Faculty of
Electrical Engineering and Informatics

The Faculty of Electrical Engineering founded in 1949 has been renowned for excellence in research and education throughout the years of changes in the scope of engineering. Over this period, the faculty has earned a wide-spread international reputation for its high academic standards and scientific achievements. Spearheading the movement to establish a modern education system, it has offered a comprehensive English curriculum since 1992. Nearly the same time, the name of the faculty was changed to Faculty of Electrical Engineering and Informatics in order to give recognition to the growing importance of computer science. The education programmes in English include a 3.5-year B.Sc., a 2-year M.Sc. and a 3-year Ph.D. programme in the fields of electrical and software engineering.

This Bulletin describes the curricula and the subjects being available for the 2009/2010 academic year, regarding the BSc, MSc and PhD programmes, respectively.

The undergraduate **B.Sc. programme** aims at providing a comprehensive knowledge with sound theoretical foundations in two areas: (1) Electrical Engineering including more specific studies in electronics, computer engineering and power engineering; and (2) Software Engineering dedicated to the major domains of computer science. The major specializations in Electrical Engineering are computer networks, control and robotics and power engineering. Studies in Software Engineering include specialization in infocommunication and software technology. Each specialization contains three courses focusing on the field of interest followed by a laboratory course and a project laboratory. In order to pursue studies in a given specialization the number of students must exceed a certain threshold, otherwise the interested students are kindly directed to another specialization.

The **M.Sc. programme** further advances the knowledge obtained in the undergraduate programmes in the same two fields: (1) Electrical Engineering, offering specializations in (i) embedded systems, (ii) infocommunication systems, and (iii) electrical machines and drives; (2) Software Engineering, offering specializations in (i) applied computer science, and (ii) system development; and (3) Business Information Systems, offering specializations in (i) Analytical Business Intelligence.

The post-graduate **Ph.D. programme** is available in all domains offered in the MSc programme.

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

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

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

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

Admission policy

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

Practical guidelines for acceptance to the MSc programme

1. Applicants with B.Sc. studies having a WGAP (Weighted Grade Average Point) equal or better than 'good' (more than 3.51 out of 5.00) will receive acceptance to the M.Sc. course.
2. Applicants with a B.Sc. qualification less than 'good' (less than 3.50 out of 5.00) are regretfully rejected to enter the M.Sc. program.
3. Applicants should also submit two recommendations given by renowned academic personnel.

Practical guidelines for acceptance to the PhD programme

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

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

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

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

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

Departments

Automation and Applied Informatics, Electronics Technology, Electron Devices, Telecommunications, Control Engineering and Information Technology, Measurement and Information Systems, Computer Science and Information Theory, Broadband Infocommunications and Electromagnetic Theory, Telecommunications and Media Informatics, Electric Power Engineering

Budapest University of Technology and Economics
Faculty of Electrical Engineering and Informatics
Faculty Office:
Building Z, 2nd Floor, Room No. 201.
Mailing Address: Bertalan Lajos utca 2.
H-1111 Budapest, Hungary
Phone: (+36-1) 463-3898
Fax: (+36-1) 463-2460
E-mail: nagy-margit@mail.bme.hu

Dean of the Faculty: Dr. László Vajta
Vice-Dean of the Faculty:
Prof. Dr. János Levendovszky
Course Directors:
B.Sc. Programmes: Dr. Bálint Kiss
M.Sc. and Ph.D. Programmes: Dr. József Harangozó
Programme Co-ordinator: Ms. Margit Nagy

Curriculum of B.Sc. Subjects in Electrical and Software Engineering

Subject			working hours / week								Requisites
Name	Code	Credits	1	2	3	4	5	6	7	8	
Compulsory English I.	BMEGT63A301	2	0/4/0p								
Compulsory English II.	BMEGT63A302	2		0/4/0p							BMEGT63A301
Communication Skills - English	BMEGT63A061	2			0/2/0p						BMEGT63A302
English for Engineers	BMEGT63A051	2				0/2/0p					BMEGT63A061

Curriculum of B.Sc. Subjects in Electrical Engineering

Subject			working hours / week								Requisites
Name	**Code**	**Credits**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	
Economics and Human Science Studies**											
Micro- and Macroeconomics	BMEGT30A001	4		4/0/0/e							
Management and Business Economics	BMEGT20A001	4				4/0/0/p					
Business Law	BMEGT55A001	2						2/0/0/p			
Obligatory Econ. & Human Elective 1		2	2/0/0/p								
Obligatory Econ. & Human Elective 2		2						2/0/0/p			
Obligatory Econ. & Human Elective 3		2						2/0/0/p			
Obligatory Econ. & Human Elective 4		2							2/0/0/p		
Obligatory Econ. & Human Elective 5		2							2/0/0/p		
Elements of Natural Science											
Mathematics A1a - Calculus	BMETE90AX00	6	4/2/0/e								
Mathematics A2a - Vector Functions	BMETE90AX02	6		4/2/0/e							BMETE90AX00-C
Mathematics A3 for Electrical Engineers	BMETE90AX09	4			2/2/0/e						BMETE90AX02-C
Mathematics A4- Probalility Theory	BMETE90AX08	4			2/2/0/p						BMETE90AX02-C
Physics 1	BMETE11AX01	5		4/0/0/e							BMETE90AX00-S
Physics 2	BMETE11AX02	5			4/0/0/e						BMETE11AX01-C
Foundation of Computer Science	BMEVISZA105	6	4/2/0/e								
Materials Sciences	BMEGEMTAV01	4	3/0/1/e								
Informatics 1	BMEVIIIA202	5			3/2/0/e						BMEVIIIA108-C
Informatics 2	BMEVIAUA203	5				3/2/0/e					BMEVIHIA107*
Free Elective Subjects											
Free Elective 1		4							4/0/0/e		
Free Elective 2		4							4/0/0/e		
Free Elective 3		2							2/0/0/e		
Fundational Technical Studies											
Basics of Programming 1	BMEVIHIA106	5	2/1/1/p								
Basics of Programming 2	BMEVIAUA116	4		2/0/2/p							BMEVIHIA106-C
Digital Design 1	BMEVIIIA104	7	4/2/0/e								
Digital Design 2	BMEVIIIA108	5		2/2/0/e							BMEVIIIA104-C
Signals and Systems 1	BMEVIHVA109	6		4/2/0/p							BMETE90AX00-S
Signals and Systems 2	BMEVIHVA200	6			3/3/0/e						BMEVIHVA109-C
Electrotechnics	BMEVIVEA201	6			4/0/1/p						BMEVIHVA109-C
Electromagnetic Fields	BMEVIHVA204	5				3/1/0/e					
Electronics 1	BMEVIHIA205	6				3/2/0/e					
Electronics 2	BMEVIAUA300	5					3/2/0/e				BMEVIHIA205-S
Microelectronics	BMEVIEEA306	5					3/0/1/p				BMEVIHIA205-S
Measurement Technology	BMEVIMIA206	5				3/2/0/p					BMEVIHVA200-S
Power System Engineering	BMEVIVEA207	5				3/1/1/e					BMEVIHVA200-S BMEVIVEA201-C
Infocommunication	BMEVITMA301	5					3/2/0/e				BMETE90AX08-C
Electronics Technology	BMEVIETA302	5					3/1/1/e				BMEGEMTAV01-S BMETE11AX01-S
Control Engineering	BMEVIIIA303	5					3/2/0/e				BMEVIHVA200-S
Specialization Studies											
Specialization Theoretical Subject 1		4						3/1/0/e			
Specialization Theoretical Subject 2		4						3/1/0/e			
Specialization Theoretical Subject 3		4						3/1/0/e			
Laboratory 1	BMEVIMIA304	5					0/0/4/p				BMEVIMIA206-C BMEVIHIA205-C
Laboratory 2	BMEVIMIA305	4						0/0/3/p			BMEVIMIA304-C BMEVIIIA303-S BMEVIAUA300-S
Laboratory for Specialization		4						0/0/3/p			
Project Laboratory		5						0/0/4/p			
Thesis Project		15							0/10/0/s		

