities to do the following tasks:

Branch: Communications and Computer Science:

Graduates holding an MSc degree in this branch would be educated and trained to develop, design, implement and maintain both communication and computer systems and equipment, which involves the following activities:

- to design public telecommunications network representing the information basis of the overall society and economy;
- to design, implement and maintain business and private networks and corresponding computer systems;
- to apply advanced technologies of multimedia communications;
- to apply and maintain hardware and software of design systems in other branches of sciences;
- to design complex communication systems;
- to design, develop and maintain complex network technologies;
- to plan and supervise quality assurance of electronic and communication systems;
- to analyse and explain the impact of electrical engineering on the environment.

Branch: Power Engineering:

Graduates holding an MSc degree in this branch would be trained and taught how to plan, develop, design, construct, supervise, control and maintain, which involves the following activities:

- to design power plants and systems;
- to carry out detailed measurements and experiments on the electric power systems;
- to design and maintain electrical installations oat all levels of complexity (installations in buildings and industry);
- to design and maintain transmission and distribution networks and lines, switching substations, city substations, distribution overhead and underground networks;
- to design and maintain facilities and plants (industry, transport, etc.) of flexible manufacturing systems controlled by automated electromotive devices, electrical machines, semiconducting power converters, etc. in various companies;
- to research and develop independent projects in their branch of specialisation.

In addition to first cycle degree holders in electrical engineering who graduate from the Faculty of Electrical Engineering in Osijek, graduates from other first cycle degree granting institutions (universities, departments) in electrical engineering would be able to enrol in the second cycle study programme in electrical engineering (leading to an MSc degree). Furthermore, first cycle degree holders in computer engineering and other engineering and natural study programmes encompassing a fundamental knowledge of mathematics, physics and electrical engineering, would also be able to enrol in the MSc study programme. However, a special course module would be organised for such students, aiming at gaining the knowledge necessary for their studies.

2.8. *Qualification awarded after the successful completion of the study programme:*

After the successful completion of the second cycle study programme (Master level) in electrical engineering graduates would be awarded the title **Master of Science** supplemented by their respective **branch: Communications and Computer Science or Power Engineering**.

3. Program Description

3.1. Second-cycle Degree Study Programme in Electrical Engineering- obligatory and elective courses

Curriculum of the Second cycle degree study programme in Electrical Engineering is described in detail in tables showing the order of enrolling and carrying out respective study courses. The tables provide course titles, weekly workload (contact hours pertaining to lectures + problem solving + laboratory practice + design/construction exercises). The courses are assumed to be conducted for the whole semester, i.e. fifteen weeks. The total weekly workload of students relative to lectures and practice is at most 25 hours excluding their duties referring to Physical Education and optional courses. All courses are one-semester courses. Students can take respective examinations after completing lectures and practice/exercises. The estimated students' workload per semester is expressed by ECTS (European Credit Transfer System) credits. ECTS credits are assigned according to the following principles and criteria:

- Credits are assigned by setting a norm in one semester to 30 ECTS credits ;
- Number of credits assigned to each course represents part of students' workload and engagement within that particular course with respect to the total semester workload (30 ECTS credits); number of credits per one course is rounded to half a credit (0.5);
- Students' workload includes the total time required for successful course completion (lectures, problem solving, laboratory practice, design/construction exercises, preparation for practice and exercises, writing reports, testing laboratory practice, seminar papers, time spent studying, i.e. independent learning, tests and examinations, etc.);
- Detailed credit value has been determined on the basis of lecturer's estimation regarding content complexity, as well as a questionnaire conducted among students concerning the existing courses at the faculty and the time required for their successful completion.

Course notation

For easy reference courses are denoted by codes in the following way:

Course code: D Bx y z

where: D – one-letter symbol for the second-cycle degree study programme
B – one- or multi-letter symbol for the study programme or an elective course
E – Electrical engineering courses
K – Communications courses
R – Second-cycle degree study programme in computer engineering
I – Elective courses

x – semester
y z – two-digit symbol for the course number in the semester

Workload notation

P - lectures
A – problem solving
L – laboratory practice
K - design/construction exercises

1st Year **Branch- Communications and Computer Science**

Semester 1

Code	*Lecturer*	*Course*	*Weekly workload*					*Examination*	*ECTS credits*
			P	A	L	K	Σ		
DEK101	Rudolf Scitovski, PhD, Full Professor	Numerical Mathematics	2	2	0	0	4	1	5
DK101	Franjo Jović PhD, Full Professor	Integration of Communication Networks	2	1	1	0	4	1	5
DEK102	Ivan Flegar PhD, Full Professor	Theory of EM Fields and Waves	3	2	0	0	5	1	5.5
DKR101	Drago Žagar PhD, Assistant Professor	Computer Networks	2	1	1	0	4	1	5
DKIR101	Snježana Rimac-Drlje PhD, Assistant Professor	Digital Signal Processing	2	1	1	0	4	1	5
		Elective course I					4	1	4.5
		TOTAL:	**9**	**6**	**2**	**0**	**25**	**6**	**30**
	Electives:								
DEIK101	Zdenko Godec PhD, Full Professor	Electrical and Magnetic Measurements	2	1	1	0	4		
DRIK101	Radoslav Galić, PhD, Associate Professor	Discrete Mathematics	2	2	0	0	4		
DRIK102	Franjo Jović PhD, Full Professor	Automata and Formal Languages	2	1	1	0	4		
DIKR101	Tomislav Švedek PhD, Full Professor	Microelectronics	2	1	1	0	4		
DIEK101	Antun Pintarić PhD, Assistant Professor	Industrial Ecology	3	1	0	0	4		
	Optional course:								
DF101	Branka Pavlović, MA, Senior Lecturer, Ivanka Ferčec, BA, Lecturer	English	1	1	0	0	2		
DF102	Branka Pavlović, MA, Senior Lecturer, Ivanka Ferčec, BA, Lecturer	German	1	1	0	0	2		

Semester 2

Code	*Lecturer*	*Course*	*Weekly workload*					*Examination*	*ECTS credits*
			P	A	L	K	Σ		
DK201	Drago Žagar PhD, Assistant Professor	Error Control Codes and Coding	3	1	1	0	5	1	6.5
DK202	Tomislav Švedek PhD, Full Professor	Transmitters	3	1	1	0	5	1	6.5
DKR201	Davor Antonić PhD, Assistant Professor	Internet Programming	3	1	1	0	5	1	6
DKIR201	Snježana Rimac-Drlje PhD, Assistant Prof.	Multimedia Systems	3	0	1	1	5	1	6
		Elective course II					4	1	5
		TOTAL:	**12**	**3**	**4**	**1**	**24**	**5**	**30**
	Electives:								
DIK201	Tomislav Švedek PhD, Full Professor	Numerical Methods in Communications	2	1	1	0	4		
DIK202	Tomislav Švedek PhD, Full Professor	Radio-relay and Satellite Communications	2	1	1	0	4		
DIK203	Drago Žagar PhD, Assistant Professor	Traffic and Queuing Theory	2	1	1	0	4		
DRIK201	Goran Martinović PhD, Assistant Professor	Real-time Computer Systems	3	1	1	0	5		
DIKR201	Vlado Majstorović PhD, Full Professor	Information Technology and Management	2	1	0	1	4		
DF201	Branka Pavlović, MA, Senior Lecturer, Ivanka Ferčec, BA, Lecturer	English	1	1	0	0	2		
DF202	Branka Pavlović, MA, Senior Lecturer, Ivanka Ferčec, BA, Lecturer	German	1	1	0	0	2		

2nd Year

Semester 3

Code	*Lecturer*	*Course*	*Weekly workload*					*Examination*	*ECTS credits*
			P	A	L	K	Σ		
DK301	Snježana Rimac-Drlje PhD, Assistant Professor	Mobile communications	3	1	1	0	5	1	7
DK302	Tomislav Švedek PhD, Full Professor	Receivers	3	1	1	0	5	1	6.5
DKIR301	Drago Žagar PhD, Assistant Professor	Communication Protocols	3	1	1	0	5	1	6.5
		Elective course III					4	1	5
		Elective course IV					4	1	5
		TOTAL:	**9**	**3**	**3**	**0**	**23**	**5**	**30**
	Electives:								
DIK301	Snježana Rimac-Drlje PhD, Assistant Professor	Digital Image Processing	2	1	1	0	4		
DIK302	Tomislav Švedek PhD, Full Professor	Antennas	2	1	1	0	4		
DRIK301	Goran Martinović PhD, Assistant Professor	Distributed Computer Systems	3	0	2	0	5		
DIKR301	Drago Žagar PhD, Assistant Professor	Network Security	2	1	1	0	4		
DIKR302	Snježana Rimac-Drlje PhD, Assistant Professor	Optical Communications	2	1	1	0	4		
DI301	Ante Lauc PhD, Full Proffesor	Science, Technology, Society	3	1	0	0	4		

Semester 4

Code	*Lecturer*	*Course*	*Weekly workload*					*Examination*	*ECTS credits*
			P	A	L	K	Σ		
D401	Zlatko Lacković PhD, Associate Professor	Management	2	1	0	0	3	1	4
D402	Ninoslav Slavek PhD, Assistant Professor, Vedran Boras PhD, Assistant Professor	Project Management	2	1	0	0	3	1	4
D403	Ante Lauc PhD, Full Proffesor	Introduction to Research Work	2	1	0	0	3	1	4
DS401		Elective course-University					3	1	4
DD401		Thesis	0	0	0	13	13	1	14
		TOTAL:	**6**	**3**	**0**	**13**	**25**	**5**	**30**

1st Year **Branch - Power Engineering**

Semester 1

Code	*Lecturer*	*Course*	*Weekly workload*					*Examination*	*ECTS credits*
			P	A	L	K	Σ		
DEK101	Rudolf Scitovski, PhD, Full Professor	Numerical Mathematics	2	2	0	0	4	1	5
DEK102	Ivan Flegar PhD, Full Professor	Theory of EM Fields and Waves	3	2	0	0	5	1	5.5
DE101	Zdravko Valter PhD, Full Professor	Electrical Machines	2	1	1	0	4	1	5
DE102	Lajos Jozsa PhD, Associate Professor	Power System Analysis	2	1	1	0	4	1	5
DEIK101	Zdenko Godec PhD, Full Professor	Electrical and Magnetic Measurements	2	1	1	0	4	1	5
		Elective course I					4	1	4.5
		TOTAL:	**9**	**6**	**2**	**0**	**25**	**6**	**30**
	Electives:								
DIE101	Srete Nikolovski PhD, Full Professor	Power System Lines	2	1	1	0	4		
DIE102	Lajos Jozsa PhD, Associate Professor	Electrical Installation and Lightning	2	1	1	0	4		
DIE103	Vedran Boras PhD, Assistant Professor	Electrical Switching Devices	2	1	1	0	4		
DIE104	Tomislav Mrčela PhD, Associate Professor	Operative Machines	2	0	2	0	4		
DIEK101	Antun Pintarić PhD, Assistant Professor	Industrial Ecology	2	1	1	0	4		
	Optional course:								
DF101	Branka Pavlović, MA, Senior Lecturer, Ivanka Ferčec, BA, Lecturer	English	1	1	0	0	2		
DF102	Branka Pavlović, MA, Senior Lecturer, Ivanka Ferčec, BA, Lecturer	German	1	1	0	0	2		

Semester 2

Code	*Lecturer*	*Course*	*Weekly workload*					*Examination*	*ECTS credits*
			P	A	L	K	Σ		
DE201	Lajos Jozsa PhD, Associate Professor	Power Plants	3	1	1	0	5	1	6
DE202	Zdravko Valter PhD, Full Professor	Electric Drives	3	1	1	0	5	1	6.5
DE203	Srete Nikolovski PhD, Full Professor	Transmission and Distribuition of Electrical Energy	3	1	1	0	5	1	6.5
DE204	Vedran Boras PhD, Assistant Professor	High Voltage Engineering	3	1	1	0	5	1	6
		Elective course II					4	1	5
		TOTAL:	**12**	**4**	**4**	**0**	**24**	**5**	**30**
	Electives:								
DIE201	Vedran Boras PhD, Assistant Professor	Ground Electrodes and Grounding Systems	2	1	1	0	4		
DIE202	Zdenko Godec PhD, Full Professor	Testing and On-line Monitoring	2	1	1	0	4		
DIE203	Ivan Flegar PhD, Full Professor	Power Electronics	2	1	1	0	4		
DIE204	Antun Pintarić PhD, Assistant Professor	Recycling of Electrical Waste	2	1	1	0	4		
DIE205	Srete Nikolovski PhD, Full Professor	Power System Economics	2	1	1	0	4		
DIER201	Zdravko Valter PhD, Full Professor	Process Measurement	2	1	1	0	4		
	Optional course:								
DF201	Branka Pavlović, MA, Senior Lecturer / Ivanka Ferčec, BA, Lecturer	English	1	1	0	0	2		
DF202	Branka Pavlović, MA, Senior Lecturer / Ivanka Ferčec, BA, Lecturer	German	1	1	0	0	2		

2nd Year

Semester 3

Code	Lecturer	Course	Weekly workload					Examination	ECTS credits
			P	A	L	K	Σ		
DE301	Vedran Boras PhD, Assistant Professor	Electric Power Substations	3	2	1	0	6	1	7
DE302	Srete Nikolovski PhD, Full Professor	Power System Protection	3	1	1	0	5	1	6
DE303	Lajos Jozsa PhD, Associate Professor	Power System Operation Control	3	1	1	0	5	1	6
		Elective course III					4	1	5.5
		Elective course IV					4	1	5.5
		TOTAL:	**9**	**4**	**3**	**0**	**24**	**5**	**30**
	Electives:								
DIE301	Lajos Jozsa PhD, Associate Professor	Power System Planning	2	1	1	0	4		
DIE302	Srete Nikolovski PhD, Full Professor	Power System Stability and Reliability	2	1	1	0	4		
DIE303	Vedran Boras PhD, Assistant Professor	Design of Switchgears and Electrical Power Substations	2	1	1	0	4		
DIE304	Vedran Boras PhD, Assistant Professor	Electricity Market	2	1	1	0	4		
DIE305	Lajos Jozsa PhD, Associate Professor	Transitional Processes in Power Systems	2	1	1	0	4		
DIE306	Lajos Jozsa PhD, Associate Professor	New Energy Sources	2	1	1	0	4		
DIE307	Ivan Flegar PhD, Full Professor	Uninterruptible Supplies	2	1	1	0	4		
DIER301	Vedran Boras PhD, Assistant Professor	Computer Integrated Product Development	2	1	1	0	4		
DI301	Ante Lauc PhD, Full Proffesor	Science, Technology, Society	3	1	0	0	4		

Semester 4

Code	Lecturer	Course	Weekly workload					Examination	ECTS credits
			P	A	L	K	Σ		
D401	Zlatko Lacković PhD, Associate Professor	Management	2	1	0	0	3	1	4
D402	Ninoslav Slavek PhD, Assistant Professor, Vedran Boras PhD, Assistant Professor	Project Management	2	1	0	0	3	1	4
D403	Ante Lauc PhD, Full Proffesor	Introduction to Research Work	2	1	0	0	3	1	4
DS401		Elective course- University					3	1	4
DD401		Thesis	0	0	0	13	13	1	14
		TOTAL:	**6**	**3**	**0**	**13**	**25**	**5**	**30**

3.2. Second Cycle Degree in Electrical Engineering (Master level) – Branch: Communications and Computer Science - Courses Description

Semester 1

DEK101	Numerical Mathematics
Lecturer:	Rudolf Scitovski, PhD, Full Professor

Course description:

1. Errors. Types of errors. Significant digits of an approximate number. Error of the function. Inverse problem.

2. Interpolation. Spline interpolation. Interpolation problem. Lagrange's interpolation formula. Newton's interpolation formula. Error estimation. Linear spline. Cubic spline.

3. Solving a system of linear equations. Norm of the vector and matrix. Condition. Triangle systems, Gauss algorithm and LU-decomposition, pivoting. QR-decomposition, Cholesky decomposition, Iterative methods, Singular value decomposition, sparse systems.

4. Root finding and a nonlinear set of equations. Bisection method. Method of simple iteration. Newton's method and modifications. Solving a nonlinear set of equations: Newton's method, quasi-Newton's methods.

5. Approximation of functions. Best L_2 approximation. Fourier polynomial.

6. Least squares problem. Introduction and examples. Methods for solving linear least squares problem. Nonlinear least squares problem. Gauss-Newton method.

7. Numerical integration. Trapezium rule. Newton-Cotes formula. Simpson's rule.

8. Numerical methods for solving ordinary differential equations. Euler's method. Runge – Kutta method. Two point boundary value problems – discretional method.

9. Numerical methods for solving partial differential equations.

Knowledge and skills acquired:

The objective of this course is to make students familiar with the basic ideas and methods of numerical mathematics for solving practical problems. During practice students should master an adequate technique and become trained for solving concrete problems.

Teaching methods:

Lectures will be illustrated by ready-made software packages and graphics using a PC and an LCD projector and carried out in mathematical laboratory. Students will use PCs and an LCD projector in practical work partially carried out in laboratory.

Student assessment:

During the semester students write homework. They can also take 2-4 tests that completely cover course contents. Successfully passed tests replace the written examination. During their studies students are encouraged to prepare seminar papers. The course final grade comprises the grade achieved by writing seminar papers.

Obligatory literature:

1. R.Scitovski, Numerička matematika, Odjel za matematiku, Osijek, 2000.

Recommended additional literature:

1. G.Dalquist, A.Björck, Numerische Methoden, R.Oldenbourg Verlag, München, 1972. (English version is available)
2. D.Kincaid, W.Cheney, Numerical Analysis, Brooks/Cole Publishing Company, New York, 1996.
3. J.Stoer, R.Bulirsch, Introduction to Numerical Analysis, 2^{nd} Ed., Springer Verlag, New York, 1993.
4. W.H.Press, B.P.Flannery, S.A.Teukolsky, W.T.Vetterling, Numerical Recipes, Cambridge University Press, Cambridge, 1989.

ECTS credits: **5 ECTS credits**

An ECTS credit value has been added to calculation according to time required for studying and successful completion of the course.

Examination methods:

The final assessment consists of both the written and the oral examination that can be taken after the completion of all the lectures and practice – problem solving.

Course assessment:

Conducting an anonymous questionnaire filled in by students after the course completion, an analysis of students' final assessments and their overall success.

DK101	Integration of Communication Networks
Lecturer:	Franjo Jović PhD, Full Professor
Course description: System engineering of complex systems. Post-structuralism and technology. Main technology paradigms: IPv6, mobile networks, ad-hoc networks, sensor networks, Bluetooth. Design of different network protocols. Standards in complex communication networks. Fast stationary networks. Integration of different networks and technologies. QOS: Application in the field of medicine, commerce and military force.	
Knowledge and skills acquired: Skill in designing complex communication network. System testing.	
Teaching methods: Lectures and laboratory practice are obligatory.	
Student assessment: Attending lectures and practice is obligatory.	
Obligatory literature: 1. Raghavendra C.S., Sivalingam K.M. i Znati T.: Wireless Sensor Networks, Kluwer 2004. 442 str. 2. 2. Mohapatra P. i Krishnamurti S.: Ad Hoc Networks: Technologies and Protocols, Kluwer 2004, str.296...	
Recommended additional literature: 1. Trans. IEEE on Communications.	
ECTS credits: **5 ECTS credits** An ECTS credit value has been added to calculation according to time required for studying and successful completion of the course.	
Examination methods: Test and oral examination.	
Course assessment: Anonymous questionnaire filled in by students during the course and after the course completion. The lecturers that have this course as obligatory will be contacted for their courses as well.	

DEK102	Theory of EM Fields and Waves
Lecturer:	Ivan Flegar PhD, Full Professor
Course description: Fundamentals of physics incorporated in the electrical engineering with the description of EM fields. Fundamentals of EM field laws. Maxwell's equations. Boundary conditions. Poynting's theorem, Poynting's vector and the flow of power. The vector and scalar EM potentials. Electrostatic field. The method of images and variable separation. Electrostatic currents. Bio-Savart's law, Inductance and mutual inductance. Introduction of EM wave theory. Plane wave characteristics, reflection and dispersion, dispersion modes, energy density, polarization. Plane wave in the dispersive material. Dispersion of EM waves in free space.. Helmholtz's equation. Hertz's vector. Basic dipole. Radiation of linear antennas.	
Knowledge and skills acquired: To learn about electro-magnetic fields and dispersion of EM waves.	
Teaching methods: Lectures and practice – problem solving.	
Student assessment: Written tests during semester and final examination	
Obligatory literature: 1. E.Zentner: *Radiokomunikacije*, Školska knjiga, Zagreb, 1980. 2. Z.Haznadar: *Elektromagnetska teorija i polja*, Liber, Zagreb, 1972. 3. E.C.Jordan, K.G.Balmain*: Electromagnetic waves and radiating systems*, Prentice-Hall, Inc. Englewood Cliffs, N.J, 1968.	
Recommended additional literature: 1. R.F. Harrington, "*Time-harmonic electromagnetic fields"*, McGraw-Hill, New York, 1961. 2. J.Kraus, *Electromagnets*, McGraw Hill, N.Y. 1984.	
ECTS credits: **5.5 ECTS credits**	

An ECTS credit value has been added to calculation according to time required for studying and successful completion of the course.

Examination methods:
Seminar paper and oral examination.

Course assessment:
Attending lectures, practice – problem solving and examination.

DKR101	Computer Networks

Lecturer: Drago Žagar PhD, Assistant Professor

Course description:
Computer network definition. Uses of computer networks. Example of computer networks. Network topologies. Computer network hardware, LAN, MAN, WAN, wireless networks. Network software, protocol hierarchy, Relationship of services to protocols. Problems of multiple access, Ethernet, Fast Ethernet, Gigabit Ethernet. Wireless computer networks, IEEE 802.11, IEEE 802.16, Bluetooth. Computer networks internetworking, repeaters, hubs, bridges, switches, routers and gateways. Routing algorithms. Congestion control in computer networks. Flow control in computer networks. Error control in computer networks and basic error detecting codes. Projecting the computer networks. Optimisation problems. Network performance measurement. System design for better performance. Network applications. Computer network security, basic cryptography methods. Firewalls and IDS systems.

Knowledge and skills acquired:
The students will get the knowledge necessary to use and design the computer networks. After the successful completion of the course the students will acquire the basic computer networks parameters.

Teaching methods:

Lectures, laboratory practice. The advanced teaching methods like E-teaching and individual work will be used except the ordinary teaching methods.

Student assessment:
Several tests during the semester, the evaluation of the laboratory practice, written and oral examination.

Obligatory literature:

1. A.S. Tannenbaum, Computer Networks, Fourth Edition, Prentice Hall, 2003.
2. A. Bažant, et al., Osnovne arhitekture mreža, Element Zagreb, 2003.

Recommended additional literature:

1. W. Stallings, Data and Computer Communications, Fourth Edition, Macmillan Publishing Company, New York, 2002.

ECTS credits: **5 ECTS credits**
An ECTS credit value has been added to calculation according to time required for studying and successful completion of the course.

Examination methods:
Written and oral examination.

Course assessment:
Examination at the end of the course.

DKIR101	Digital Signal Processing

Lecturer: Snježana Rimac-Drlje PhD, Assistant Professor

Course description:
Introduction: Characterization and classification of discrete-time signals. Digital processing of continuous-time signals: sampling, aliasing, quantization and reconstruction. The z-transform, regions of convergence, inverse and properties. Linear time invariant (LTI) discrete-time systems; convolution, impulse response, transfer function. Methods for the FIR and IIR filter design. Properties of the discrete Fourier's series and transformation. Spectral analysis with the DFT and FFT. Time windows. Digital multiple resolution of signal processing, decimation, interpolation, poly-phase decomposition. Adaptive signal processing. Principles of the multidimensional signal processing. Digital signal processing of speech, music, medical images, radar images, application in communication and automation.

Knowledge and skills acquired:
Student will be introduced to the basic techniques for digital signal processing, the FFT applications, as well as the z-transform applications. Students will acquire the practical knowledge of the digital filter design and signal

processing in time and frequency domain.

Teaching methods:

Lecture (2 hours per week), practice – problem solving (1 hours), laboratory practice (1 hour)

Student assessment:

Testing the practice in laboratory, written and oral examination.

Obligatory literature:

1. A. V. Oppenheim, R. W. Schafer, J. R. Buck: Discrete-Time Signal Processing, Prentice Hall, 1999.

Recommended additional literature:

1. M.H. Hayes, Digital Signal Processing, Schaum's outlines, McGraw-Hill, 1999.

ECTS credits: **5 ECTS credits**

An ECTS credit value has been added to calculation according to time required for studying and successful completion of the course.

Examination methods:

The final examination consists of the written and oral part.

Course assessment:

Students' evaluate the course.

Electives – Semester 1

One elective course has to be chosen. Due to the set standards of student workload to 30 ECTS credits, every elective course carries 4.5 ECTS credits. A student who enrols a larger number of elective courses is not awarded additional ECTS credits.

DEIK101	Electrical and Magnetic Measurements

Lecturer: Zdenko Godec PhD, Full Professor

Course description:

Testing. Selection of optimal measurement instruments for defined purpose. Voltmeters, ammeters, ohmmeters, watt meters, watt-hour meters, analog and digital oscilloscopes, recorders, logic analyzers, frequency meters, spectrum analyzers, measurement bridges, compensators, multi-meters, instrument transformers. PC based measuring systems. Lab VIEW software development package. Measurement methods of electric quantities (current, voltage, frequency, phase displacement, apparent power, active power, reactive power, power factor, energy, resistance, inductance, capacitance, dissipation factor, impedance, admittance). Noise, interference, minimizing interference. Measurement of electric energy quality. High voltage measurements. Magnetic measurements. Measurements of characteristics of magnetic materials (magnetization curve, loops, permeability, core loss).

Knowledge and skills acquired:

Skills for correct measurements of electrical and magnetic quantities. Skill to interpret specifications of the instruments and to estimate measurement uncertainty. Knowledge to form PC based measuring systems.

Teaching methods:

Lectures, practice in laboratory.

Student assessment:

Preliminary, written and oral examination.

Obligatory literature:

1. Z. Godec, Expressing measurement results (Croatian version only), Graphic, Zagreb, 1995.
2. Z. Godec, D. Dorić, Measurement basics, practice in laboratory (Croatian version only), Sveučilište u Osijeku, Elektrotehnički fakultet, Osijek, 2001.
3. Z. Godec, D. Dorić, Measurements in electrical engineering and practice in laboratory (Croatian version only), Sveučilište u Osijeku, Elektrotehnički fakultet, Osijek, 2000.

Recommended additional literature:

1. D. Vujević, B. Ferković, Fundamentals of measurements in electrical engineering 1 and 2 (Croatian version only), Školska knjiga, Zagreb, 1996.
2. V. Bego, Measurements in electrical engineering (Croatian version only), Školska knjiga, Zagreb, 1990.
3. D. Karavidović, Measurements in electrical engineering 1 and 2 (Croatian version only), ETF Osijek, 1994.
4. Šantić, Electronic instrumentation (Croatian version only), Školska knjiga, 1993.
5. J. Božičević, Fundamentals of automatics II (Croatian version only), Školska knjiga, Zagreb, 1982.

ECTS credits: **4.5 ECTS credits**
An ECTS credit value has been added to calculation according to time required for studying and successful completion of the course.

Examination methods:
Written and oral examination.

Course assessment:
Two preliminary examinations.

DRIK101	Discrete Mathematics

Lecturer: Radoslav Galić, PhD, Associate Professor

Course description:
Mathematics logic. Logic operations. Truth tables. Tautologies. Predicate calculation. Whole numbers. Divisibility, prime numbers, congruency. Euler function. Binary relations. Equivalence relations, set partition. Arrangement relations, networks. Binary operations. Algebra structures. Groups. Final group examples. Rings. Whole number rings. Boolean algebras. Boolean algebra presentation. Boolean function. Combinations. Final sets, set product. Counting techniques. Permutations. Permutation groups. Combinations. Variations. Recursive relations. Fibonacci series. Stirling number. Linear recursive formulas. Block designs. Final project planes.

Knowledge and skills acquired:
Students get acquainted with the fundamental linear algebra calculation and algebra structures which are the basis for many other courses. During the lectures and practice the basic concepts will be discussed and by using the examples their efficiency and application will be illustrated.

Teaching methods:
Students are obliged to attend both lectures and exercises.

Student assessment:
During the semester students could take several tests which replace the written examination. This ensures continuous assessment of students' work and knowledge.

Obligatory literature:
2. D. Žubrinić, Diskretna matematika, Element, Zagreb,2001.

Recommended additional literature:
1. D. Veljan, Kombinatorna I diskretna matematika, Algoritam, Zagreb, 2001.
2. S. Lipschutz, Discrete Mathematics, McGraw Hill, New York, 1986.

ECTS credits: **4.5 ECTS credits**
An ECTS credit value has been added according to calculation of required time for studying and successful course completion.

Examination methods:
The final examination consists of the written and the oral part. Students could take the final examination after the completion of lectures and practice.

Course assessment:
Conducting an anonymous questionnaire filled in by students after the course completion, an analysis of students' final assessments and their overall success.

DRIK102	Automata and Formal Languages

Lecturer: Franjo Jović PhD, Full Professor

Course description:
Context-free languages. Context sensitive languages. Derivation tree. Grammars and machines: Chomsky's hierarchy, closure properties, regular and finite languages. Push-down automation and context free grammars. Parsing. Turing machine and language theory. Fixed point principle and language theory. Inductions. Semantic types: operational, formal and axiomatic. Computability. Problem of program finiteness and infiniteness. Goedel's theorem. Church - Turing thesis.

Knowledge and skills acquired:
Development of simple lexes and parser. Validity analysis of a context free program.

Teaching methods:
Lectures and laboratory practice are obligatory

Student assessment:

Seminar work, oral examination.

Obligatory literature:

1. Moll R., Arbib M.A. i Kfoury A.J.: An introduction to formal language theory, Springer Verlag 1987.
2. Winskel G.: The Formal Semantics of Programming Languages, MIT Press, 1997.

Recommended additional literature:

2. Srbljić T. Automati i jezici, Školska knjiga, Zagreb 1998.

ECTS credits: **5 ECTS credits**

An ECTS credit value has been added to calculation according to the time required for studying and successful completion of the course.

Examination methods:

Test and oral examination.

Course assessment:

Anonymous questionnaire filled in by students during the course and after the course completion. The lecturers that have this course as obligatory will be contacted for their courses as well.

DIKR101	**Microelectronics**

Lecturer: Tomislav Švedek PhD, Full Professor

Course description:

Integrated circuits production technologies: planar silicon technology, hybrid thin and thick film technology. Components of bipolar and un-polar integrated circuits: transistors, diodes, resistors, capacitors. Digital bipolar and un-polar integrated circuits: current switch, basic gates of TTL, ECL, I2L, NMOS and CMOS families. Analog bipolar and un-polar integrated circuits: constant current stages, referent voltage stages, DC voltage level shift stages, basic stages of amplification (CE, CS), differential amplifier', operational amplifiers architectures. Techniques of integrated circuits design: PLD, GA, StC, FC. Design principles of complex microelectronic analog and digital circuits: amplifiers, comparators, A/D and D/A converters, filters, wave-shape generators. DFT – design for testability methods in integrated circuit. Introduction to nanotechnology

Knowledge and skills acquired:

- basic knowledge about integrated circuits production technologies
- basic skills of analog and digital circuits design in one of microelectronic technologies
- skills in projecting the IC design: from technical requirements, through design of integral sub-circuits, to methods of the circuit testing

Teaching methods:

Lectures, project.

Student assessment:

Written theoretical work and participating in IC project design

Obligatory literature:

1. T.Švedek, Osnove mikroelektronike, Elektrotehnički fakultet Osijek, Osijek, 2002.

Recommended additional literature:

1. P.Biljanović, Mikroelektronika, Školska knjiga, Zagreb, 1983
2. A.S.Sedra, K.C.SMith, Microelectronic Circuits, 3.Edition, Saunders College Publishing, New York, 1991

ECTS credits: **4.5 ECTS credits**

An ECTS credit value has been added to calculation according to time required for studying and successful completion of the course.

Examination methods:

Oral examination

Course assessment:

Examination, tests, discussion

DIEK101	**Industrial Ecology**
Lecturer:	Antun Pintarić PhD, Assistant Professor
Course description: Introduction to industrial ecology and life cycle assessment. Material flow analysis. Life cycle management. Environmental design. Sustainable production and consumption systems.	
Knowledge and skills acquired: Systematic analysis of global, regional and local material and energy flows and uses associated with products, processes, industrial sectors, and economies. Provide the students with analytical tools and methods for implementing principles of industrial ecology.	
Teaching methods: Lecture, Seminar, Case studies	
Student assessment: Seminar, laboratory practice, examination	
Obligatory literature: 1. Graedel T.E., Allenby B.R., Industrial Ecology, New Jersey, Prentice Hill. 1995. 2. Keoleian, G.A., Environmental Life-Cycle Assessment, McGraw-Hill: New York, 1996.	
Recommended additional literature: 1. Frosch R., Industrial Ecology: A Philosophical Introduction, Proceedings of the National Academy of Sciences of the USA, 1992. 2. Graedel, T. Industrial Ecology and Global Change, Cambridge, MA: Cambridge University Press, 1994.	
ECTS credits: **4.5 ECTS credits** An ECTS credit value has been added to calculation according to the time required for studying and successful completion of the course.	
Examination methods: Seminar paper, final examination	
Course assessment: Examinations, tests, discussion.	