S - Signature of the Subject is required
C - Credit of the Subject is required
** - Cannot be taken prior to the Subject (can be taken in parallel)*

***Course descriptions and available Economics and Human Sciences Electives are listed in this Bulletin at the Faculty of Economic and Social Sciences on page 171. Restrictions may apply.*

Curriculum of B.Sc. Subjects in Software Engineering

Subject			working hours / week								Requisites
Name	**Code**	**Credits**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	
Economics and Human Science Studies											
Micro- and Macroeconomics	BMEGT30A001	4	4/0/0/e								
Management and Business Economics	BMEGT20A001	4		4/0/0/p							
Business Law	BMEGT55A001	2			2/0/0/p						
Obligatory Econ. & Human Elective 1		2	2/0/0/p								
Obligatory Econ. & Human Elective 2		2			2/0/0/p						
Obligatory Econ. & Human Elective 3		2				2/0/0/p					
Obligatory Econ. & Human Elective 4		2				2/0/0/p					
Obligatory Econ. & Human Elective 5		2					2/0/0/p				
Elements of Natural Science											
Calculus 1 for Informaticians	BMETE90AX04	7	4/2/0/e								
Calculus 2 for Informaticians	BMETE90AX05	7		4/2/0/e							BMETE90AX04-C
Probability Theory	BMEVISZA208	4			3/1/0/e						BMETE90AX05*
Introduction to the Theory of Computing 1	BMEVISZA103	5	2/2/0/e								
Introduction to the Theory of Computing 2	BMEVISZA110	4		2/2/0/e							BMEVISZA103-S
Coding Technology	BMEVIHIA209	5			3/1/0/p						BMEVISZA110-C
Theory of Algorithms	BMEVISZA213	5				2/2/0/e					BMEVISZA110-S
Physics 1i	BMETE11AX03	4		4/0/0/e							BMETE90AX04-C
Physics 2i	BMETE11AX04	4			4/0/0/e						BMETE11AX03-C
Free Elective Subjects											
Free Elective 1		2						2/0/0/p			
Free Elective 2		4							4/0/0/e		
Free Elective 3		4							4/0/0/e		
Fundational Technical Studies											
Signals and Systems	BMEVIHVA214	5				3/1/0/p					BMETE90AX05-C
Electronics	BMEVIEEA307	4					3/1/0/p				BMETE11AX04*
Control Engineering	BMEVIAUA309	4					3/1/0/p				BMEVIHVA214-C
Digital Design 1	BMEVIMIA102	5	2/2/0/p								
Digital Design 2	BMEVIMIA111	5		2/2/0/e							BMEVIMIA102-C
Computer Graphics and Image Processing	BMEVIIIA316	4					3/1/0/p				
Computer Architectures	BMEVIHIA210	5			2/2/0/e						BMEVIMIA111-S
Computer Networks	BMEVIHIA215	4				3/1/0/e					BMEVIHIA210*
Telecommunication Networks and Services	BMEVITMA310	4					3/1/0/e				BMEVIIIA215-S
Measurement Laboratory 1	BMEVIMIA211	2			0/0/2/p						BMEVIMIA102-C
Measurement Laboratory 2	BMEVIMIA216	2				0/0/2/p					BMEVIMIA211-C
Measurement Laboratory 3	BMEVIMIA312	2					0/0/2/p				BMEVIMIA111-S BMEVIMIA219-S
Measurement Laboratory 4	BMEVIMIA315	2						0/0/2/p			BMEVIHIA215-S BMEVIMIA219-S
Basics of Programming 1	BMEVIEEA100	5	2/2/0/e								
Basics of Programming 2	BMEVIIIA114	4		2/2/0/p							BMEVIEEA100-C
Software Technology	BMEVIIIA217	4			3/1/0/e						BMEVIIIA114-C
Software Techniques	BMEVIAUA218	4				3/1/0/e					BMEVIIIA217-S
Management of Information Systems	BMEVITMA314	4						3/1/0/e			BMEVITMA310-S
Operating Systems	BMEVIMIA219	4				3/1/0/e					BMEVIHIA210-S
Databases	BMEVITMA311	5					3/1/0/e				BMEVISZA213-S
Artificial Intelligence	BMEVIMIA313	5					3/1/0/e				BMEVISZA213-S
Software Laboratory 1	BMEVIEEA101	2	0/0/2/p								BMEVIEEA100*
Software Laboratory 2	BMEVIIIA115	2		0/0/2/p							BMEVIIIA114*
Software Laboratory 3	BMEVIIIA212	2			0/0/2/p						BMEVIIIA114-C
Software Laboratory 4	BMEVIIIA220	2				0/0/2/p					BMEVIIIA217-S
Software Laboratory 5	BMEVITMA308	2						0/0/2/p			BMEVITMA308-C
System Modeling	BMEVIMIA401	5							3/1/0/e		BMEVISZA208-C BMEVIIIA217-S
Specialization Studies											
Specialization Subject 1		4						3/1/0/e			
Scecialization Subject 2		4						3/1/0/e			
Specialization Subject 3		4						3/1/0/e			
Specialization Laboratory 1		2						0/0/2/p			
Specialization Laboratory 2		2							0/0/2/p		
Project Laboratory		6						0/0/4/p			
Thesis Project		15							0/10/0/s		