DF101	**English** - Optional
Lecturer:	Branka Pavlović, MA, Senior Lecturer / Ivanka Ferčec, BA, Lecturer
Course description: Telephone and data networks. Transmission systems. Switching. Developments in data processing and telecommunications – trends in computer communications. Radio communications. Mobile communications. International Telecoms.	
Knowledge and skills acquired: Reading and understanding texts from the fields of communications, acquisition of new ESP vocabulary, broadening of knowledge pertaining to new structures typical of the English language, broadening and acquisition of new verbal and non-verbal communication patterns.	
Teaching methods: Lectures and exercises include terminology relative to specific fields of students' future profession, understanding and acquisition of specific grammatical structures of the English language, as well as ESP characteristics necessary for basic speech acts, introduction to techniques and methods of reading and writing abstracts as well as fundamentals of business communication.	
Student assessment: Individual homework or group task projects, regular communication, exercises, written and oral examination.	
Obligatory literature: 1. Comfort, J. et al., English for the Telecommunications Industry, OUP, Oxford, 1986.	
Recommended additional literature: 1. R.Murphy, English Grammar in Use, CUP, Cambridge, 1995. 2. Scientific and professional journals from the field of communications.	
ECTS credits: **0 ECTS credits** This course is optional and does not carry ECTS credits.	
Examination methods: Written and oral examination.	

Course assessment:
Conducting an anonymous questionnaire filled in by students after the course completion, an analysis of students' final assessments and their overall success.

DF102	**German** - optional
Lecturer:	Branka Pavlović, MA, Senior Lecturer / Ivanka Ferčec, BA, Lecturer

Course description:
Grundbegriffe, Energiebergriffe, Energieformen, Energieumwandlung, Elektrizität und unser Alltag, Strom und Physik, Weg der elektrischen Energie, Größen, Einheiten, Kurzzeichen, Mathematik, Strom und Physik.

Knowledge and skills acquired:
Reading comprehension of electrical engineering texts, acquiring new vocabulary and new syntactic structures, acquiring new communicative patterns.

Teaching methods:
Lectures and language practice.

Student assessment:
Written and oral examination.

Obligatory literature:
1. V. Grujoski: Deutsche Fachtexte aus der Elektrotechnik, Sveučilišna tiskara, Zagreb, 1996.

Recommended additional literature:
1. Medić: Kleine deutsche Grammatik, Školska knjiga, Zagreb, 1998,

ECTS credits: **0 ECTS credits**
This course is optional and does not carry ECTS credits.

Examination methods:
Written and oral examination.

Course assessment:
Students' evaluation at the course end.

Semester 2

DK201	**Error Control Codes and Coding**
Lecturer:	Drago Žagar PhD, Assistant Professor

Course description:
Communication and processing. Source information coding. Optimal coding. Protecting coding. Mathematical algebra usage in information protection. Block codes. Parity codes, single parity check codes, product codes, binary repetition codes, and binary parity repetition codes. Hamming codes. Binary linear codes. Cyclic codes. Shift registers usage for encoding and decoding. Bose-Chaudhury-Hocquenghem code. Peterson-Gorenstein-Zierler decoder. Reed-Solomon code. Convolution codes. Viterbi decoder. Codes efficiency. Error control codes usage.

Knowledge and skills acquired:
The students will get the knowledge necessary to use and design the computer and communication error control codes. After the successful completion of the course By the students will acquire the parameters of the error protecting codes in communication and computer networks.

Teaching methods:
Lectures, laboratory practice.

Student assessment:
Several tests during the semester, evaluation of the laboratory practice, written and oral examination.

Obligatory literature:
1. V. Sinković, Informacija, simbolika i semantika, Školska knjiga, Zagreb, 1997.
2. N. Rožić, Informacija i komunikacije, kodiranje s primjenama, Alinea, Zagreb 1992.

Recommended additional literature:
1. S. Lin, D. J. Costello,Jr. Error Control Coding: Fundamentals and Applications, Prentice Hall, Inc. New Jersey, 1983
2. S. Gravano, Introduction to Error Control Codes, Oxford University Press, Oxford, 2001.
3. M. Purser, Introduction to Error-Correcting Codes, Artech House, Boston-London, 1995.

ECTS credits: **6.5 ECTS credits** An ECTS credit value has been added to calculation according to time required for studying and successful completion of the course.
Examination methods: Written and oral examination.
Course assessment: End of the course examination.

DK202	**Transmitters**
Lecturer:	Tomislav Švedek PhD, Full Professor
Course description: Oscillators. Theory of negative resistance oscillators and positive feedback oscillators. High-frequency LC oscillators. Low-frequency RC oscillators. Procedures for enhancement of oscillator amplitude and frequency stability. Oscillators with quartz crystal. Frequency synthesis procedures: direct and indirect synthesis, phase loop synchronization. High-frequency power amplifiers (class A, B and C). Frequency multipliers. Sine-wave signal modulation: amplitude modulation (AM) and argument modulation (FM and PM), modulator and demodulator structures. Discrete modulation of sine-wave: amplitude shift keying (ASK), phase shift keying (PSK) and frequency shift keying (FSK), modulator and demodulator structures. Pulse modulation: pulse amplitude modulation (PAM), pulse width modulation (PDM), pulse position modulation (PPM) and pulse frequency modulation (PFM), modulator and demodulator structures. Digital modulation procedures: pulse-code modulation (PCM) and delta sigma modulation (DSM), modulator and demodulator structures.	
Knowledge and skills acquired: Knowledge of basic oscillator theory, high-frequency tuned amplifiers, and modulators - basic skills of design high-frequency circuits.	
Teaching methods: Lectures.	
Student assessment: Written seminar works	
Obligatory literature: 1. I.Modlic, B.Modlic: Visokofrekvencijska elektronika - Oscilatori, pojačala snage, Školska knjiga, Zagreb, 1982. 2. I.Modlic, B.Modlic: Visokofrekvencijska elektronika - Modulacija, modulatori, sintezatori frekvencije, Školska knjiga, Zagreb, 1982.	
Recommended additional literature: 1. M.Schwartz: Information, Transmission, Modulation and Noise, McGraw-Hill, 1980	
ECTS credits: **6.5 ECTS credits** An ECTS credit value has been added to calculation according to time required for studying and successful completion of the course.	
Examination methods: Written and oral examination.	
Course assessment: Examination, tests, discussion	

DKR201	**Internet Programming**
Lecturer:	Davor Antonić PhD, Assistant Professor
Course description: Internet fundamentals and development. Network addressing and naming of computers, URL, DNS servers. Basics of network programming: client-server and other models, system support for networking. Main network services (telnet, ftp, www) and protocols (TCP/IP). Internet access: SLIP, PPP. World wide web: fundamentals, browsers, searching. Internet security: intruders and protection. Design of www documents. Client-side technologies: HTML (syntax, standard structure, hypertext, forms), cascade styles, JavaScript, JavaScript and HTML, JavaScript dynamic documents, Java Applets, XML, DHTML. Server-side technologies: CGI, servers, PHP, ASP and ASP.NET, cookies. Web access to data (PHP/SQL). Web portals. Web design and application examples.	
Knowledge and skills acquired:	

Fundamentals of the internet and advanced web programming. Design and implementation of web contents on client and server side by using new technologies.

Teaching methods:

Lectures and laboratory practice are obligatory. Seminar is recommended, because it replaces part of the final examination.

Student assessment:

Continuous assessment of laboratory practice.

Obligatory literature:

1. R.W. Sebesta, Programming the World Wide Web (2nd Ed.), Addison-Wesley, Boston, MA, 2004.
2. F. Halsall, Computer Networking and the Internet (5th Ed.), Addison-Wesley, Boston, MA, 2005.
3. H. Deitel, P. Deitel, T. Nieto, K. Steinbuhler, The Complete Wireless Internet and Mobile Business Programming Training Course, Prentice Hall, New York, NY, 2003.

Recommended additional literature:

1. T. Powell, Thomas, Web Design: The Complete Reference. Berkeley, CA, Osborne/McGraw-Hill, New York, NY, 2000.
2. M. Hall, L. Brown; Core WEB programming, A Sun Microsystems Press/Prentice Hall PTR Book, New York, NY, 2001.
3. K. Kalata, Internet Programming, Thompson Learning, London, 2001.

ECTS credits: **6 ECTS credits**

An ECTS credit value has been added to calculation according to time required for studying and successful completion of the course.

Examination methods:

Written and oral examination. Grades earned in laboratory practice, seminar and homework can replace the written examination and/or increase the final grade.

Course assessment:

Students evaluate teaching methods by anonymous questionnaires.

DKIR201	**Multimedia Systems**

Lecturer: Snježana Rimac-Drlje PhD, Assistant Professor

Course description:

Introduction: Areas of application. Fundamentals of human audio and visual perception and their influence on the compression methods. Image representation on a computer; colour models. Compression methods: entropy coding (Runlength, Huffman, arithmetic, LZW). Standards for the still image coding JPEG and JPEG2000. Digitalization of video signal, standards for video compression: MPEG-2, MPEG-4, H261, H263. Characteristics of speech and speech model. Algorithms and standards for speech compression. Digitalization of the audio signals, audio coding. MPEG-7, MPEG-21. Distributed multimedia systems. Packet audio/video in the network environment. Multimedia transport across ATM networks, IP networks and DSLs. Multimedia in mobile communications. Communication protocols for multimedia, quality of services. Video-telephony, videoconferences, interactive television, cable television, DVB, video surveillance.

Knowledge and skills acquired:

Student will acquire the knowledge of standards of speech, audio and video coding. Student will become familiar with multimedia systems and parameters, which influence the multimedia transmission quality. Student will write programs for multimedia processing and will deal with DSP implementation in multimedia applications.

Teaching methods:

Lecture (3 hours per week), laboratory practice (1 hour), practice (1 hour)

Student assessment:

Testing the laboratory practice, written and oral examination.

Obligatory literature:

1. R. Steinmetz, K. Nahrstedt: Multimedia Fundamentals: Media coding and Content processing, Prentice-Hall, 2002.
2. K. R. Rao, Multimedia Communication Systems: Techniques, Standards, and Networks, Prentice Hall PTR, 2002.

Recommended additional literature:

1. B. Furht, S. W. Smoliar, H. Zhang: Video and Image Processing in Multimedia Systems, Kluwer, 1995.

ECTS credits: **5 ECTS credits**

An ECTS credit value has been added to calculation according to time required for studying and successful

completion of the course.

Examination methods:
Project, written and oral examination.

Course assessment:
Students evaluate teaching methods.

Electives – Semester 2

One elective course has to be chosen. Due to the set standards of student workload to 30 ECTS credits, every elective course carries 4.5 ECTS credits. A student who enrols a larger number of elective courses is not awarded additional ECTS credits.

DIK201	Numerical Methods in Communications
Lecturer:	Tomislav Švedek PhD, Full Professor

Course description:
Different formulation of EM fields for solving numerical problems. Fundamental procedures based on solving an integral equation, differential equations and extended spherical wave equations. Increasing of numerical methods accuracy and combination of different methods. Canonical numerical problems. Definition of dispersive fields. Absorbing boundary conditions. Characteristics of non-usual dispersion structures, discontinuity, basic circuits. Moment method, finite element method.

Knowledge and skills acquired:
To learn about numerical analysis methods in communications. Learn to use the MoM and MFE procedure for radiation problems.

Teaching methods:
Lecture, practice – problem solving.

Student assessment:
Written seminar works.

Obligatory literature:
1. Z.Haznadar,Ž.Štih: *Elektromagnetizam 2*, Školska knjiga, Zagreb, 1997.
2. R.F.Harington*: Field Computation By Moment Methods*, Cazenovia, N.Y., 1987.
3. J.J.H.Wang, *Generalized MoM in Electromagnets,* John Wiley & Sons INC., N.Y.,1991.

Recommended additional literature:
1. R.F. Harrington, "*Time-harmonic electromagnetic fields"*, McGraw-Hill, New York, 1961.
2. E.C.Jordan, K.G.Balmain*: Electromagnetic waves and radiating systems*, Prentice-Hall, Inc. Englewood Cliffs, N.J, 1968.
3. J.Kraus, *Electromagnetics*, McGraw Hill, N.Y. 1984.

ECTS credits: **5 ECTS credits**
An ECTS credit value has been added to calculation according to time required for studying and successful completion of the course.

Examination methods:
Seminar paper and oral examination.

Course assessment:
Examination, tests, discussion

DIK202	Radio-relay and Satellite Communications
Lecturer:	Tomislav Švedek PhD, Full Professor

Course description:
Examples of radio-relay systems (analog, digital, multi-channel). Division of electromagnetic spectrum, RR link planning. Reliability and quality of link, referent circuit. Radio equipment of RR link: MUX, modem, transmitter, receiver. Propagation conditions: atmospheric effects, free-space loss. RR link antennas: antennas characteristics, antennas types. Frequency planning: channel planning, interference, cross-link in "back-to-back" systems, inter-modulation products. RR link design: Fresnell's zone, fading influence to availability, diversity technique. Synchronous digital hierarchy. Radio-diffusion and communication satellites and satellites for special purposes: orbits. Technical characteristics and parameters of communication satellites and Earth station: antennas, low-noise front-end amplifiers, output amplifiers, transponders. Switching on satellite. Design of up-link and down-link.

Atmospheric influence. Receiver noise temperature. Mobil satellite systems. Satellite antennas. Satellite communications for special purposes – TDRSS.

Knowledge and skills acquired:

Knowledge of basic oscillator theory, high frequency tuned amplifiers, and modulators - basic skills of designing high-frequency circuits.

Teaching methods:

Lectures.

Student assessment:

Tests, preparation for laboratory practice

Obligatory literature:

1. I.Modlic, B.Modlic: Visokofrekvencijska elektronika - Oscilatori, pojačala snage, Školska knjiga, Zagreb, 1982.
2. I.Modlic, B.Modlic: Visokofrekvencijska elektronika - Modulacija, modulatori, sintezatori frekvencije, Školska knjiga, Zagreb, 1982.

Recommended additional literature:

1. M.Schwartz: Information, Transmission, Modulation and Noise, McGraw-Hill, 1980.

ECTS credits: **5 ECTS credits**

An ECTS credit value has been added to calculation according to time required for studying and successful completion of the course.

Examination methods:

Written and oral examination

Course assessment:

Examination, tests, discussion

DIK203	**Traffic and Queuing Theory**

Lecturer: Drago Žagar PhD, Assistant Professor

Course description:

The sources of communication services and traffic: categories, properties and performance demands. Communication efficiency. Capacities and flows in network. Problems of analyses and syntheses of information networks. One processor serving systems: properties, border values, numerical solutions. Systems with finite capacity. The models of information traffic sources. Networks with single category of users. Blocking in serving networks. Dynamical behaviour of serving systems. Network stability. Methods for traffic measurement and processing. Integration of heterogeneous traffic categories. Techniques for processing and routing the traffic in network nodes: traffic classification, marking, flow control (Leacky bucket), traffic scheduling (FIFO, PQ, CBQ, WBQ), traffic discarding (RED, WRED) and traffic forwarding. Queuing theory. Serving systems: model M/Er/1, model M/D/1, and model M/M/m with waiting. Communication validation. Quality in information network. Optimization problems of communications.

Knowledge and skills acquired:

The students will get the knowledge necessary to use and project the traffic characteristics of information and communications networks.

Teaching methods:

Lectures, laboratory practice.

Student assessment:

Several tests during the semester, the evaluation of the laboratory practice, written and oral examination.

Obligatory literature:

1. V. Sinković, Informacijske mreže, Školska knjiga, Zagreb, 1994.
2. T.G. Robertazzi, Computer Networks and Systems. Queueing Theory and Performance Evaluation, Springer Verlag, New York, 1990.

Recommended additional literature:

1. J.N. Daigle, Queueing Theory for Telecommunications, Addison-Wesley, Reading, 1992.
2. J. Walrand, Introduction to Queueing Networks, Prentice-Hall, Englewood Cliffs, 1988.

ECTS credits: **5 ECTS credits**

An ECTS credit value has been added to calculation according to time required for studying and successful completion of the course.

Examination methods:
Written and oral examination.

Course assessment:
Students' evaluation at the course end.

DRIK201	Real-time Computer Systems

Lecturer: Goran Martinović PhD, Assistant Professor

Course description:
Classification and examples of real-time systems according to timing requirements. Other requirements and interfaces to environment. Time, timing bases and limits in time measurement. System modelling: task model, time- and event-triggered systems, interrupt processing, WCET analysis. Resource management: scheduling algorithms on single processor and in complex environments. Algorithm complexity. Evaluation parameters. Communication and synchronization. Real-time extensions of operating system. Specialized software tools in embedded systems. Desirable properties of programming languages for system design. Access to hardware components from high-level languages. Reliability and availability. Real-time systems design: specification, realization, analysis and testing in control, communication, multimedia and some special applications.

Knowledge and skills acquired:
Understanding of timing, as well as other important boundaries by application of today's computer systems. Knowledge and use of relevant methodologies and development tools which enable an increase of system performance.

Teaching methods:

Lectures and laboratory practice are obligatory. Seminar is recommended, because it replaces part of the final examination.

Student assessment:
Continuous assessment of laboratory practice and homework (occasionally).

Obligatory literature:

1. J.W.S. Liu, Real-Time Systems, Prentice Hall, 2000.
2. R. Grehan, R. Moote, I. Cyliax, Real-Time Programming: A Guide to 32-bit Embedded Development, Addison Wesley, New York, NY, 1999.
3. Burns, A. Wellings, Real Time Systems and Programming Languages: Ada 95, Real-Time Java and Real-Time C/POSIX (3rd Ed.), Addison Wesley, New York, NY, 2001.
4. Selected papers and lecturer's www site.

Recommended additional literature:

1. P.A. Laplante, A Practical Approach to Real-Time Systems: Selected Readings (3rd Ed.), IEEE Computer Society Press, 1997.
2. H. Kopetz, Real-Time Systems Design Principles for Distributed Embedded Applications, Kluwer Academic Publishers, 1997.
3. A.C. Shaw, Real-Time Systems and Software, John Wiley & Sons, Indianapolis, IN, 2001.

ECTS credits: **5 ECTS credits**
An ECTS credit value has been added to calculation according to time required for studying and successful completion of the course.

Examination methods:
Written and oral examination. Grades earned in laboratory exercises, seminar and homework can replace the written examination and/or increase the final grade.

Course assessment:
During and at the end of semester, students evaluate teaching methods by anonymous questionnaires. Lecturers who treat this course a prerequisite for their courses are also welcomed to give feedback information about the knowledge acquired during this course.

DIKR201	Information Technology and Management

Lecturer: Vlado Majstorović PhD, Full Professor

Course description:
Introduction. Importance of information technologies. Trends of information technology. Information technology and management. Fundamentals of information technology. Information system in management. Information systems used in management and decision-making. Information technology and business. Role and importance of business. Business-undertakers and their influence. New possibilities of business-undertakers and preparation for the electronic management. Planning and undertaking of electronic management. Internet as a new channel of product distribution. Activities of undertakers in the field of electronic management. Market and market research preceding business. Market research in business management. Business management and ethics.

Knowledge and skills acquired:
The objective of this course is to make students familiar with basic aspects of information technology concerning development of business opportunities throughout the world. Special attention will be given to the possibilities and application of information technology in business management.

Teaching methods:

Lectures, practice-problem solving.

Student assessment:
Tests.

Obligatory literature:

1. V. Čerić, M. Verga, Informacijska tehnologija u poslovanju, Element, Zagreb, 2004.
2. Ž. Panian, Internet i malo poduzetništvo, Informator, Zagreb, 2000.
3. J. Deželjin i dr., Poduzetnički menadžment, M.E.P. Consult, Zagreb, 2002.
4. J. Mishra, A. Mohanty, Design of Information Systems - a Modern Approach, Alpha Science, Bhabaneswar, 2000.

Recommended additional literature:

1. M.L. Tushman, P. Anderson, Managing Strategic Inovation and Change, Oxford University Press, 1977.
2. V. Srića, J, Müller, Put k elektroničkom poslovanju, Sinergija, Zagreb, 2001.
3. G. Curtis, D. Cobham, Bussiness Information Systems - Analysis, Design and Practice, Prentice Hall, Harlow, 2002.

ECTS credits: **5 ECTS credits**
An ECTS credit value has been added to calculation according to time required for studying and successful completion of the course.

Examination methods:
Seminar and the oral examination..

Course assessment:
Examination, tests, discussion.

DF201	**English** - Optional

Lecturer: Branka Pavlović, MA, Senior Lecturer / Ivanka Ferčec, BA, Lecturer

Course description:
Introduction to computer science terminology. Computer applications. Configuration. Hardware vs. software. Memory. Buying a computer. Input devices. Output devices. Storage devices. Operating systems. The graphical user interface. Multimedia systems.

Knowledge and skills acquired:
Reading and understanding texts from the field of computer science, acquisition of new ESP vocabulary, broadening of knowledge pertaining to new structures typical of the English language, broadening and acquisition of new verbal and non-verbal communication patterns.

Teaching methods:

Lectures and exercises include terminology relative to specific fields of students' future profession, understanding and acquisition of specific grammatical structures of the English language, as well as ESP characteristics necessary for basic speech acts, introduction to techniques and methods of reading and writing abstracts.

Student assessment:
Individual homework or group task projects, regular communication, exercises, written and oral examination.

Obligatory literature:

1. Ferčec, I. A Course in Scientific English: Mathematics, Computer Science, Physics, Odjel za matematiku/Elektrotehnički fakultet, Osijek, 2001.

Recommended additional literature:
1. R.Murphy, English Grammar in Use, CUP, Cambridge, 1995.
2. Professional journals from the field of computer science.

ECTS credits: **0 ECTS credits**
This course is optional and does not carry ECTS credits.

Examination methods:
Written and oral examination.

Course assessment:
Conducting an anonymous questionnaire filled in by students after the course completion, an analysis of students' final assessments and their overall success.

DF202	**German** - optional

Lecturer: Branka Pavlović, MA, Senior Lecturer / Ivanka Ferčec, BA, Lecturer

Course description:
Woher kommt der Strom?, Elektrische Unfälle und deren Verhütung, Farbfernsehen, Aus der Geschichte der Elektrotechnik, Von der Windmühle zur Windkraftanlage, Computer beim Autofahren, Prozessautomatisierung, Autofahrer Leit – und Informationssystem, Energieformen und Energieumwandlung.

Knowledge and skills acquired:
Reading comprehension of electrical engineering text, acquiring new vocabulary and new syntactic structures, acquiring new communicative patterns.

Teaching methods:
Lectures and language practice include terminology referring to specific fields of students' future profession, understanding and acquisition of specific grammatical structures of German language, as well as ESP characteristics necessary for basic speech acts, introduction to techniques and methods of reading and writing abstracts.

Student assessment:
Individual homework or group task projects, regular communication, exercises, written and oral examination.

Obligatory literature:
1. V. Grujoski: Deutsche Fachtexte aus der Elektrotechnik, Sveučilišna tiskara, Zagreb, 1996.

Recommended additional literature:
1. Medić: Kleine Deutsche Grammatik, Školska knjiga, Zagreb, 1998.

ECTS credits: **0 ECTS credits**
This course is optional and does not carry ECTS credits.

Examination methods:
Written and oral examination.

Course assessment:
Students' evaluation at the course end.

Semester 3

DK301	**Mobile communications**

Lecturer: Snježana Rimac-Drlje PhD, Assistant Professor

Course description:
Evolution of the mobile communication systems; differences between first, second and third generation. Mobile communication channel; channel models. Different propagation scenario, path loss calculation, multi-path fading, interference; propagation modelling. Influence of the propagation conditions to the design of the mobile phone networks. Cellular concept. Micro-cells and pico-cells. Indoor propagation. Description and comparison of the TDMA, FDMA and CDMA access techniques. Optimisation of the capacity, power control and dynamic channel allocation. Specifications of the GSM system: elements and architecture of GSM, registration, roaming, call setup, TDMA structures, channel types, speech coding, data transmission, channel coding, signalling, modulation, power control, slow frequency hopping, GSM services. GPRS and EDGE. Basics of DECT and TETRA systems. Third generation of mobile systems: IMT2000 and UMTS.

Knowledge and skills acquired:

Student will acquire a fundamental knowledge of the mobile communication channel modelling and the propagation condition influence to the mobile networks design. Student will learn about the second and the third generation of the cellular mobile systems. According to propagation model student will be able to calculate basic parameters of system (coverage area, co channel interference, traffic, indoor losses, cellular concept), as well as the base station parameters.

Teaching methods:

Lecture (3 hours per week), practice – problem solving (1 hours), laboratory practice (1 hour)

Student assessment:

Testing of the laboratory practice, written and oral examinations

Obligatory literature:

1. M. J. Hernando, F. Perez-Fontan, Introduction to mobile communications engineering, Artech House, 1999
2. E. Zentner, Antene i radiosustavi, Školska knjiga , Zagreb, 2001.

Recommended additional literature:

1. S. Tabbane, Handbook of Mobile Radio Networks, Artech House Books, 2000.
2. N. Blaunstein, Radio propagation in cellular networks, Artech House, 2000.

ECTS credits: **7 ECTS credits**

An ECTS credit value has been added to calculation according to time required for studying and successful completion of the course.

Examination methods:

Project, written and oral examination.

Course assessment:

Students' evaluation.

DK202	**Receivers**
Lecturer:	Tomislav Švedek PhD, Full Professor

Course description:

Radiotransmition and noise. Media and ionospherical, stratospherical and trop-spherical influence on radio-signal dispersion. Antennas. Radio-receivers. Characteristic of radio-receivers: input characteristic, amplification, noise factor, selectivity, dynamic area, unwanted sub-waves, stability and frequency accuracy, output characteristic. Preparing of audio-signal before analog and digital modulation. AM and FM heterodyne radio-receivers, direct and digital radio-receivers. Analog heterodyne radio-receiver of signal (mono, stereo): VF amplifiers, oscillators, mixers, MF amplifiers, demodulators. Digital data's broadcasting in the FM audio signal radio-diffusion: RDS system, ARI system. FDM, TDM i CDM systems. Extend spectrum systems with direct sequence (DS), frequency hoping (FH), FH/DS systems, systems with FM. Coding, autocorrelation and cross code correlation.

Knowledge and skills acquired:

To learn about receiver performance and analysis of HF receivers.

Teaching methods:

Lectures.

Student assessment:

Written seminar works.

Obligatory literature:

1. M.Gregurić: *Radioprijenma tehnika*, Školska knjiga, Zagreb, 1994.
2. B.Modlic, Miješanje, mješala i sintezatori frekvencija, Školska knjiga, Zagreb, 1995.

Recommended additional literature:

1. M.Schwartz, *Information transmission, modulation and noise,* McGraw-Hill, New York, 1980.

ECTS credits: **6.5 ECTS credits**

An ECTS credit value has been added to calculation according to time required for studying and successful completion of the course.

Examination methods:

Seminar paper and oral examination.

Course assessment:

Examination, tests, discussion

DKIR301	Communication Protocols
Lecturer:	Drago Žagar PhD, Assistant Professor
Course description: Communication model. Communication network architecture. Protocols and protocol architecture. Protocol specification. Protocol verification. Protocol implementation. Protocol validation. Tools for analyses and syntheses of communication protocols. Protocol simulators. Layered approach, OSI model. Hierarchical approach, DoD model. Physical interface and physical layer protocols. Data link protocols. Local networks and protocols: CSMA/CD, WDMA, IEEE 802.11, 802.16. Routing protocols, RIP, OSPF, BGP. Reservation protocols, RSVP resource reservation protocol. IP protocol and internetworking. IPv6 protocol. Control protocols, ICMP protocol. Transport protocols, TCP and UDP. Application protocols, virtual terminal, FTP, SMTP, News, HTTP. Mobile network protocols, GSM, GPRS and UMTS. WAP protocol. Network management protocols, SNMP.	
Knowledge and skills acquired: The students will get the knowledge necessary to use, analyse and design the communications protocols.	
Teaching methods: Lectures, exercises, laboratory.	
Student assessment: Several tests during the semester, evaluation of laboratory practice, written and oral examination.	
Obligatory literature: 1. Gerard J. Holzmann, Design and Validation of Computer Protocols, Prentice Hall, New Jersey, 1991. 2. W. Stallings, Data and Computer Communications, Macmillan Publishing Company, New York, 2002.	
Recommended additional literature: 1. W. Stallings, Data and Computer Communications, Fourth Edition, Macmillan Publishing Company, New York, 2002. 2. A. Bažant, et al, Osnovne arhitekture mreža, Element Zagreb, 2003.	
ECTS credits: **5 ECTS credits** An ECTS credit value has been added to calculation according to time required for studying and successful completion of the course.	
Examination methods: Written and oral examination.	
Course assessment: Students' evaluation by the end of the course.	

Electives – Semester 3

One elective course has to be chosen. Due to the set standards of student workload to 30 ECTS credits, every elective course carries 5 ECTS credits. A student who enrols a larger number of elective courses is not awarded additional ECTS credits.

DIK301	Digital Image Processing
Lecturer:	Snježana Rimac-Drlje PhD, Assistant Professor
Course description: Elements of human visual perception. An image as a two- dimensional random signal; autocorrelation function; spectrum. Sampling and quantization. Image enhancement in the spatial domain: contrast stretching, sharpening, smoothing, enhancement using logical and arithmetic operations, log transformations, first and second order derivatives (Laplacian), operation on histogram. Median filter. Enhancement in the frequency domain: linear filtering (low-pass, high-pass, band-pass, band-reject filters). Gaussian and Butterworth filters. Homomorphic filtering. Modelling of noise in image (Gaussian, uniform, exponential, periodic, salt & paper noises). Image restoration in the presence of noise. Wiener filtering. Feature extraction. Texture features. Edge detection. Segmentation. Colour models. Colour image processing. 2D transformations: Karhuen-Loeve, discrete co sinus transformation (DCT), discrete wavelet transformation (DWT) and their implementation in image compression. Digital processing of medical images and satellite images, image processing in communications, robotics and automatics.	
Knowledge and skills acquired: Student will be introduced to basic techniques for digital image representation, analysis and processing. Student will adopt the knowledge of algorithms and their practical implementation in different area of applications.	
Teaching methods:	

Lecture (2 hours per week), practice – problem solving (1 hours), laboratory practice (1 hour)

Student assessment:
Testing laboratory practice, written and oral examinations

Obligatory literature:
1. R.C. Gonzales, R. E. Woods: Digital Image Processing, Prentice Hall 2002.

Recommended additional literature:
1. A. V. Oppenheim, R. W. Schafer, J. R. Buck: Discrete-Time Signal Processing, Prentice Hall, 1999.

ECTS credits: **5 ECTS credits**
An ECTS credit value has been added to calculation according to time required for studying and successful completion of the course.

Examination methods:
Project, written and oral examination.

Course assessment:
Students' evaluation.

DIK302	**Antennas**

Lecturer: Tomislav Švedek PhD, Full Professor

Course description:
Antenna parameters: polarization, radiation pattern, directivity, impedance, mutual impedance, gain, effective surface, noise temperature. Basic theorems and applications. Basic EM wave sources. Near and far EM field and approximations. Un-pole and bi-pole antennas. Impedance and mutual impedance of bi-pole antenna. Loading of bi-pole antennas. Regular and irregular rays. Super-directivity. Array synthesis. Yagi antennas. Aperture antennas: open waveguide, E and H horn antennas. Reflectors. Lens. Slot antennas. Helicoidal antennas. Patch antennas radiation. Resonant structure arrays radiation.

Knowledge and skills acquired:
To learn about EM wave dispersion and different antenna types.

Teaching methods:
Lectures.

Student assessment:
Written seminar works

Obligatory literature:
1. Z.Smrkić: *Radiokomunikacije*, Školska knjiga, Zagreb, 1980.
2. E.Zentner: *Antene i radiosustavi,* Graphis,Zagreb, 2001

Recommended additional literature:
1. W.L.Stutzman, G.A.Thiele, *Antenna Theory and Design*, John Wiley &Sons, New York, 1998.
2. C.A.Balanis, *Antenna Theory*, John Wiley &Sons, New York, 1982.

ECTS credits: **5 ECTS credits**
An ECTS credit value has been added to calculation according to time required for studying and successful completion of the course.

Examination methods:
Seminar paper and oral examination.

Course assessment:
Examination, tests, discussion

DRIK301	**Distributed Computer Systems**

Lecturer: Goran Martinović PhD, Assistant Professor

Course description:
Definition, goals and models of distributed computer systems. Communication: layered protocols, remote procedure calls and object invocation. Processes: threads, client-server processes, code migration, transactions, agents. Naming of distributed system entities. Synchronization: logical clock, global state, algorithms of election and mutual exclusion, transactions. Consistency and replication. Fault tolerance on the process, client-server and group communication level. Security: secure channels, authentication control. Distributed systems based on objects, documents, coordination and services. Distributed environments: clusters and computational grid. Relation computational grid - web services and Internet technologies. Resource management. Models, standards, algorithms,

languages and systems software. Performance evaluation. Application examples: technical and natural science, virtual enterprises, industrial applications.

Knowledge and skills acquired:
Insight into fundamental knowledge of properties, prerequisites and ways of design, use and evaluation of distributed computer systems. Overview and use of system and software tools, as well as development of rather simple application programs in a distributed computer system.

Teaching methods:

Lectures and laboratory practice are obligatory. Seminar is recommended, because it replaces part of the final examination.

Student assessment:
Continuous assessment of laboratory practice and homework (occasionally).