S - Signature of the Subject is required
C - Credit of the Subject is required
** - Cannot be taken prior to the Subject (can be taken in parallel)*

Curriculum of M.Sc. Subjects in Software Engineering Applied Computer Science Specialization

Subject			working hours / week				Requisites
Name	**Code**	**Credits**	**1**	**2**	**3**	**4**	
Fundamentals in Natural Sciences							
System Optimization	BMEVISZM117	4	4/0/0/e/4				
Stochastics 1 - 2	BMETE90MX43	4		4/0/0/e/4			
Formal Methods	BMEVIMIM100	4	3/0/0/p/4				
Data Security	BMEVIHIM102	4	3/0/0/p/4				
Languages and Automata	BMEVISZM104	4		3/0/0/p/4			
Software Architectures	BMEVIAUM105	4		3/0/0/p/4			
Subjects from Economic and Human Sciences							
Elective Subject 1	BMEGTxxMxxx	2			2/0/0/p/2		
Elective Subject 2	BMEGTxxMxxx	2			2/0/0/p/2		
Elective Subject 3	BMEGTxxMxxx	2			2/0/0/p/2		
Engineering Management	BMEVITMM112	4				4/0/0/e/4	
Basic Obligatory Subjects for the Specialization							
Distributed Systems	BMEVIAUM124	4	2/1/0/e/4				Excluded if BMEVIIIM140 was already taken
Mobil Software Development	BMEVIAUM125	4	2/1/0/e/4				
Model-Driven Paradigms	BMEVIAUM126	4	2/1/0/e/4				Excluded if VIMIM147 and VIIIM228 was already taken
Service-Oriented Systems	BMEVIAUM208	4		2/1/0/e/4			Excluded if BMEVIMIM234 was already taken
Integrated Information Systems	BMEVIAUM209	4		2/1/0/e/4			
Laboratory for Distributed Systems and Mobile Software Development	BMEVIAUM210	4		0/0/3/p/4			
Laboratory for Service-Oriented Systems and Model-Driven Paradims	BMEVIAUM302	4			0/0/3/p/4		
Basic Compulsory Elective Subjects for the Specialization							
Compulsory Elective Subject 1	BMEVIAUMxxx	4		2/1/0/e/4			
Compulsory Elective Subject 2	BMEVIAUMxxx	4			2/1/0/e/4		
Compulsory Elective Subject 3	BMEVIAUMxxx	4			2/1/0/e/4		
Project Laboratory 1	BMEVIAUM813	5	0/0/5/p/5				
Project Laboratory 2	BMEVIAUM863	5		0/0/5/p/5			Credits of BMEVIAUM813
Thesis Project 1	BMEVIAUM913	10			0/5/0/p/10		Credits of BMEVIAUM863
Thesis Project 2	BMEVIAUM963	20				0/10/0/p/20	Credits of BMEVIAUM913 and subjects of Fundamentals in Natural Sciences
Freely Elective Subjects							
Freely Elective Subject 1	BMExxxxxxxx	2				2/0/0/p/2	
Freely Elective Subject 2	BMExxxxxxxx	2				2/0/0/p/2	
Freely Elective Subject 3	BMExxxxxxxx	2				2/0/0/p/2	

Notes:

1. Elective Subjects from Economic and Human Sciences:						
Quality Management	BMEGT20M002			2/0/0/p/2		
Argumentation, Negotiation, Persuasion – Tools for Getting Your Points Adopted	BMEGT41MS01			2/0/0/p/2		
Investments	BMEGT35M004			2/0/0/p/2		
Management Accounting	BMEGT35M005			2/0/0/p/2		

2. Basic Compulsory Elective Subjects: *three subjects will be determined before the actual semester.*

3. Free Elective Subjects: *a list of these subjects is under construction.*

Curriculum of M.Sc. Subjects in Software Engineering System Development Specialization