Obligatory literature:

1. A.S. Tanenbaum, M. van Steen. Distributed Systems: Principles and Paradigms, Prentice Hall, Upper Saddle River, NJ, 2002.
2. V.K. Garg, Elements of Distributed Computing, Wiley-IEEE Press, Indianapolis, IN, 2002.
3. M. Boger, Java in Distributed Systems: Concurrency, Distribution and Persistence, John Wiley & Sons, Indianapolis, IN, 2001.
4. IEEE Distributed Systems Online: http://dsonline.computer.org.

Recommended additional literature:

1. A.S. Tanenbaum, Modern Operating Systems (2nd Ed.), Prentice Hall, Englewood Clifs, NJ, 2001.
2. J. Blazewicz, K. Ecker, B. Plateau, D. Trystram (Eds.), Handbook on Parallel and Distributed Processing, Springer - Verlag, Berlin, 2000.
3. C.S.R. Murthy, G. Manimaran, Resource Management in Real-Time Systems and Networks, MIT Press, Cambridge, MA, 2001.

ECTS credits: **6.5 ECTS credits**
An ECTS credit value has been added to calculation according to time required for studying and successful completion of the course.

Examination methods:
Written and oral examination. Grades earned in laboratory exercises, seminar and homework can replace the written examination and/or increase the final grade.

Course assessment:
During and at the end of semester, students evaluate teaching methods by anonymous questionnaires. Lecturers who treat this course a prerequisite for their courses are also welcomed to give feedback information about the knowledge acquired during this course.

DIKR301	**Network Security**
Lecturer:	Drago Žagar PhD, Assistant Professor

Course description:
Introduction to Cryptography. Substitution ciphers. Transposition ciphers. Fundamental cryptographic principles. Symmetric-key algorithms, DES, AES, Rijndael. Cipher modes. Cryptanalysis. Public-key algorithms, RSA. Digital signatures. Management of public keys. Certificates. X.509. Communication security. IP sec. Firewalls. IDS. Virtual private networks. Wireless security. Authentication protocols. Shared secret key. Diffie-Hellman key exchange. Key distribution centre. Kerberos. E-mail security, PGP, PEM, S/MIME. Web security, SSL. Network privacy.

Knowledge and skills acquired:
The students will get the knowledge necessary to use cryptographic methods and other security mechanisms in communication and computer networks.

Teaching methods:

Lectures, practice – problem solving, laboratory practice.

Student assessment:
Several tests during the semester, the evaluation of laboratory practice, written and oral examination.

Obligatory literature:

1. C. Kaufman, R. Perlman, M. Speciner, Network security, 2nd ed., Englewood Cliffs, NJ, Prentice Hall, 2002.
2. D.R. Stinson, Cryptography theory and practice, 2nd ed., Boca Raton, FL, CRC Press, 2002.

Recommended additional literature:

1. D. Kahn, The codebreakers, 2nd ed., New York, Macmillan, 1995.

ECTS credits: **5 ECTS credits**
An ECTS credit value has been added to calculation according to time required for studying and successful completion of the course.

Examination methods:
Written and oral examination.

Course assessment:
Students' evaluation at the end of the course.

DIKR302	Optical Communications

Lecturer: Snježana Rimac-Drlje PhD, Assistant Professor

Course description:
Theory of optical communications. Light propagation in fibres and power loss. Fibre and fibre nonlinearities. EM modes, modes coupling. Optical detection theory. Optical sources and transmitters. Optical detectors and receivers. Optical amplifiers. Modulations. Direct Detection optical systems. Coherent Systems. Multi-channel optical systems (WDM, FDM, SCM, OTDM). Fibre optic communications networks (LAN and WAN, SONET/SDH). Optical communication in atmosphere, antennas. Standard project procedures (ITU, IEEE).

Knowledge and skills acquired:
To learn about basic of the opto-electrical communication systems.

Teaching methods:
Students are obliged to attend both lectures and practice - problem solving.

Student assessment:
During the semester students are offered several optional tasks which replace the written examination. This ensures continuous assessment of students' work and knowledge.

Obligatory literature:
1. G.P.Agrawal: *Fiber-Optic communication Systems*, John Wiley & Sons, N.Y., 1997.
2. J.Budin: *Optičke komunikacije*, Univerza v Ljubljani, Ljubljana, 1993.

Recommended additional literature:
1. R.Ramaswami, *Optical Networks*, Morgan Kaufman Publishe, INc., 1998.
2. A.Yariv, *Optical Electronics in Modern Communications,* Oxford University Press, Eng., 1996.

ECTS credits: **5 ECTS credits**
An ECTS credit value has been added to calculation according to time required for studying and successful completion of the course.

Examination methods:
Seminar paper and oral examination.

Course assessment:
At the end of semester an official inquiry can be done in connection with that how students evaluate the course teaching and lecturers participating in course teaching.

DI301	Science, Technology, Society

Lecturer: Ante Lauc PhD, Full Professor

Course description:
Introduction: science, techniques/technology, society; - Sociology of Science; History, sociology of scientific cognition, social construction of science and technology; - Science: logics and structure of science, fundamental and applied sciences, paradigm in science, history of science and scientific institutions. – Techniques and technology: definition, logics and structure of techniques, division of techniques into disciplines; - Modern science & technology: science and technology as a social matrices of technologies and social values; - Theory of economic and technological determinism, energy/ ecology, social construction of technological systems; - Scientific discoveries, technical inventions and technological innovations; social preconditions and consequences of scientific discoveries, invention as a social process. - Theories about society, social stratification, education and society, technological effects on society, technological accidents, social control of technology. - Profession: definition, social characteristics of professional, professions as social groups, ethical problems of professions; - Elements of profession: role of knowledge, professional monopole, recognition of profession, professional organizations, professional ethics and social responsibility.
At the seminars topics from lectures are covered in more details –

- through discussion on examples of scientific discoveries and technical innovations (6s), and getting more familiar with
- the scientific information system in Croatia and worldwide (2s);
- on-line search of data bases (3s);
- cd-roms (1s);
- Current con-tents and similar secondary scientific publications(3s)

Knowledge and skills acquired:
Course "Science, Technology, Society" is the first course (between the two) of social sciences at the pre-graduate study at Faculty of Elecktrotechnical engineering, providing students with the basic knowledge of science, technique and technology as well as society necessary for understanding the interaction among these three civilization systems. Gained knowledge enables students to acquire the topics of the specific professional subjects of the study more professionally, enables them to use successfully the distance learning methods and sources of information and knowledge, also providing necessary know-how and social framework for creating a self-concept of own profession and to enable them for social relations in post-industrial society and European business practice.

Teaching methods:

Lectures and seminars.

Student assessment:
During the semester students are offered several optional tasks which replace the written examination. This ensures continuous assessment of students' work and knowledge.

Obligatory literature:

1. Michael Haralambos – Uvod u sociologiju, Globus,1994.
2. Ivanović, M - Znanost, tehnika, društvo (Science, Technology, Society) - Albert E & Grafika, Osijek 2005,

Recommended additional literature:

1. Zbornik, (ur. D. Polšek), - Sociologija znanstvene poznaje- Hrvatski kulturni dom, Rijeka. 1995.,
2. Čaldarović, O.: - Socijalna teorija i hazardni život, - Hrvatsko sociološko društvo, Zagreb, 1995.
3. Cifrić, I.: - Napredak i opstanak- Hrvatsko sociološko društvo, Zagreb, 1995.
4. Šporer, Z.: Sociologija profesija- Hrvatsko sociološko društvo, Zagreb, 1990
5. Ivanović, M. - Procesi postkomunističke tranzicije- Albert E & Grafika, Osijek, 2005.

ECTS credits: **5 ECTS credits**
An ECTS credit value has been added to calculation according to time required for studying and successful completion of the course.

Examination methods:
Oral examination.

Course assessment:

1. Insight into the written preparation of lectures and seminars
2. Students' attendance of lectures
3. Anonymous questionnaire filled in by students after course completion
4. An analysis of students' final assessments and their overall success

Semester 4

D401	Management
Lecturer:	Zlatko Lacković PhD, Associate Professor

Course description:
Fundamentals of business management. Management strategies. Operational management. Human resource management. Electronic management. Business planning.

Knowledge and skills acquired:
The objective of this course is to make students familiar with all the elements of business management. At the end of the course they will be able to apply their technical knowledge and act as an independent business under takers or business managers in enterprises or in some branches of organizational units.

Teaching methods:

Lectures and practice.

Student assessment:
Testing general knowledge.

Obligatory literature:

1. Lacković,Z.,Management malog poduzeća,Elektrotehnički fakultet,Osijek,2004.

Recommended additional literature:

2. Deželjin,J., I ost.Poduzetnički menedžment,HITA-CONSULTING,Zagreb,1999.
3. B. Kotruljić: O trgovini i savršenom trgovcu (Venecija, 1573.) m oderno izdanje HAZU, Zagreb, 1985.; Hrvatska gospodarska književna baština I., Zagreb, Birotehnika, 1991.
4. Mill,J.S.,: Principles of political economy some application to social philosophy, Parler, London 1984.
5. Schumpeter, J.; Business Cycles, McGraw Hill, New York 1939.
6. Drucker,P; Inovacije I poduzetništvo,Globus,Zagreb,1992..
7. P. Samuelson: Ekonomija, Mate, Zagreb.
8. P. Sikavica i M. Novak: Poslovna organizacija, (2. izd.), Informator, Zagreb, 1993.
9. Bennett,R.,Management,Informator,Zagreb,1994.

ECTS credits: **4 ECTS credits**

An ECTS credit value has been added to calculation according to time required for studying and successful completion of the course.

Examination methods:

Oral examination together with successfully written task.

Course assessment:

Conducting an anonymous questionnaire filled in by students after course completion

D402	Project Management

Lecturer: Ninoslav Slavek PhD, Assistant Professor, Vedran Boras PhD, Assistant Professor

Course description:

Introduction to Project Management. Preliminary project evaluation, Critical decision points, risk evaluation. Project proposal. Project plan, task decomposition, risk analysis, scheduling project. Managing design, structures design, baseline design, system design specification, functional specification, quality assurance. Managing the project team. Marketing for project grow. Post completion analysis. Project cost estimating. Optimizing project resources. Software quality control. Project tracking.

Knowledge and skills acquired:

Basic knowledge of the computer hardware. Basic knowledge of the system and application software.

Teaching methods:

Lectures and practice.

Student assessment:

Laboratory practice and oral examination.

Obligatory literature:

1. R. Pressman, Software engineering, McGraw-Hill, 1987.
2. D. Grundler, Primijenjeno računalstvo, Graphis, Zagreb, 2000.
3. Grady Booch: Object-oriented Analysis and Design with Applications, Addison Wesley, Menlo Prk, Cal., 1994.

Recommended additional literature:

1. D. Patterson, J. Hennessy, Computer Organization and Design: The Hardware / Software Interface (2nd Edition), Morgan Kaufmann Publ., San Francisco, 1997.
2. A.S. Tanenbaum, Structured Computer Organization, 7th ed., Prentice-Hall, New Jersey, 2005.

ECTS credits: **4 ECTS credits**

An ECTS credit value has been added to calculation according to time required for studying and successful completion of the course.

Examination methods:

Test and oral examination

Course assessment:

During the semester and at the end of the semester students fill in an anonymous questionnaire.

D403	Introducing to Research Work

Lecturer: Ante Lauc PhD, Full Professor

Course description:

1. Introducing to science – Definition of science, science structure and logic, structure elements – terms, language, hypotheses, laws, theories, paradigm; Ways of science thinking; relations between science and philosophy, ideology, techniques, art and politics; Scientific fields (exact, technical, bio-medical, social and humanistic science); Definition of scientific disciplines (objects and methods of research); Dualism in science (theory, practice). 2. Researching in exact and technical sciences - Terms of scientific research; definition and features of scientific research; presumes and logic in scientific research; fundamental and applied research; Methodology in scientific research (induction, deduction, experiment, simulation). 3. Types of scientific works – Terms and types of research (expert, scientific and technical researches); Category of scientific works, Scientific information. 4. Elements of scientific research – Detection scientific problems, research hypotheses, researching goal, experimental draw (project), addition and non-addition variables, 5. Scientific research phases – Definition of problems and research goals; bibliography; identification of research variables, setting up hypotheses; making draw of project, methodology and researching techniques; interpretation, making deductions and scientific report. 6. Parts of scientific work, scientific project, structure of scientific article.

Seminar works:

a) explore the themes thoroughly,
b) discuss scientific and technical innovations
c) look for scientific information in Croatia and in the world
d) search for on line and see the data bases
e) deal with scientific language rules and syntaxes in scientific speech, scientific abbreviations, bibliography, etc.
f) learn to make projects (structure of project and methodology of team work)

Knowledge and skills acquired:

Providing students with the basic knowledge of science, techniques and technology as separate region of human thinking and creativity. Introduce method and elements of research. Gained knowledge enables students to acquire the topics of the specific professional subjects of the study more professionally, enables them to use successfully the distance learning methods and sources of information and knowledge also providing necessary know-how framework for creating a concept of expert project and team work.

Teaching methods:

Lectures and seminars.

Student assessment:

During the semester students are offered several optional tasks which replace the written examination. This ensures continuous assessment of students' work and knowledge.

Obligatory literature:

1. M. Vujević: Uvod u znanstveni rad, Školska knjiga, Zagreb, 2000.
2. Ivanović, M. - Uvod u znanstveni rad u tehničkim znanostima (Introducing to Researching in Tehnical Sciences)

Recommended additional literature:

1. V. Silobrčić: Kako sastaviti, objaviti i ocijeniti znanstveno djelo, Medicinska naklada Zagreb, 2003
2. K. Popper: Logika naučnog otkrića, Nolit, Beograd, 1973.;
3. T. Kun: Struktura naučnih revolucija, Nolit, Beograd, 1974.

ECTS credits: **4 ECTS credits**

An ECTS credit value has been added to calculation according to time required for studying and successful completion of the course.

Examination methods:

Oral examination.

Course assessment:

5. Insight into the written preparation of lectures and seminars
6. Students' attendance of lectures
7. Anonymous pool of students at the end of the course
8. An analysis of student's final assessment and their overall success.

DD401	Thesis
Course description: In the framework of writing the diploma work student will solve the problems from the field he has been educated during his studies. The writing of diploma work will be under the supervision of his tutor. By successfully accomplishing his diploma work student will prove that the knowledge acquired at the faculty can be successfully applied in his practical work.	
Knowledge and skills acquired: Knowledge and skills for independent work as an engineer.	
Teaching methods: Tutorials	
Student assessment: Supervision of the tutor.	
ECTS credits: **13 ECTS credits** An ECTS credit value has been added to calculation according to time required for studying and successful completion of the course.	
Examination methods: Thesis defense in front of Ph.D. committee.	

Second Cycle Degree in Electrical Engineering (Master level)
Branch: Power Engineering - Courses description

*the courses that are common for both branches are described above

Semester 1

DE101	Electrical Machines
Lecturer:	Zdravko Valter PhD, Full Professor
Course description: Synchronous machines. Synchronous machine by the stiffing network. Speed-torque characteristic. Synchronous machine by the internal network. Synchronous motor. Performances and properties. Asynchronous machines. Speed-torque characteristic. Squirrel-cage motor. Slip-ring motor. Performances and kinds of protection. DC machines. Types of excitation. Reaction of armature. Charasteristics for generator and motor. Voltage and speed control. Commutation. One-phase motors. Asynchronous and synchronous one-phase motors. Universal motor. Linear motors. Stepping motors.	
Knowledge and skills acquired: Knowledge of the properties, characteristics and modes of control for various electrical machines. Capability to calculate and choose electrical machines for concrete application.	
Teaching methods: Lecture, calculate and laboratory practice.	
Student assessment: Writing laboratory reports.	
Obligatory literature: 1. Valter, Z.: Električni strojevi I i II, interna skripta ETF Osijek, 2004/05. 2. Wolf, R.: Osnove električnih strojeva, Školska knjiga, Zagreb 1991. 3. Dolenc, A. i dr.: Električni strojevi, TE/4 JLZ, Zagreb 1973. 4. Kelemen, T.: Transformator, TE/13 HLZ, Zagreb 1997.	
Recommended additional literature: 1. Piotrovskij, L.M.: Električni strojevi, Tehnička knjiga, Zagreb 1970. 2. Dolenc, A. i dr.: Transformatori I i II, skripta ETF, Zagreb 1978. 3. Bego, V.: Mjerni transformatori, TE/8 JLZ, Zagreb 1982. 4. Sirotić, Z.; Maljković, Z.:Sikroni strojevi, skripta ETF Zagreb, 1996.	
ECTS credits: **5 ECTS credits** An ECTS credit value has been added according to calculation of time required for studying and successful course completion.	

Examination methods:
Written and oral examination.

Course assessment:
Conducting an anonymous questionnaire filled in by students after course completion.