Subject			working hours / week				Requisites
Name	**Code**	**Credits**	**1**	**2**	**3**	**4**	
Fundamentals in Natural Sciences							
System Optimization	BMEVISZM117	4	4/0/0/e/4				
Mathematical Logics + Applied Algebra	BMETE90MX42	4		4/0/0/e/4			
Formal Methods	BMEVIMIM100	4	3/0/0/p/4				
Data Security	BMEVIHIM102	4	3/0/0/p/4				
Languages and Automata	BMEVISZM104	4		3/0/0/p/4			
Software Architectures	BMEVIAUM105	4		3/0/0/p/4			
Subjects from Economic and Human Sciences							
Elective Subject 1	BMEGTxxMxxx	2			2/0/0/p/2		
Elective Subject 2	BMEGTxxMxxx	2			2/0/0/p/2		
Elective Subject 3	BMEGTxxMxxx	2			2/0/0/p/2		
Engineering Management	BMEVITMM112	4				4/0/0/e/4	
Basic Obligatory Subjects for the Specialization							
Object-Oriented Development	BMEVIIIM140	4	2/1/0/e/4				Excluded if BMEVIAU124 was already taken
Parallel and Grid Systems	BMEVIIIM141	4	2/1/0/e/4				
Software Testing	BMEVIIIM142	4	2/1/0/e/4				Excluded if BMEVIMIM148 was already taken
Metamodels in Software Design	BMEVIIIM228	4		2/1/0/e/4			Excluded if VIMIM147 and VIAUM126 were already taken
Software Quality	BMEVIIIM229	4		2/1/0/e/4			
Lab. for Grid and Object Oriented Develop.	BMEVIIIM230	4		0/0/3/p/4			
Laboratory for Software Testing and Quality	BMEVIIIM308	4			0/0/3/p/4		
Basic Compulsory Elective Subjects for the Specialization							
IT Security and Management	BMEVIIIM274	4		2/1/0/e/4			
SOA-Based Integration	BMEVIIIM371	4			2/1/0/e/4		
Linux-Based System Development	BMEVIIIM339	4			2/1/0/e/4		
Project Laboratory 1	BMEVIIIM814	5	0/0/5/p/5				
Project Laboratory 2	BMEVIIIM864	5		0/0/5/p/5			Credits of BMEVIIIM814
Thesis Project 1	BMEVIIIM914	10			0/5/0/p/10		Credits of BMEVIIIM864
Thesis Project 2	BMEVIIIM964	20				0/10/0/p/20	Credits of BMEVIIIM914 and subjects of Fundamentals in Natural Sciences
Freely Elective Subjects							
Freely Elective Subject 1	BMExxxxxxxx	2				2/0/0/p/2	
Freely Elective Subject 2	BMExxxxxxxx	2				2/0/0/p/2	
Freely Elective Subject 3	BMExxxxxxxx	2				2/0/0/p/2	

Notes:

1. Elective Subjects from Economic and Human Sciences:							
Quality Management	BMEGT20M002				2/0/0/p/2		
Argumentation, Negotiation, Persuasion – Tools for Getting Your Points Adopted	BMEGT41MS01				2/0/0/p/2		
Investments	BMEGT35M004				2/0/0/p/2		
Management Accounting	BMEGT35M005				2/0/0/p/2		

2. Free Elective Subjects: *a list of these subjects is under construction.*

Curriculum of M.Sc. Subjects in Electrical Engineering
Embedded Systems Specialization

Subject			working hours / week				Requisites
Name	**Code**	**Credits**	**1**	**2**	**3**	**4**	
Fundamentals in Natural Sciences							
Physics 3	BMETE11MX01	5	3/1/0/e/5				
Measurement Theory	BMEVIMIM108	4	3/0/0/p/4				
Software Design	BMEVIIIM110	4	3/0/0/p/4				
Advanced Linear Algebra + Stochastics	BMETE90MX30	6		4/2/0/e/6			
Nanoscience	BMEVIETM114	5		4/0/0/p/5			
Subjects from Economic and Human Sciences							
Elective Subject 1	BMEGTxxMxxx	2			2/0/0/p/2		
Elective Subject 2	BMEGTxxMxxx	2			2/0/0/p/2		
Elective Subject 3	BMEGTxxMxxx	2			2/0/0/p/2		
Engineering Management	BMEVITMM112	4				4/0/0/e/4	
Basic Obligatory Subjects for the Specialization							
System Architectures	BMEVIMIM149	4	2/1/0/e/4				
Software Technology for Embedded Systems	BMEVIMIM150	4	2/1/0/e/4				
Real-time and Safety-critical Systems	BMEVIMIM151	4	2/1/0/e/4				
Information Processing	BMEVIMIM237	4		2/1/0/e/4			
Embedded System Design	BMEVIMIM238	4		2/1/0/e/4			
Laboratory for System Architectures	BMEVIMIM239	4		0/0/3/p/4			
Laboratory for Information Processing	BMEVIMIM322	4			0/0/3/p/4		
Basic Compulsory Elective Subjects for the Specialization							
Interfacing Embedded Systems to Information Systems	BMEVIMIM343	4		2/1/0/e/4			
High-Performance Microcontrollers	BMEVIMIM342	4			2/1/0/e/4		
Digital Filters	BMEVIMIM278	4			2/1/0/e/4		
Project Laboratory 1	BMEVIMIM802	5	0/0/5/p/5				
Project Laboratory 2	BMEVIMIM852	5		0/0/5/p/5			Credits of BMEVIMIM802
Thesis Project 1	BMEVIMIM902	10			0/5/0/p/10		Credits of BMEVIMIM852
Thesis Project 2	BMEVIMIM952	20				0/10/0/p/20	Credits of BMEVIMIM902 and subjects of Fundamentals in Natural Sciences
Freely Elective Subjects							
Freely Elective Subject 1	BMExxxxxxxx	2				2/0/0/p/2	
Freely Elective Subject 2	BMExxxxxxxx	2				2/0/0/p/2	
Freely Elective Subject 3	BMExxxxxxxx	2				2/0/0/p/2	

Notes:

1. Elective Subjects from Economic and Human Sciences:						
Quality Management	BMEGT20M002			2/0/0/p/2		
Argumentation, Negotiation, Persuasion – Tools for Getting Your Points Adopted	BMEGT41MS01			2/0/0/p/2		
Investments	BMEGT35M004			2/0/0/p/2		
Management Accounting	BMEGT35M005			2/0/0/p/2		

2. Free Elective Subjects: *a list of these subjects is under construction.*

Curriculum of M.Sc. Subjects in Electrical Engineering
Infocommunication Systems Specialization

Subject			working hours / week				Requisites
Name	**Code**	**Credits**	**1**	**2**	**3**	**4**	
Fundamentals in Natural Sciences							
Physics 3	BMETE11MX01	5	3/1/0/e/5				
Communication Theory	BMEVIHVM107	4	3/0/0/p/4				
Software Design	BMEVIIIM110	4	3/0/0/p/4				
Combinatorial Optimization + Stochastics	BMETE90MX38	6		4/2/0/e/6			
Photonic Devices	BMEVIETM113	5		4/0/0/p/5			
Subjects from Economic and Human Sciences							
Elective Subject 1	BMEGTxxMxxx	2			2/0/0/p/2		
Elective Subject 2	BMEGTxxMxxx	2			2/0/0/p/2		
Elective Subject 3	BMEGTxxMxxx	2			2/0/0/p/2		
Engineering Management	BMEVITMM112	4				4/0/0/e/4	
Basic Obligatory Subjects for the Specialization							
Wireline and Wireless Transmission Technologies	BMEVITMM155	4	2/1/0/e/4				
Convergent Networks and Services	BMEVITMM156	4	2/1/0/e/4				Excluded if BMEVIHIM244 was already taken
Network and Service Management	BMEVITMM157	4	2/1/0/e/4				
Human-Computer Interaction	BMEVITMM224	4		2/1/0/e/4			
Network Planning	BMEVITMM215	4		2/1/0/e/4			Excluded if BMEVIHIM354 was already taken
Laboratory for Infocommunications I.	BMEVITMM245	4		0/0/3/p/4			
Laboratory for Infocommunications II.	BMEVITMM311	4			0/0/3/p/4		
Basic Compulsory Elective Subjects for the Specialization							
Information and Network Security	BMEVITMM280	4		2/1/0/e/4			
Optical Networks	BMEVITMM347	4			2/1/0/e/4		
Performance Analysis of Infocom. Systems	BMEVITMM325	4			2/1/0/e/4		
Project Laboratory 1	BMEVITMM807	5	0/0/5/p/5				
Project Laboratory 2	BMEVITMM857	5		0/0/5/p/5			Credits of BMEVITMM807
Thesis Project 1	BMEVITMM907	10			0/5/0/p/10		Credits of BMEVITMM857
Thesis Project 2	BMEVITMM957	20				0/10/0/p/20	Credits of BMEVITMM907 and subjects of Fundamentals in Natural Sciences
Freely Elective Subjects							
Freely Elective Subject 1	BMExxxxxxxx	2				2/0/0/p/2	
Freely Elective Subject 2	BMExxxxxxxx	2				2/0/0/p/2	
Freely Elective Subject 3	BMExxxxxxxx	2				2/0/0/p/2	

Notes:

1. Elective Subjects from Economic and Human Sciences:					
Quality Management	BMEGT20M002			2/0/0/p/2	
Argumentation, Negotiation, Persuasion – Tools for Getting Your Points Adopted	BMEGT41MS01			2/0/0/p/2	
Investments	BMEGT35M004			2/0/0/p/2	
Management Accounting	BMEGT35M005			2/0/0/p/2	

2. Free Elective Subjects: *a list of these subjects is under construction.*

Curriculum of M.Sc. Subjects in Electrical Engineering
Electrical Machines and Drives Specialization

Subject			working hours / week				Requisites
Name	**Code**	**Credits**	**1**	**2**	**3**	**4**	
Fundamentals in Natural Sciences							
Physics 3	BMETE11MX01	5	3/1/0/e/5				
Alternating Current Systems	BMEVIVEM111	4	3/0/0/p/4				
Measurement Theory	BMEVIMIM108	4	3/0/0/p/4				
Advanced Linear Algebra + Analysis	BMETE90MX39	6		4/2/0/e/6			
Electrical Insulations and Discharges	BMEVIVEM116	5		4/0/0/p/5			
Subjects from Economic and Human Sciences							
Elective Subject 1	BMEGTxxMxxx	2			2/0/0/p/2		
Elective Subject 2	BMEGTxxMxxx	2			2/0/0/p/2		
Elective Subject 3	BMEGTxxMxxx	2			2/0/0/p/2		
Engineering Management	BMEVITMM112	4				4/0/0/e/4	
Basic Obligatory Subjects for the Specialization							
Theory and design of electric machines	BMEVIVEM173	4	2/1/0/e/4				
Electrical Equipment and Insulation	BMEVIVEM174	4	2/1/0/e/4				
Control of Electrical Drives	BMEVIVEM175	4	2/1/0/e/4				
Electrical Systems of Renewable Energies	BMEVIVEM262	4		2/1/0/e/4			
Electric Vehicles	BMEVIVEM263	4		2/1/0/e/4			
Laboratory for Electrical Machines and Drives 1	BMEVIVEM264	4		0/0/3/p/4			
Laboratory for Electrical Machines and Drives 2	BMEVIVEM319	4			0/0/3/p/4		
Basic Compulsory Elective Subjects for the Specialization							
Servo and Robot Drives	BMEVIVEM287	4		2/1/0/e/4			
Modelling and Simulation	BMEVIVEM365	4			2/1/0/e/4		
Microcomputer Controlled Drives	BMEVIVEM366	4			2/1/0/e/4		
Project Laboratory 1	BMEVIVEM819	5	0/0/5/p/5				
Project Laboratory 2	BMEVIVEM869	5		0/0/5/p/5			Credits of BMEVIVEM319
Thesis Project 1	BMEVIVEM919	10			0/5/0/p/10		Credits of BMEVIVEM869
Thesis Project 2	BMEVIVEM969	20				0/10/0/p/20	Credits of BMEVIVEM919 and subjects of Fundamentals in Natural Sciences
Freely Elective Subjects							
Freely Elective Subject 1	BMExxxxxxxx	2				2/0/0/p/2	
Freely Elective Subject 2	BMExxxxxxxx	2				2/0/0/p/2	
Freely Elective Subject 3	BMExxxxxxxx	2				2/0/0/p/2	

Notes:

1. Elective Subjects from Economic and Human Sciences:					
Quality Management	BMEGT20M002			2/0/0/p/2	
Argumentation, Negotiation, Persuasion – Tools for Getting Your Points Adopted	BMEGT41MS01			2/0/0/p/2	
Investments	BMEGT35M004			2/0/0/p/2	
Management Accounting	BMEGT35M005			2/0/0/p/2	

2. Free Elective Subjects: *a list of these subjects is under construction.*

Description of B.Sc. Subjects in Electrical Engineering
Elements of Natural Science