DE102	Power System Analysis

Lecturer: Lajos Jozsa PhD, Associate Professor

Course description:
Voltage control in the network. Rated voltage and its definition. Precautions and practical measures for voltage drop decreasing. Option of higher voltage level. Reducing of the reactance. Decreasing of the reactive power. Compensation of the voltage drop. Voltage regulation. Power flow in the network: Mathematical model of the network. Equations for nodal power and power flow. Classification of the nodes. Power flow calculation by Gauss-Seidel and Newton - Raphson algorithm. Short circuit and other faults in the network. Causes and consequences of short circuits. Physical basics of short circuits. Treatment of the three phase network neutrals. Calculation of short circuit current (three phase short circuit, line to line short circuit and single line short circuit). Measures for short circuit current reduction. Phase to ground fault. Protection, fault location and elimination of phase to ground fault. Power transmission stability: Limits of power flow transmission. Static stability of the lossless system. Static stability of arbitrary system. Transient stability. Analysis of transient stability by equal area method. Influence of short circuit types on transient stability. Determination of critical clearing angle. Influence of automatic reclosing on transient stability.

Knowledge and skills acquired:
Getting acquainted with the physical basics of the power sysem operation, as well as with the methods of modelling and calculation for power system analysis.

Teaching methods:
Lectures, problem solving and laboratory practice.

Student assessment:
Written and oral tests in problem solving and laboratory practice.

Obligatory literature:
1. L. Jozsa, Tokovi snaga u mreži- Skripta ETF Osijek,1993.
2. L. Jozsa: Kratki spoj – dijelovi predavanja, interna skripta, ETF Osijek, 2002
3. S. Nikolovski, Elektroenergetske mreže – zbirka riješenih zadataka, ETF Osijek, 1998.

Recommended additional literature:
1. M.i K. Ožegović, Električne energetske mreže IV, FESB Split, 1999.
2. Arrulaga and Arnold, Computer anaysis of power systems, Wiley and Sons, 1990.
3. H. Požar, Visokonaponska rasklopna postrojenja, Tehnička knjiga Zagreb, 1990.
4. B. Stefanini, Prijenos električne energije II dio - mreže, Skripta FER Zagreb, 1971

ECTS credits: **5 ECTS credits**
An ECTS credit value has been added according to calculation of time required for studying and successful course completion.

Examination methods:
Written and oral test.

Course assessment:
Students evaluation.

Electives – Semester 1

One elective course has to be chosen. Due to the set standards of student workload to 30 ECTS credits, every elective course carries 4.5 ECTS credits. Student who enroles a larger number of elective courses does not award additional ECTS credits.

DIE101	Power System Lines
Lecturer:	Srete Nikolovski PhD, Full Professor

Course description:
Overhead lines. Overhead line conductors (materials, structure, dimensions). Mechanical calculations, mechanical load and forces, state equation, stress and span parameters, wind load, tower structures, safety distances. Insulating materials, insulator types, insulator choice. Overhead line accessories – wiring and protective tools. Overhead line towers – materials, types, bases, dimensioning. Overhead line grounding (grounding resistance, touch and step voltage, dimensioning of grounding devices, protective conductor). Overhead line assembling. Cable lines. Cable conductors (material, structure, dimensioning), cable types division. Cable parameters (resistance, inductance, capacitance, conductance) calculations. Cable size choice and dimensioning (voltage drop calculation, thermal calculation, short circuit and techno-economic calculation). Cable line burring, cable line accessories (in earth, in ground, in water). Cable networks grounding. Cable lines protection.

Knowledge and skills acquired:
Construction. Building and monitoring all types of overhead and cable lines. Calculation and analysis of electrical and mechanical conditions on overhead and cable lines.

Teaching methods:
Lecturers, numerical examples, project mechanical-electrical conditions on overhead and cable lines

Student assessment:
Tutorial and project.

Obligatory literature:
1. Lajos Jozsa, Nadzemni vodovi, skripta ETF, Osijek, 1995.
2. V. Srb, Kabelska tehnika, priručnik, Tehnička knjiga, Zagreb, 1970.
3. N. Srb, Niskonaponske mreže i instalacije, Tehnička knjiga, Zagreb, 1991..

Recommended additional literature:
1. M. Ožegović, K. Ožegović, Električne energetske mreže I, II i III FESB, Split, 1996.
2. K. Edvin, Elektrische Anlagen II, skripta, Institut RWTH Achen, 1973.

ECTS credits: **4.5 ECTS credits**
An ECTS credit value has been added according to calculation of time required for studying and successful course completion.

Examination methods:
Written and oral examinations.

Course assessment:
Project and anonymous questionnaires.

DIE102	Electrical Installation and Lightning
Lecturer:	Lajos Jozsa PhD, Associate Professor

Course description:
Basic concept and terms (measured quantities and measured units, operational divices, marked systems of low voltage networks, fault types, types of LV networks and installations). Valid electrical-engineering rules and standards in that field. International rules. Importance of norm EN50160. Safety measures at work, safety protection of indirect and direct touch voltage. Concepts of low voltage lines and networks (parameters -resistance, capacitance, inductance i conductance through isolation), type of lines, construction of low voltage line, constructions of installations and cable lines. Voltage drop on LV line and selection of line in regard to overloading the line. Types of loads and consumer facilities, influence of loads on circumstances in low voltage networks and installations, and also environmental influence of loads. Development of electrical networks and installation, introduction of new technologies in regard of decreasing its influence on environment. Class of lightning. Criteria of quality lightning. Rules. Public and road lightning. Lightning control. Lightning of exterior parts of objects. Inteior lightning. Standards and norms. Benefits. Design of lightning.

Knowledge and skills acquired:

Construction, building and control of overhead and cable lines and low voltage installations. Calculation and analysis of electrical and mechanical parameters of low voltage installations. Design and calculation of lightning.

Teaching methods:

Construction, numerical examples. Mechanical and electrical project.

Student assessment:

Project

Obligatory literature:

1. V. Srb, Kabelska tehnika, priručnik, Tehnička knjiga, Zagreb, 1970.
2. N. Srb, Niskonaponske mreže i instalacije, Tehnička knjiga, Zagreb, 1991.
3. Eduard Širola: Cestovna rasvjeta, Grafika Hrašće, 1997

Recommended additional literature:

1. M. Ožegović, K. Ožegović, Električne energetske mreže I, II i III FESB, Split, 1996.
2. Eduard Širola: Javna rasvjeta, preporuke, Tehnička knjiga Zagreb, 1979

ECTS credits: **4.5 ECTS credits**

An ECTS credit value has been added according to calculation of time required for studying and successful course completion.

Examination methods:

Written and oral test.

Course assessment:

Students evaluation.

DIE103	**Electrical Switching Devices**

Lecturer: Vedran Boras PhD, Assistant Professor

Course description:

Closing and opening operation in DC and AC electric circuit. Electrical contacts and energy theory of electrical arc. Contact resistance. Contact materials properties and contacts thermic stress. Kinds, characteristics and constuction of switching devices. Mutual acting between switching devices and electric network, transient phenomena. Division and function of switching devices. Circuit-breakers, switches, contactors, switch-disconnectors, disconnectors, grounding switch, fuses, surge arresters, cam-operated switches, control and auxiliary devices, spark-gaps. Breaking capacity. Testing, maintenance, selection and design of electrical switching devices.

Knowledge and skills acquired:

Getting physical phenomena regarding the arising parameters and quenching of electrical arc. Defining characteristics of switch devices and defining location for incorporation of switch devices. Approach to the maintenance of switch devices and resolution of real examples in the designing process.

Teaching methods:

Lecture and practical exercises.

Student assessment:

Seminar paper

Obligatory literature:

1. B.Belin: Uvod u teoriju električnih sklopnih aparata, Školska knjiga, Zagreb 1978.

Recommended additional literature:

1. Flurscheim C.H.: Power Circuit Breakers - theory and design, Peter Peregrinus, Ltd., London 1975.
2. Ragaller K.: Current Interuption in HV Networks, Plenum Press, New York, 1980.
3. CIGRE WG 13.06, Final report of the Second International Enquiry on High Voltage Circuit-Breaker Failures and Defects in service, 1994.
4. Clegg B., Ewart G., Brankin F.: Advances in Cicuit Breaker testing and condition monitoring, Proceedings IEE Monitors and condition assessment equipment, IEE digest No. 186, 1996.

ECTS credits: **4.5 ECTS credits**

An ECTS credit value has been added according to calculation of time required for studying and successful course completion.

Examination methods:

Oral examination

Course assessment:

Questionnaire, tutorials

DIE104	Operative Machines
Lecturer:	Tomislav Mrčela PhD, Associate Professor
Course description: Introduction. Basic parts and work principles of thermal turbines. Thermal turbines classifications. Multi-scale turbines. Turbines control. Cramps, box, bearings, installation, wind-turbines, work principles and classifications (advantages and disadvantages). Water-turbines, work principles and classifications (advantages and disadvantages). Gas-turbines -privilege and weakness. Line between turbines and generators. Power transmitters.	
Knowledge and skills acquired: During the course, students acquire general knowledge of operative machines and work principles, they aquire special knowledge of norms and standards used in designing operative machines.	
Teaching methods: Lecture, seminar,case studies.	
Student assessment: Seminar.	
Obligatory literature: 1. D. Horvat, Vodene turbine I, Sveučilište u Zagrebu, Zagreb 1985. 2. J.P. Molly, Windenergie in Theorie,Verlag C. F. Müller Karlsruhe 1988.	
Recommended additional literature: 1. Tehnička enciklopedija XIII, HLZ	
ECTS credits: **4.5 ECTS credits** An ECTS credit value has been added according to calculation of time required for studying and successful course completion.	
Examination methods: The course is successfully completed through two preliminary examinations during the semester or at the end of the semester by taking a written and an oral examination.	
Course assessment: Examination, tests, discussion.	

DF101	**English** - optional
Lecturer:	Branka Pavlović, MA, Senior Lecturer / Ivanka Ferčec, BA, Lecturer
Course description: Electric power systems. Switching and transformer equipment. Construction and design of transformers. Transmission and distribution of electric current. Transmission lines. (Renewable) Energy resources. Types of power plants.	
Knowledge and skills acquired: Reading and understanding texts from the fields of electrical and power engineering, acquisition of new ESP vocabulary, broadening of knowledge pertaining to new structures typical of the English language, broadening and acquisition of new verbal and non-verbal communication forms.	
Teaching methods: Lectures and exercises include terminology relative to specific fields of students' future profession, understanding and acquisition of specific grammatical structures of the English language, as well as ESP characteristics necessary for basic speech acts, introduction to techniques and methods of reading and writing abstracts as well as fundamentals of business communication.	
Student assessment: Individual homework or group task projects, regular communication, exercises, written and oral examination.	
Obligatory literature: 1. Bartolić, Lj. Technical English in Electronics and Electrical Power Engineering, Školska knjiga, Zagreb, 1994.	
Recommended additional literature: 1. R.Murphy, English Grammar in Use, CUP, Cambridge, 1995. 2. Scientific and professional journals from the fields of electrical and power engineering.	
ECTS credits: **0 ECTS credits** This course is optional and does not carry ECTS credits.	
Examination methods:	

Written and oral examination.

Course assessment:
Conducting an anonymous questionnaire filled in by students after course completion, an analysis of students' final assessments and their overall success.

DF102	**German** - optional
Lecturer:	Branka Pavlović, MA, Senior Lecturer / Ivanka Ferčec, BA, Lecturer

Course description:
Grundbegriffe. Energiebergriffe. Energieformen. Energieumwandlung. Elektrizität und unser Alltag. Strom und Physik. Weg der Elektrischen Energie.

Knowledge and skills acquired:
Reading comprehension of electrical-engineering text, acquiring new vocabulary, new syntactic structures, acquiring new communicative patterns.

Teaching methods:
Lectures and language practice.

Student assessment:
Written and oral assessment

Obligatory literature:
2. V. Grujoski: Deutsche Fachtexte aus der Elektrotechnik

Recommended additional literature:
2. MEDIĆ: KLEINE DEUTSCHE GRAMMATIK

ECTS credits: **0 ECTS credits**
This course is optional and does not carry ECTS credits.

Examination methods:
Written and oral examination.

Course assessment:
Students' evaluation at the course end.

Semester 2

DE201	**Power Plants**
Lecturer:	Lajos Jozsa PhD, Associate Professor

Course description:
Classification of energy forms. Primary energy forms. Transformation of energy forms. Useful energy forms. Renewable and non-renewable forms of primary energy. Basic energy transformations. Empirical laws of energy transformation. Concept of entropy and entropy difference. Cyclical processes. Technical values of different energy forms. Basic power plant characteristics. Energy characteristics of power plants. Power plant load diagrams. Hydro power plants. Parts of hydro power plants. Hydro turbines. Types of hydro power plants. Hydro power plant characteristics. Hydro power plant adjustment to the load. Reversible hydro power plants. Hydro power plants on tide and ebb. Thermal power plants. Steam power plants. Steam boiler. Condensing power plants. Cyclical processes in condensing power plants. Efficiency of steam power plants. Basic energy characteristic of thermal units. Costs of thermal plant construction. Combined production of steam and electrical energy. Thermal power plants adjustment to the load. Thermal plants with gas turbines. Nuclear power plants: Bascis schemes for steam generation in nuclear power plants. Chain reaction. Fission cross section. Nuclear reactor. Multiplication factor. Reactivity of the reactor. Types of thermal reactors. Breeder reactor. Nuclear fuel cycle. Alternative energy sources: Utilization of solar, geothermal and wind energy. Electrical Schemes of power plants. Primary electrical circles. Electrical circles of consumption of auxiliaries. Secondary electrical circles.

Knowledge and skills acquired:
Getting acquainted with the fundamentals of energy conversions in the power plants, as well as with the elements and functions of various power plant types.

Teaching methods:
Lectures, problem solving and laboratory practice.

Student assessment:
Written and oral tests in problem solving and laboratory practice.

Obligatory literature:

1. L. Jozsa: Energetski procesi i elektrane, Interna skripta ETF Osijek, 2005.

Recommended additional literature:

1. H. Požar: Osnove energetike I. II. III. Školska knjiga, Zagreb, 1992.
2. Tehnička enciklopedija, svezak 4, Leksikografski zavod, Zagreb, 1988

ECTS credits: **6 ECTS credits**

An ECTS credit value has been added according to calculation of time required for studying and successful course completion.

Examination methods:

Written and oral test.

Course assessment:

Students evaluation.

DE202	**Electric Drives**

Lecturer: Zdravko Valter PhD, Full Professor

Course description:

Automation of electric drives. Information and communication systems for electric drives. Typical controls for electric drives. DC motor drive with variable voltage control. AC-DC and DC-DC converters. AC drives with variable frequency and voltage control. AC-AC converters. Servo drives. Servo motors and stepping motors. Mechatronik systems. High dynamic using Motion Control. Motion Control applications. Automation of technical processes using bus systems for connecting measure, control and drive technique. Electric drives simulating using software package MATLAB-Simulink and its tool part SimPowerSystems.

Knowledge and skills acquired:

Knowledge of drive types, their properties and characteristics. Capability to calculate and choose a drive system for concrete application. Understanding how an automatic electric drive works and how it is applied in the industrial processes automation.

Teaching methods:

Lecture, calculate and laboratory practice.

Student assessment:

Creating simple simulating programmes in Matlab-Simulink

Obligatory literature:

1. Valter, Z.: Elektromotorni pogoni, interna skripta ETF Osijek, 2005.
2. Jurković, B.: Elektromotorni pogoni, Školska knjiga, Zagreb, 1990.
3. Grupa autora: Elektromotorni pogoni, TE/4 JLZ, Zagreb, 1973.

Recommended additional literature:

1. Riefenstahl, U.: Elektrische Antriebstechnik, Teubner Verlag, Stuttgart Leipzig, 2000.
2. Gugić, P.: Električni servomotori, Školska knjiga, Zagreb, 1987.
3. Jadrić, M.; Frančić, B.: Dinamika električnih strojeva, Graphis, Zagreb, 1997.
4. Stölting, H.-D.; Kallenbach, E.: Handbuch Elektrische Kleinantriebe, Hanser Verlag, München Wien, 2001.

ECTS credits: **6.5 ECTS credits**

An ECTS credit value has been added according to calculation of time required for studying and successful course completion.

Examination methods:

Seminar paper and oral examination.

Course assessment:

Conducting an anonymous questionnaire

DE203	Transmission and Distribuition of Electrical Energy
Lecturer:	Srete Nikolovski PhD, Full Professor
Course description: Power transmission network types. DC power transmission. AC power transmission. Power transmission stability. One machine system – power – rotor angle curve. Stability problem after transmission line is disconnected and after clearing short circuit at transmission line. Types of distributive networks. Voltage drop on distribution network element. Calculation of single supplied, double supplied and complex networks with ring structure. Distributed and lumped load-consumption. Complex networks with ring structure. Load flow, short circuit and reliability calculations. Grounding of transmission and distribution networks. Touch and step voltage safety requirements. Distributive networks protection. Networks planning, load growth, location of new transformer stations in network. Voltage regulation in distributive networks, reactive power compensation, availability and reliability of distributive networks.	
Knowledge and skills acquired: Analysis and calculation of transmission and distribution networks. Design.	
Teaching methods: Lecturers, numerical examples and laboratory practice with simulation softwares EasyPower, DIgSilent, ATP	
Student assessment: Tutorials.	
Obligatory literature: 1. M.i K. Ožegović: Električne mreže I, II, III i IV skripta ETF Split, 1996. 2. N. Srb, Električne instalacije i niskonaponske mreže, Tehnička knjiga, Zagreb, godina 1991. 3. S. Nikolovski: Elektroenergetske mreže – zbirka riješenih zadataka, ETF Osijek, 1998	
Recommended additional literature: 1. Bergen, Vitall. Power system analysis, Prentice Hall 2000	
ECTS credits: **6.5 ECTS credits** An ECTS credit value has been added according to calculation of time required for studying and successful course completion.	
Examination methods: Written and oral examinations.	
Course assessment: Tutorial.	

DE204	High Voltage Engineering
Lecturer:	Vedran Boras PhD, Assistant Professor
Course description: Electric field. Electric Fields numerical calculation. Gaseous dielectrics. Gas discharge. Dielectric breakdown in homogenous field. Dielectric breakdown by heterogeneous field. Solid dielectrics. Liquid dielectrics. AC HV generator. DC HV generator. Impulse voltage. Overvoltages. Insulation coordination principles. Traveling waves. Modelling of elements for overvoltages calculation. Measuring and testing in HV engineering. Testing in HV engineering, discharge and breakdown in dielectrics, AC HV and DC HV impulse generator in HV laboratory, HV testing, impulse voltage generator and impulse voltage testing, traveling waves, overvoltages and overvoltage protection.	
Knowledge and skills acquired: Definition and identification of specific problems in regard to construction and selection of HV components. Causes of insulation Stretch and components most critical parts. Testing equipments in HV laboratory and practical testing.	
Teaching methods: Lecture and practical exercises and laboratory practice.	
Student assessment: consultation	
Obligatory literature: 1. Padelin M.: Zaštita od groma, Školska knjiga, Zagreb 1987. 2. Uglešić I.: Tehnika visokog napona, FER, Zavod za visoki napon i energetiku, Zagreb, 2003.	
Recommended additional literature: 1. Greenwood F.: Electrical Transients in Power Systems, John Wiley & Sons, 1991. 2. Hrs I., Komen V.: Tehnoekonomska opravdanost uvođenja metaloksidnih odvodnika prenapona u	

distributivne mreže, Institut za elektroprivredu, Zagreb, 1992.IEC 71-1, 71-2: Insulation coordination

ECTS credits: **6 ECTS credits**
An ECTS credit value has been added according to calculation of time required for studying and successful course completion.

Examination methods:
Oral and written examination

Course assessment:
Questionnaire, talks and tutorials.

Electives – semester 2

One elective course has to be chosen. Due to the set standards of student workload to 30 ECTS credits, every elective course carries 5 ECTS credits. Student who enroles a larger number of elective courses does not award additional ECTS credits.

DIE201	Ground Electrodes and Grounding Systems
Lecturer:	Vedran Boras PhD, Assistant Professor

Course description:
Basic aspects about grounding. Ground electrodes and grounding systems. Permissible body current limit. Critical parameters. Soil structure and selection of soil model. Grounding methods. Grounding system parameters. Ground electrodes. Group ground electrodes. Grounding grid and ground elements combinations. Grounding parameters. Calculations in homogeneous and heterogeneous soil. Calculation current density. Reduction factor. Overhead lines and grounding systems. Power cables and grounding systems. Transferred potentials. Ground fault current division computation.. Simiplified calculations of ground resistance and grounding parameters. Design procedure of grounding systems. Grounding systems-mutual effects. Design of grounding systems by means of a PC. Impulse characteristic of grounding systems. Measurement and testing ground resistance and grounding parameters.

Knowledge and skills acquired:
Acquisition of elementary knowledge for: safe grounding design of ground electrodes and grounding systems; Measurement and testing grounding parameters; achieving safety from dangerous touch and step voltages; providing means to carry electric currents into the ground under normal and fault conditions.

Teaching methods:
Lecture and problem solving and laboratory practice.

Student assessment:
Seminar paper

Obligatory literature:
1. ANSI/IEEE Std 80-1986: IEEE Guide for Safety in AC Substation Grounding.
2. IEEE Std 142-1991, IEEE recommended practice for grounding of industrial and commercial power systems.

Recommended additional literature:
1. Erdungen für Starkstromanlagen über 1 kV, DIN VDE0141, 1989.
2. Meliopoulos, S., „Power system grounding and transients“, M. Dekker, Inc. New York, 1988.

ECTS credits: **5 ECTS credits**
An ECTS credit value has been added according to calculation of time required for studying and successful course completion.

Examination methods:
oral examination

Course assessment:
questionnaire, tutorials

DIE202	Testing and On-line Monitoring
Lecturer:	Zdenko Godec PhD, Full Professor

Course description:

Testing in quality management. Accreditation and certification. Requirements for the competence of testing and calibration laboratories. Quality assurance of electrical products. Routine, type and special tests of electrical equipments. Inspection, diagnostics and on-line monitoring of electrical equipments in operation. Electrical power quality, measurements, testing and monitoring.

Knowledge and skills acquired:
Knowledge of quality management and quality assurance in manufacture of electrical products. Knowledge of inspection and commissioning of electrical equipments. Knowledge about diagnostics and monitoring possibilities of electrical equipments in operation.

Teaching methods:

Lectures, laboratory practice.

Student assessment:
Seminar and discussion.

Obligatory literature:

1. Z. Godec, Expressing measurement result (in Croatian), Graphis, Zagreb, 1995.
2. R. Wolf, Testing electrical machines I, II and III (in Croatian), ETF Zagreb,

Recommended additional literature:

1. Dielectric diagnosis of electrcal equipment for AC applications and its effects on insulation coordination, CIGRE, 1990.
2. Generic guidelines for the life extension of plant electrical equipment, EPRI EL-5885, Project 2820-2, final report, July 1988.5. Standards.6. Papers.

ECTS credits: **5 ECTS credits**
An ECTS credit value has been added according to calculation of time required for studying and successful course completion.

Examination methods:
Seminar paper and oral examination

Course assessment:
Tutorial

DIE203	**Power Electronics**

Lecturer: Ivan Flegar PhD, Full Professor

Course description:
Voltage harmonics in public ac networks. Apparent power components: active, reactive, distortive, scattered , asymmetrical. ac characteristics of electronic power converters. Influence of electronic power converters on public ac networks. Mitigation of influences. Concepts of instantaneous active, reactive and aparent power. Conditions for perfect instantaneous compensations. Active filters.

Knowledge and skills acquired:
Acquisition of knowledge on interaction power electronic equipment with power sources and loads

Teaching methods:

Lectures, exercises, laboratory practice.

Student assessment:
Test, examination.

Obligatory literature:

1. N.Mohan, T.M. Undeland, W.P.Robbins, Power Electronics;John Wiley &Sons Inc., New York, 1995.
2. P.T.Krein, Elements of Power Electronics, Oxford University Press, Oxford, 1998.

Recommended additional literature:

1. K.Thorborg, Power electronics, New York, Prentice Hall, 1988.

ECTS credits: **5 ECTS credits**
An ECTS credit value has been added according to calculation of time required for studying and successful course completion.

Examination methods:
Written and oral part exam or designed, tested and described in a form of technical report a power electronic circuit.

Course assessment:
Tests.

DIE204	Recycling of Electrical Waste
Lecturer:	Antun Pintarić PhD, Assistant Professor
Course description: Environmental impact of engineering products and processes. Life-cycle analysis. Product end-of-life management. Categories of waste electrical and electronic equipment (WEEE). Waste composition. Potential uses for WEEE. Processing techniques and technologies for WEEE. Recycling targets. Disassembly and parts/material sorting. Hazardous components. Legislation (WEEE Directive). Recyclability assessment. Design for recycling.	
Knowledge and skills acquired: To produce a hierarchy of waste management in order of priority. To understand the interrelated nature of environmental engineering processes. To integrate basic science and engineering principles into economical solutions for WEEE problems.	
Teaching methods: lectures, seminar	
Student assessment: seminar, final examination	
Obligatory literature: 1. Recycling-Handbuch: Strategie – Technologie – Produkte, Düsseldorf, VDI-Verlag 1996 2. W. Koellner, W. Fichtler: Recycling von Elektro- und Elektronikschrott, Berlin, Springer-Verlag, 1996	
Recommended additional literature: 1. M. Šercer, D. Opsenica, G. Barić, Oporaba plastike i gume, Topgraf, Velika Gorica, 2000. 2. V. Potočnik., Obrada komunalnog otpada – svjetska iskustva, Topgraf, Velika Gorica, 1997. 3. K. Ishii, Modularity: A Key Concept in Product Life-cycle Engineering, Handbook of Life-cycle Enterprise, Kluwer, 1998.	
ECTS credits: **5 ECTS credits** An ECTS credit value has been added according to calculation of time required for studying and successful course completion.	
Examination methods: Seminar, final examination	
Course assessment: examination, tests, discussion.	

DIE205	Power System Economics
Lecturer:	Srete Nikolovski PhD, Full Professor
Course description: Basics of engineering economics: money flow, interest rates calculation, amortization of goods, methods for economic appraisal of investments in power systems. Electric energy demand: load-duration curve and approximations, load management. Generation of electric energy: technical and economic characteristics of termal- and hydro-electric generating units. Techno-economical calculations in transmission and distribution networks. Efficiency management in generation and transmission. Transmission losses and capacity. Basics of power market economics: marginal costs and prices, pricing of congestion and losses, tariff systems, contracts, spot pricing, regulative aspects. Cost-benefit reliability analysis of power systems.	
Knowledge and skills acquired: Acquired knowledge in basics of engineering economics and calculations of generation, transmission and distribution costs, as well as in power market economics. Acquired skills in cost-benefit reliability analysis.	
Teaching methods: Lectures , problem solving.	
Student assessment: Seminars, test	
Obligatory literature: 1. Steven Soft: Power System Economics, J.Wiley and Sons, New York, USA, 2002 2. T.W.Berrie: Electricity Economics and Planning, Peter Peregrinus Ltd., London, UK, 1992 3. H. Nagel: Planiranje razdjelnih mreža, Graphis, Zagreb, 1999.	
Recommended additional literature: 1. V.A. Levi: Planiranje razvoja elektroenergetskih sistema pomoću računara, Stylos, Novi Sad, SCG, 1998. 2. R. Billinton, R.N.Allan: Reliability Evaluation of Power Systems, 2nd Edition, Plenum Press, New York,	

USA, 1996

ECTS credits: **5 ECTS credits**
An ECTS credit value has been added according to calculation of time required for studying and successful course completion.

Examination methods:
Student project

Course assessment:
Students' surveys

DIER201	**Process Measurement**

Lecturer: Zdravko Valter PhD, Full Professor

Course description:
Introduction with basic explanations. Measure dimensions definitions and measure signals appearances. Static and dynamic behaviours of measuring meters. Active and passive sensors. Tensors. Electrodynamic, piezoelectric, thermo-dynamic, photoelectric, magnetic and chemic sensors. Measuring using a PC. Analogue/digital converters. Measurement hardware and software. Familiarizing with measurement software package LabVIEW. Measuring methods and sensors for pressure, level, flow, temperature, moisture and noise. Measuring of other process dimensions. Measuring bus systems in the industrial process automation.

Knowledge and skills acquired:
Knowledge necessary for understanding of dynamic dimensions measurement. Familiarizing with measurement system applications in the industrial processes automation.

Teaching methods:
Lecture, laboratory practice and visit to industrial plants

Student assessment:
Creating several simple application programmes in LabVIEW

Obligatory literature:
1. Valter, Z.: Procesna mjerenja, Script at ETF Osijek, 2004.

Recommended additional literature:
1. Freudenberger, A.: Prozessmesstechnik, Vogel Verlag, Würzburg, 2000.
2. Hesse, S.; Schnell, G.: Sensoren für die Prozess- und Fabrikautomation, Vieweg Verlag, Wiesbaden, 2004.
3. Prock, J.: Einführung in die Prozessmesstechnik, Teubner Verlag, Stuttgart, 1997.
4. Schwetlick, H.: PC-Messtechnik, Vieweg Verlag, Braunschweig Wiesbaden, 1997.

ECTS credits: **5 ECTS credits**
An ECTS credit value has been added according to calculation of time required for studying and successful course completion.

Examination methods:
Seminar paper and oral examination

Course assessment:
Questionnaire

DF201	**English** - optional

Lecturer: Branka Pavlović, MA, Senior Lecturer / Ivanka Ferčec, BA, Lecturer

Course description:
Electric power systems. Switching and transformer equipment. Construction and design of transformers. Transmission and distribution of electric current. Transmission lines. (Renewable) Energy resources. Types of power plants.

Knowledge and skills acquired:
Reading and understanding texts from the field of power engineering, acquisition of new ESP vocabulary, broadening of knowledge pertaining to new structures typical of the English language, broadening and acquisition of new verbal and non-verbal communication forms.

Teaching methods:
Lectures and exercises include terminology relative to specific fields of students' future profession, understanding and acquisition of specific grammatical structures of the English language, as well as ESP characteristics necessary for basic speech acts, introduction to techniques and methods of reading and writing abstracts.

Student assessment:
Individual homework or group task projects, regular communication, exercises, written and oral examination.

Obligatory literature:
1. Bartolić, Lj. Technical English in Electronics and Electrical Power Engineering, Školska knjiga, Zagreb, 1994.

Recommended additional literature:
3. R.Murphy, English Grammar in Use, CUP, Cambridge, 1995.
4. Professional journals from the field of computer science.

ECTS credits: **0 ECTS credits**
This course is optional and does not carry ECTS credits.

Examination methods:
Written and oral examination.

Course assessment:
Conducting an anonymous questionnaire filled in by students after course completion, an analysis of students' final assessments and their overall success.

DF202	**German** - optional
Lecturer:	Branka Pavlović, MA, Senior Lecturer / Ivanka Ferčec, BA, Lecturer

Course description:
Woher kommt der Strom? Elektrische Unfälle und deren Verhütung, Farbfernseher, Aus der Geschichte der Elektrotechnik, Von der Windmühle zur Windkraftanlage

Knowledge and skills acquired:
Reading comprehension of electrical-engineering text, acquiring new vocabulary, new syntactic structures, acquiring new communicative patterns.

Teaching methods:
Lectures and language practice.

Student assessment:
Written and oral assessment

Obligatory literature:
2. V. Grujoski: Deutsche Fachtexte aus der Elektrotechnik

Recommended additional literature:
2. MEDIĆ: KLEINE DEUTSCHE GRAMMATIK

ECTS credits: **0 ECTS credits**
This course is optional and does not carry ECTS credits.

Examination methods:
Written and oral examination.

Course assessment:
Students' evaluation at the course end.

Semester 3

DE301	**Electric Power Substations**
Lecturer:	Vedran Boras PhD, Assistant Professor

Course description:
Introduction to electric power substations. Structure of electric power substations (primary and secondary equipment). Electric power substations basic circuit diagrams. Classification of electric power substations. Voltage stretch and insulation coordination. Surge arresters-surge arrester selection and determining arrester location. Current stretch. Short circuit current in electric power substations. Thermal calculus. Calculation of forces, which are acting on electric power substations elements. Electric power substations elements (busbar and bare conductors, insulators, power cables, circuit breakers, disconnectors, MV fuses, current transformers, voltage transformers, power transformers, short circuit reactor coils). Circuit configurations for HV and MV switchgear installations, Switchyard layouts. Grounding in electric power substations. Lightning protection in electric power substations. Reliability calculus of electric power substations.

Knowledge and skills acquired:
Acquisition of elementary knowledge for design, maintenance and control of electric power substations

Teaching methods:
Lecture and practical exercises and laboratory practice

Student assessment:
tutorial

Obligatory literature:
1. H. Požar: Visokonaponska rasklopna postrojenja. Tehnička knjiga - Zagreb, 1967.
2. John D. Mc. Donald: Electric Power Substations Engineering, CRC Press, 2003.

Recommended additional literature:
1. B. Belin: Uvod u teoriju električnih sklopnih aparata, Školska knjiga-Zagreb, 1987.

ECTS credits: **7 ECTS credits**
An ECTS credit value has been added according to calculation of time required for studying and successful course completion.

Examination methods:
oral examination

Course assessment:
questionnaire, tutorials

DE302	Power System Protection

Lecturer: Srete Nikolovski PhD, Full Professor

Course description:
Electrical properties of human body, human body as a part of electrical circuit, dangerous touch and step voltage definition. Power system protection – fundamental theory. Division of power protection devices. Over current, over voltage, directional, differential and distance relay devices. Negative and zero sequence voltage and current relays. Line, motor, generator and transformer protection. Applied distance protection, over voltage protection, over current protection, earth- fault protection, differential protection, bus bar protection, asynchronous motor protection, under frequency and system protection. Fire protection in power facilities.