Foundation of Computer Science

BMEVISZA105

Dr. András Recski

Basic concepts of combinatorics (permutations, variations, combinations). Basic concepts of graph theory (vertex, edge, degree, isomorphism). Path, circuit, connectivity, trees. Planar graphs, duality. Algorithms in graph theory (minimum cost tree, shortest path, maximum matching, flow problems, topological sorting, PERT method). Higher connectivity numbers of graphs. Graph colouring problems (vertex, edge and map colouring). Euler- and Hamiltonian circuits. Basic concepts of algorithms and complexity. Polynomially solvable and NP-complete problems. Basic concepts in number theory (divisibility, primes, congruences, Euler-Fermat theorem), algorithms in number theory (prime tests, public key criptography). Basic concepts of abstract algebra (operations, structures), semigroups. Groups, their relations to transformations, important special groups, factor group. Rings and fields. (6 credits)

Informatics 1

BMEVIIIA202

Dr.Károly Kondorosi

Computer Architectures: Typical units and block-diagram of computers. CPU, memory, I/O controllers, connections, integrated solutions, motherboards and extensions. Software model of a CPU, characteristic parameters, performance. Possibilities of improving performance, advanced architectures. Structuring and managing the main memory. Hardware support for multitasking. Overview of a typical simple CPU (e.g. Intel 386). Peripherals, I/O subsystem, controllers. Multiprocessor systems, loosely and tightly coupled architecture. Modularisation, bus systems. Bus controllers, control policies on multi-master buses. Operating Systems: Historical overview, stages of the evolution. Basic concepts and principles: multiprogramming, processes, system of multiple processes, cooperation and competition, communication and synchronisation. Deadlock situations. Multiprogramming: processes and threads in a single processor system, queuing and state model of OS. CPU scheduling. Memory management and virtual memory. File-system, I/O system, disk scheduling. Networking and distributed systems. Case-studies: Windows, Linux and Unix. (5 credits)

Informatics 2

BMEVIAUA203

Dr. István Vajk

Computer networks: Basic concepts, network topologies, network structures, network architectures (OSI and TCP/IP models). Communication channel. Error-correction and error-control coding. End-to-end connection. Connection-based and connection lost data transmission. Services. IEEE 802.3 and Ethernet. TCP/IP protocol.

Database design: Basic concepts. Architecture of a database management system. Logical databases. Relational data model. Key, functional dependencies, normal forms, relational algebra. Physical databases, indexing techniques. Logical planning of relational databases. The SQL language.

Formal languages: Basic concepts, languages, grammatik, automata, Chomsky hierarchy. Finite state machines and regular languages. Context-free and LL(k) languages. Compilers. (5 credits)

Materials Sciences

BMEGEMTAV01

Dr. László Dévényi

Fundamental concepts of material structures and the principles of study of material properties and their relations. Special attention is paid to materials used in the electronics industries including their production and technological usability. Topics include: basics of crystallography, crystal defects, dimensional effects, nano-, micro-, and macrostructures, multi-component systems. Thermal behaviour, diffusion mechanisms. Phase transformations, heat treatments, recrystallization. Mechanical properties and their measurements, elastic and plastic deformation processes. Materials deterioration processes such as corrosion, fracture, fatigue (mechanical, thermal, etc.), creep, migration. Microscopy, electron microscopy, X-ray diffraction. Conduction properties, conductive, superconductive, resistive, and insulator materials. Semiconductor materials. Effects of material properties on semiconductor materials used in microelectronics and in integrated optoelectronics. Insulator, dielectric and ferro-electric materials. Production of semiconductor single crystals and the related measurement techniques (Hall, CV). Non-metallic materials in electrotechnics. Magnetic properties and the types of magnetic materials used in industrial applications. Intelligent materials. (4 credits)

Mathematics A1a - Calculus

BMETE90AX00

Dr. Dénes Petz

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

Mathematics A2a - Vector Functions

BMETE90AX02

Dr. Lajos Rónyai

Solving systems of linear equations: elementary row operations, Gauss-Jordan- and Gaussian elimination. Homogeneous systems of linear equations. Arithmetic and rank of matrices. Determinant: geometric interpretation, expansion of determinants. Cramer's rule, interpolation, Vandermonde determinant. Linear space, subspace, generating system, basis, orthogonal and orthonormal basis. Linear maps, linear transformations and their matrices. Kernel, image, dimension theorem. Linear transformations and systems of linear equations. Eigenvalues, eigenvectors, similarity, diagonalizability. Infinite series: convergence, divergence, absolute convergence. Sewuences and series of functions, convergence criteria, power series, Taylor series. Fourier series: expansion, odd and even functions. Functions in several variables: continuity, differential and integral calculus, partial derivatives, Young's theorem. Local and global maxima/minima. Vector-vector functions, their derivatives, Jacobi matrix. Integrals: area and volume integrals. (6 hours/6 credits)

Mathematics A3 for Electrical Engineers

BMETE90AX09

Dr.József Fritz

Differential geometry of curves and surfaces. Tangent and normal vector, curvature. Length of curves. Tangent plane, surface measure. Scalar and vector fields. Differentiation of vector fields, divergence and curl. Line and surface integrals. Potential theory. Conservative fields, potential.

Independence of line integrals of the path. Theorems of Gauss and Stokes, the Green formulae. Examples and applications.

Complex functions. Elementary functions, limit and continuity. Differentiation of complex functions, Cauchy-Riemann equations, harmonic functions. Complex line integrals. The fundamental theorem of function theory. Regular functions, independence of line integrals of the path.

Cauchy's formulae, Liouville's theorem. Complex power series. Analytic functions, Taylor expansion. Classification of singularities, meromorphic functions, Laurent series. Residual calculation of selected integrals.

Laplace transform. Definition and elementary rules. The Laplace transform of derivatives. Transforms of elementary functions. The inversion formula. Transfer function.