Knowledge and skills acquired:
Construction, testing and monitoring of protection devices in a power system. Analysis and protection devices coordination.

Teaching methods:
Lectures, numerical problems, laboratory practice with numerical relays and software EasyPower and DIgSILENT

Student assessment:
Seminars, tutorial

Obligatory literature:
4. Steven Soft: Power System Economics, J.Wiley and Sons, New York, USA, 2002
5. T.W.Berrie: Electricity Economics and Planning, Peter Peregrinus Ltd., London, UK, 1992
6. H. Nagel: Planiranje razdjelnih mreža, Graphis, Zagreb, 1999.

Recommended additional literature:
3. V.A. Levi: Planiranje razvoja elektroenergetskih sistema pomoću računara, Stylos, Novi Sad, SCG, 1998.
4. R. Billinton, R.N.Allan: Reliability Evaluation of Power Systems, 2nd Edition, Plenum Press, New York, USA, 1996

ECTS credits: **6 ECTS credits**
An ECTS credit value has been added according to calculation of time required for studying and successful course completion.

Examination methods:
Writen and oral examination.

Course assessment:
Conducting an anonymous questionnaire among students.

DE303	Power System Operation Control

Lecturer: Lajos Jozsa PhD, Associate Professor

Course description:

Basic rules of power system operation. Power and voltage control of power plant supplying its own consumers. Active and reactive power control of power plant by parallel operation with the system. Power system operation from the regulation point of view. Power plant classification in terms of operating costs. Economic load distribution between thermal units. Higher level cooperation of power systems. Active power flow between interconnected systems in normal operation. Frequency.

Knowledge and skills acquired:
Getting acquainted with the fundamentals of power system operation control, as well as with the possibilities of the customers' power and energy demand supply.

Teaching methods:

Lectures, problem solving and laboratory practice.

Student assessment:
Laboratory practice tests.

Obligatory literature:

1. L. Jozsa: Osnove regulacije u EES

Recommended additional literature:

1. Tehnička enciklopedija, svezak 4, Leksikografski zavod, Zagreb, 1988.

ECTS credits: **6 ECTS credits**
An ECTS credit value has been added according to calculation of time required for studying and successful course completion.

Examination methods:
Written and oral test.

Course assessment:
Students evaluation.

Electives –semester 3

One elective course has to be chosen. Due to the set standards of student workload to 30 ECTS credits, every elective course carries 5 ECTS credits. Student who enroles a larger number of elective courses does not award additional ECTS credits.

DIE301	**Power System Planning**
Lecturer:	Lajos Jozsa PhD, Associate Professor

Course description:
General goals, basic criteria and approaches in power system planning. Forecast of demand growth for electrical energy: long-term deterministic and probabilistic extrapolation and correlation forecasting methodology, long-term macroeconomic methodology, middle-term deterministic methodology, forecasting of peak-demand and load-duration curve.Generating capacity planning: hydro-electric generating units installation planning, planning of reinforcements in generating capacity using reliability calculation, power system probabilistic production simulation.Transmission capacity planning: models for transmission network reinforcements, bulk power system reliability analysis, models for reinforcements of reactive energy sources. Distribution network planning: maximal current capacity, maximal interruption duration, load forecasting, operating demands.

Knowledge and skills acquired:
Acquired knowledge of basic methods for planning of generation capacity, transmission and distribution networks and load forecasting. Acquired skills in deterministic and probabilistic techniques in modern power system planning.

Teaching methods:

Lectures, problem solving

Student assessment:
Seminars, test

Obligatory literature:

1. X. Wang, J.R. McDonald: Modern Power System Planning, McGraw-Hill Book Company, UK, 1994
2. H. Nagel: Planiranje razdjelnih mreža, Graphis, Zagreb, 1999.
3. H.Požar: Snaga i energija u elektroenergetskim sistemima, 2.izdanje, Informator, Zagreb, 1983

Recommended additional literature:

1. R.L.Sullivan: Power System Planning, McGraw-Hill, New-York, USA, 1977
2. V.A. Levi: Planiranje razvoja elektroenergetskih sistema pomoću računara, Stylos, Novi Sad, SCG,1998.

3. R. Billinton, R.N. Allan: Reliability Evaluation of Power System, 2nd edition, Plenum Press, New York, USA, 1996

ECTS credits: **5 ECTS credits**
An ECTS credit value has been added according to calculation of time required for studying and successful course completion.

Examination methods:
Oral examination

Course assessment:
Conducting an anonymous questionnaire among students.

DIE302	Power System Stability and Reliability

Lecturer: Srete Nikolovski PhD, Full Professor

Course description:
Stability- definitions and fundamental theory, synchronism, swinging equation of synchronous machine, synchronizing power. One machine stability problem- equal area criterion. Multi machines stability problem- classical approach. Static stability and small signal oscillations method. Transient stability- system with constant impedances. Step by step – numerical method. Reliability - fundamental theory and definitions, conceptual approach. Reliability indices, reliability and availability functions. Types and causes of faults. Independent and dependant faults, faults with a common cause. Multiple faults in power system facilities. Repair intensity function modelling. Reliability model of component with disconnection due to fault. Repairable components- availability and unavailability functions. Restoration function.

Knowledge and skills acquired:
Analysis and control of power system related the aspects of reliability and stability. Construction, maintenance power system elements related the reliability and stability aspects.

Teaching methods:
Lecturers, numerical examples. Project done with reliability analysis software

Student assessment:
Test

Obligatory literature:
1. S. Nikolovski, Osnove analize pouzdanosti EE sustava, udžbenik, ETF Osijek, 1995
2. K. i Marija Ožegović, Električne mreže IV i V isdanje FESB Spilit.
3. R. Billinton, R.N. Allan, Reliability evaluation of engineering system, Plenum press, 1992 .

Recommended additional literature:
1. P.Anderson , A.A. Fouad, Power system control and stability IEEE Press 1997.
2. R.Bilinton,R.N.Allan, Reliability assesment of a large electric power system, Kluwer Press 1993.
3. E. Balagurusamy, Reliability engineering, McGraw-Hill, New York, 1990.

ECTS credits: **5 ECTS credits**
An ECTS credit value has been added according to calculation of time required for studying and successful course completion.

Examination methods:
Writen and oral examination.

Course assessment:
Tutorial and project.

DIE303	Design of Electrical Instalations and Electrical Power Substations

Lecturer: Vedran Boras PhD, Assistant Professor

Course description:

Legislation and documents for design, construction and maintenance of switchgears, electrical power network and electrical installations (EPMI). Design documents: designation of documents and items (EPMI). Electrical diagrams, charts and tables. Recommendations for the preparation of circuit diagrams. Permissible body current limit. General characteristic and classification of LV electrical installations. Protective measures from direct and indirect contact. Technical measure for overload and overcurrent protection. Technical measure for overvoltage protection. Technical measure for other protection. Application of regulation, standards and factory instruction for maintenance and operating (EPMI). Modern approach in measurement, testing and monitoring of working events by putting in operation and maintenance (EPMI).

Knowledge and skills acquired:
Acquisition of elementary knowledge for design, manufacture project documents, construction, planning and maintenance (EPMI).

Teaching methods:

Lecture and practical exercises and laboratory practice.

Student assessment:
seminar paper

Obligatory literature:
Laws, regulations, standards.

1. Zakon o građenju
2. Zakon o prostornom uređenju
3. Propisi iz oblasti: zaštite okoliša, protupožarne zaštite i zaštite pri korištenju el. energije
4. Elektrotehnički propisi

Recommended additional literature:

1. IEC, VDE, CENELEC and HRN Standards
2. G. Seip: Electrical Installations Handbook, J. Wiley, 2000.

ECTS credits: **5 ECTS credits**
An ECTS credit value has been added according to calculation of time required for studying and successful course completion.

Examination methods:
oral and written examination

Course assessment:
questionnaire, talks and tutorials.

DIE304	**Electricity Market**

Lecturer: Vedran Boras PhD, Assistant Professor

Course description:
Restructuring electricity sector. Competition in power system. Bilateral contracts. Power market Fundamentals.Regulation and deregulation. Day-ahead market designs. Fundamentals of auctions design. Pricing power energy and capacity. Planning purchase and sale electricity on open electricity market. Power demand and supply. Competition on electricity market. Marginal cost on power market. Reliability and investment policy. Reliability and generation. Operating-reserve prices. Market dynamics and the profit function. Market structure. Market architecture. Designing and testing market rules. Power market. Locational prices (power transmission, power distribution, losses). Physical transmission rights. Congestion pricing methods. Pricing losses on lines and at nodes.

Knowledge and skills acquired:
Knowledge of power market operation. Regulatory process and operating electrical power utilities in market conditions.

Teaching methods:

Lecture and practical exercises

Student assessment:
test

Obligatory literature:

1. S. Stoft: „Power System Economics: Designing Markets for Electricity, J. Wiley 2002.
2. G. Rothwell, T. Gomez: Electricity Economics: Regulation and Deregulation. J. Wiley 2003.

Recommended additional literature:

1. M. Shahidehpour, H. Yamin, Z. Li: Market operations in electric power systems: Forecasting, Scheduling, and Risk Management, J. Wiley 2002.

ECTS credits: **5 ECTS credits**
An ECTS credit value has been added according to calculation of time required for studying and successful course completion.

Examination methods:
oral examination

Course assessment:
questionnaire, talks and tutorials

DIE305	Transitional Processes in Power Systems

Lecturer: Lajos Jozsa PhD, Associate Professor

Course description:
Static symmetric and asymmetric power system states. Temporary and continual voltage travelling waves in a power system as dynamical variables depending on time and space. Electromagnetic waves. Basic electrical-engineering materials division: insulators and conductors. Skin effect. Transmission power lines. Wave length, characteristic impedance and propagation constant. Power Line as a model with concentrated parameters. Transition equations of transmission power line. Travelling wave propagation along the transmission power line. Transmission power line model without losses. Wave propagation along one-phase power lines. Relations between voltage and current travelling waves. Wave propagation along poly-phase power lines. Analysis methods. Coordination of insulation principles. Significant voltage strain of power components under normal operation. Temporary overvoltages. Transient overvoltages. Electric power devices operation as temporary overvoltages response. Transformer device and compensation operation as overvoltages result. Wave propagation along the transformer windings. Electric rotation devices operation caused by wave consequences. Dielectric parameters of external insulation. Dielectric strength during temporary overvoltages. High voltage cables. Overvoltage along cables. Metal-oxide surge arrestors – basic principles and parameters. Other protective sparkling devices. Surge arrestor's protective characteristics. Corona phenomenon on transmission power line. Electromagnetic phenomenon calculation methods. Linear uncoupled concentrated parameters. Overhead transmission power lines. Underground cables. Cable models. Transformers. Voltage and current sources. Electric power breakers.

Knowledge and skills acquired:
Travelling waves. Termination and reflections. Temporary overvoltages, coordination of insulation. Protective devices.

Teaching methods:
lectures and exercises

Student assessment:
written and oral examination

Obligatory literature:
1. P. Chowdhuri, Electromagnetic Transients in power system, J. Whiley, 1996
2. L.V.Beweley, Traveling Waves on Transmission Systems, J. Whiley 1951.

Recommended additional literature:
1. Z. Haznadar, Ž. Štih, Elektromagnetizam, Školska knjiga, Zagreb 1997.
2. Debs A.S.: Modern Power Systems Control and Operation, Kluwer Academic Publisher, Boston 1988.
3. Anderson P.M., Fouad A.A.: Power system control and stability, IEEE Press, New York, 1994.

ECTS credits: **5.5 ECTS credits**
An ECTS credit value has been added according to calculation of time required for studying and successful course completion.

Examination methods:
written and oral examination

Course assessment:
seminar paper and oral presentation

DIE306	New Energy Sources

Lecturer: Lajos Jozsa PhD, Associate Professor

Course description:

The importance of new energy sources. Forms and classification of new energy sources. Non-renewable new energy sources (oil, natural gas, nuclear and geothermal). Renewable new energy sources (hydro power, biomass, wind, solar and other). Basics of new energy transformations. Primary to useful energy conversion (chemical and nuclear energy conversion to internal thermal caloric energy, internal thermal caloric energy conversion to mechanical energy, mechanical energy conversion to electrical energy, direct energy conversions to the electrical energy, and electrical energy conversion to other energy forms). New energy sources for transportation. Storage for new energy sources. Total energy consumption and new energy sources contribution. Environmental impact of new energy sources. Life-cycle usage (pollution and climate change). Sustainable development and new energy sources (damage and benefit from energy use, savings and efficiency).

Knowledge and skills acquired:
Knowledge about most important energy sources and their impact on life. Understanding the importance and basics about energy conversions. Acquiring basics about energy modelling and planning for future energy needs considering benefits and damage.

Teaching methods:
Lecturing and problem solving.

Student assessment:
Two control examinatios.

Obligatory literature:
1. P. Kulišić: Novi izvori energije – sunčana energija i energija vjetra, Školska knjiga, 1991.
2. B. Udovičić: Energetika, Školska knjiga, Zagreb, 1993.
3. H. Požar: Osnove energetike 1, 2 i 3, Školska knjiga, Zagreb, 1992

Recommended additional literature:
1. D. Feretić i suradnici: Elektrane i okoliš, Element, Zagreb, 2000.
2. V. Knapp: Novi izvori energije - nuklearna energija fisije i fuzije, Školska knjiga, 1993.

ECTS credits: **5.5 ECTS credits**
An ECTS credit value has been added according to calculation of time required for studying and successful course completion.

Examination methods:
Control examinations and individual work or final examination

Course assessment:
Control examinations, questionnaire, discussion with students.

DIE307	**Uninterruptible Supplies**

Lecturer: Ivan Flegar PhD, Full Professor

Course description:
Basic concepts. Directives, standards and regulations. Dc power supplies. Ac power supplies. Secondary cells. Basic properties of lead acid and Ni-Cd batteries. Types of uninterruptible supplies. Compatibility with power sources (public network, diesel generator, photovoltaic cells). Compatibility with loads (linear, nonlinear,time-variable). Rating, putting into service and maintenance of uninterruptible power supplies.

Knowledge and skills acquired:
Acquisition of knowledge in the field of uninterruptible power supplies. It is a prerequisite for the comprehension of operation, testing and design of uninterruptible power supplies..

Teaching methods:
Lectures, exercises, laboratory practice.

Student assessment:
Test, examination

Obligatory literature:
1. D.C.Griffith, Uninterruptible power supplies, Marcel Dekker Inc., New York/Basel, 1989.
2. A.Kusko, Emergency/standby power systems, McGraw Hill Book Comp., New York, 1989

Recommended additional literature:
1. I.Flegar, Power electronic circuits (In Croatian), Graphis, Zagreb, 1996

ECTS credits: **5 ECTS credits**
An ECTS credit value has been added according to calculation of time required for studying and successful course completion.

Examination methods: Written and oral partial examination or designed, tested and described in a form of a technical report
Course assessment: Tests

DIER301	**Computer Integrated Product Development**
Lecturer:	Milenko Obad PhD, Associate Proffesor

Course description:
Introduction to the methodology of integrated product development Principle steps. Product and process systematisation. QFD (Quality Function Deployment) methodology and its application. CFD (Concurrent Function Deployment) methodology and its application. FMEA methodology. TVM (Total Value Management) methodology and their application in the product development. Support tools. Architecture of integrated product development. Synchronous CAD. Quick prototype construction. Virtual product development. Product development in the virtual reality. Animation and simulation in product and process testing and validation. Construction classification. Support of the decision making process. Progressive and intelligent models. Intelligent CAD systems. Problems and visions. Levels of intelligence. Product intelligence. Case-base systems. Web systems in automatization of engineer`s communication and data access. Network tools and services. Synthesis models. Decision support tools. Knowledge-based product and process models. Tools for learning.

Knowledge and skills acquired:
Familiarizing with the methodologies and principles of computer integrated product development, familiarizing with the application of digital product models in the entire developmental cycle, familiarizing with the integration of computer aided methodology in the developmental cycle of products, familiarizing with the simulation methods and virtual product development, intelligent supports in the product development.

Teaching methods:
Students are obligated to attend both lectures and exercises.

Student assessment:
During the semester students can take several tests which replace the written examination. This ensures a continuous assessment of students' work and knowledge.

Obligatory literature:
1. J. Usher: "Integrated Product and Process Development: Methods, Tools,and Technologies"; Wiley 1998.
2. M. Obad: "Dizajn proizvoda uz podršku računala", Sveučilište u Mostaru, Mostar, 2004.

Recommended additional literature:
1. B. Prasad: "Concurrent Engineering Fundamentals: Volume II: Integrated Product Development"; Prentice Hall, 1997.

ECTS credits: **5 ECTS credits**
An ECTS credit value has been added according to calculation of time required for studying and successful course completion.

Examination methods:
Seminar paper and oral examination .

Course assessment:
At the end of the semester an official questionnaire can be conducted in order to get students´ evaluation of course teaching and lecturers participating in the course teaching.

Semester 4*

*The 4th semester is common for both branches, for description see above