Classification of differential equations. Existence and uniqueness of solutions. The homogeneous linear equation of first order. Problems leading to ordinary differential equations. Electrical networks, reduction of higher order equations and systems to first order systems.The linear equation of second order. Harmonic oscillators. Damped and forced oscillations. Variation of constants, the inhomogeneous equation. General solution via convolution, the method of Laplace transform. Nonlinear differential equations. Autonomous equations, separation of variables. Nonlinear vibrations, solution by expansion. Numerical solution. Linear differential equations. Solving linear systems with constant coefficients in the case of different eigenvalues. The inhomogeneous problem, Laplace transform. Stability. (4 hours/4 credits)

Mathematics A4- Probalility Theory

BMETE90AX08

Dr.Bálint Tóth

Notion of probability. Conditional probability. Independence of events. Discrete random variables and their distributions (discrete uniform distribution, classical problems, combinatorial methods, indicator distribution, binomial distribution, sampling with/without replacement, hypergeometrical distribution, Poisson distribution as limit of binomial distributions, geometric distribution as model of a discrete memoryless waiting time). Continuous random variables and their distributions (uniform distribution on an interval, exponential distribution as model of a continuous memoryless waiting time, standard normal distribution). Parameters of distributions (expected value, median, mode, moments, variance, standard deviation). Two-dimensional distributions. Conditional distributions, independent random variables. Covariance, correlation coefficient. Regression. Transformations of distributions. One- and two-dimensional normal distributions. Laws of large numbers, DeMoivre-Laplace limit theorem, central limit theorem. Some statistical notions. Computer simulation, applications. (4 hours/4 credits)

Physics 1

BMETE11AX01

Dr. László Orosz

MECHANICS: Measurements, units, models in physics. Space, time, different frames of references. Motion of a particle in 3D. Newton's laws. Work, kinetic energy, potential energy. Work-energy theorem. Conservation laws in mechanics. Motion in accelerated frames, inertial forces. Newton's law of gravitation. Basics of the theory of special relativity. System of particles, conservation laws. Kinematics and dynamics of a rigid body. Oscillatory motion, resonance. Wave propagation, wave equation, dispersion, the Doppler-effect.

THERMODYNAMICS: Heat and temperature. Heat propagation. Kinetic theory of gases. Laws of thermodynamics. Reversible and irreversible processes, phase transitions. Entropy, microscopic interpretation of entropy. Elements of statistical physics.

STATIC ELECTRIC AND MAGNETIC FIELDS: Electric charge. Electric field, electric flux, electric potential. Basic equations of electrostatics. Applications of Gauss's law. Capacitors, energy of the static electric field. Dielectrics, boundary conditions.

Electric current. Magnetic field. Current carrying wire in magnetic field. Magnetic field produced by an electric current, the Biot-Savart law. (4 hours/5 credits)

Physics 2

BMETE11AX02

Dr. László Orosz

ELECTRODYNAMICS: Faraday's law. Self induction, mutual induction. Magnetic properties of matter. Magnetic data storage. Maxwell equations. Generation, propagation and reflection of electromagnetic waves. Basics of geometrical optics. Wave optics, interference, diffraction. Polarised light.

BASICS OF ATOMIC PHYSICS: Natural and coherent light sources. Physical foundations of optical communication. Matter waves of de Broglie. The Schrödinger equation. The electron structure of atoms. Electron spin. Free-electron theory of metals. Band structure of solids. Superconduction. Quantum-mechanical phenomena in modern electronics. Basics of nuclear physics. Nuclear reactors. Elementary particles. Curiosities in cosmology. (4 hours/5 credits)

Description of B.Sc. Subjects in Electrical Engineering
Fundational Technical Studies

Basics of Programming 1

BMEVIHIA106

Dr.László Jereb

Basic concept of solving problems with computer: program, algorithm, specification, algorithm design. Fundamental concept of programming in high level languages: elements of languages, statements, data structures, control structures, loops. Construction of simple algorithms: sorting, searching, recursion, recursive data structures. Design, coding, debugging, segmentation, functional decomposition. (5 credits)

Basics of Programming 2

BMEVIAUA116

Dr. Tihamér Levendovszky

This course, as a basic BSc. course, based on the previous term, continues the exposition of the methods and tools of the computational problems. The main goal of the term is the introduction of object-oriented programming. Based on the C programming language skills, the object-oriented techniques are introduced with the help of the C++ programming language. The curriculum of the computer laboratories continuously follows the lectures. (4 credits)

Control Engineering

BMEVIIIA303

Dr.István Harmati

The control of technological, economical, and environmental processes belongs to the electrical engineers' most important professional activities that require both abstract and applied knowledge and competences. Besides its contribution to form an engineering viewpoint of problem solving, the course teaches the fundamentals of control engineering, the main principles of analysis and synthesis of control loops, and the use of the related technical computing tools. Students successfully satisfying the course requirements are prepared to analyze discrete and continuous control loops, to design different types of compensators, and to later engage courses in more advanced fields in control theory such as optimal control and identification of dynamical systems. Moreover, the course provides students with the necessary theoretical and technical background to start their specialization study blocks (such as embedded control systems, robotic systems, vehicle control systems, etc.) and to solve in laboratory practice exercises in the framework of the practical courses Laboratory I and II.

Digital Design 1

BMEVIIIA104

Dr.Péter Arató

Basic logic design principles. Analog versus digital signal processing. Boole algebra, number systems. Basic models of combinational and sequential systems.

Truth-table representation of combinational systems. Switching functions, disjunctive and conjunctive canonical forms.

Building blocks of combinational systems (gates). Minimization of switching functions on Karnaugh map. (Disjunctive and conjunctive minimal two-level realisations, handling of don't care minterms). The Quine-McCluskey method. Optimal cover algorithm for selection from prime implicants. Multiple-output minimization.

Transient behavior and timing of combinational systems (static, dynamic and functional hasards and their elimination). Special problems of symmetric switching functions.

Classification of sequential systems as state machines (asynchnronous and synchronous realisations, Mealy- and Moore-models). State table and state diagram. Flip-flops as building blocks (SR, JL, T, DG and D flip-flops).

Design steps of synchronous state machines (constructing the preliminary state table, state reduction, state assignment). Clock skew and its elimination by applying data-lock-out flip-flops. Special problems with the design of asynchronous state machines (avoiding critical races and essential hazards).

Practical realisation of flip-flops. (simple edge-triggered, master-slave, data-lock-out structures). Metastable states.

Applying MSI chips for designing functional units. Multiplexers, demultiplexers, decoders counters, shift registers, arithmetic units and comparators.

Static and dynamic RAM units, read-only memory units (ROM) and their application int he design. Microprogrammed control.

Application-specific units (ASIC). PLA and FPGA units and their application.

Basic principles of hardware description languages (VHDL and VERILOG and their comparison). (7 credits)

Digital Design 2

BMEVIIIA108

Dr.Péter Arató

Architecture of digital systems. Control and data path. Classification of bus systems. Basic principles and evolution of the architectures of digital computers. Microprocessors and microcomputers. Functional units and bus systems of microcomputers. Interfacing of RAM and ROM units to bus systems. Basic principles of assembly programming. The instruction set of a simple microprocessor. Memory organization (FIFO, LIFO, stack).

Interrupt systems in microcomputers, priority structures, programmable interrupt-handling units. Programmable input-output system. Parallel and serial data transmission units. Direct memory access (DMA) and its controller interfacing.

Microcontroller architectures. Design example with microcontroller.

Digital signal processors (DSP) and its evolution, basic principles for application.

Classification of FPGA developing systems and their main services. (5 credits)

Electromagnetic Fields

BMEVIHVA204

Mrs. Dr. Amália Iványi

Transmission lines, sinusoidal steady-state, transient phenomena. Electric charge and current. Electric field strength, magnetic flux density. El;ectric and magnetic potential. Electric flux density, magnetic field strength. Linear and nonlinear materials. Energy and power density. Pointing vector. Maxwell's equations. Boundary and continuity conditions. Static electric field. Laplace's equation, solution methods. Stationary magnetic field, Biot-Savart and Neumann laws. Electromagnetic waves, retarded potentials. Hertzian dipole., far field. Plane waves in insulators and conductors. Wave guides, dielectric guide. Numerical methods: variational principles, Ritz and Galerkin procedures, finite difference, finite element and global formulation. Boundary element formulation. (5 credits)

Electronics 1

BMEVIHIA205

Dr.László Pap

Basic analog transistor circuits. Basic single transistor amplifier stages. Small signal equivalent circuits of the basic single-stage amplifiers. Common base (gate), common emitter (source), common collector (drain) amplifier stages. Degenerate common emitter (source) stages; analysis and features. Frequency response of the amplifiers. High frequency small signal models, the Miller-effect. Low frequency analysis of the transistor circuits. Biasing of active devices. Current mirror. Maximum output signal analysis of the transistor circuits. Power amplifiers; A, AB, B, C, AD and BD power stages. Two-transistor basic amplifiers. Differential amplifier, cascod stage. Differential amplifier: large signal analysis and transfer characteristics; incremental analysis and half-circuit analysis techniques. Nonlinear distortion of the transistor stages. Harmonic and cross modulation distortion. Ideal operational amplifier, basic circuits. Structure of the operational amplifiers. The effect of the feedback to the small signal parameters. Frequency compensation of the feedback amplifiers. Comparator circuits. Sample and hold circuits. D/A and A/D converters. Schmitt trigger, monostabil multivibrator. Oscillators, square-wave relaxation oscillator, astabil multivibrator, sinusoid RC and LC oscillators, crystal oscillators. Basic elements of the digital electronic circuits. Parameters of the digital inverter: logic levels, delay time, etc. The transfer characteristics of the digital inverter, threshold level. The CMOS logic circuits. Basic CMOS inverter, W/L ratio, transfer characteristics. Dynamic behavior of the CMOS circuits. The structure of the CMOC gates. (6 credits)

Electronics 2

BMEVIAUA300

Dr. István Varjasi

Noise in electronic devices, noise bandwidth, power density spectrum, probability density function of the noise signal. Thermal noise, flicker noise, etc. Equivalent noise circuits of the electronic devices, equivalent input and output noise of the amplifiers. Noise figure. The phase-locked loops and their applications. Structure, linear small signal baseband model, different types of the PLL-s. Analysis of the linear baseband model. FM modulator and demodulator. Clock signal generators, jitter. Selective electronic circuits. Specification, approximation, tolerance scheme, transformations. Active RC circuits, switched capacitor selective circuits, resonant filters (LRC circuits, ceramic filters, etc.). Nonlinear circuit: rectifiers, limiters, piecewise linear circuits. Logarithmic and exponential amplifiers. Circuits of mixers and frequency transpose. Modulators and demodulators. Basic knowledge of energy conversion techniques. Power rectifiers, DC regulators: analog and switch-mode circuits. DC- DC and DC-AC converters. Overcurrent protection. Thyristors and their applications, new power electronic semiconductor devices and modules. Tree phase rectifiers, power converters. Power efficiency of the electronic circuits. Problems of the implementation. Description of passive distributed circuits in the time and frequency domain. Modeling and design of active analog circuits with distributed reactive elements (very high frequency amplifiers, oscillators, mixers, etc.). Microelectronic implementation of distributed circuits. High frequency integrated circuits (oscillators, power attenuators, etc.). Thermal problems of the electronic circuits, methods of heat removal. Conduction, convection, radiation. Thermal resistance and capacitance. Cooling methods, heat pipe. Thermal design of electronic devices with CFD. Heat sink of mobile equipment. (6 credits)

Electronics Technology

BMEVIETA302

Dr. Gábor Harsányi

Lectures: Classification of electronic products and technologies; types forms, and assembling methods of electronic components; interconnection substrates of circuit modules, materials and technologies; printed wiring boards (PWBs), insulating substrate passive (thin- and thick-film) networks and high density interconnects; design methods and considerations; mounting and assembling methods of circuit modules; design and application of combined (optoelectronic and mechatronic) modules; basics of appliance design; quality, reliability, environment and other human oriented issues of electronics technology.

Laboratories: technology of double sided printed wiring boards with through-hole metallization; film deposition technologies of thick film circuits: screen-printing and firing. film deposition and patterning technologies of thin film networks: vacuum evaporation, photolithography and etching; laser processed applied in electronics technology; through-hole mounting of circuit modules; surface mounting of circuit modules. (5 credits)

Electrotechnics

BMEVIVEA201

Dr. István Vajda

The process of electrical energy supply (from the power station to the consumer). Generation of electrical energy (sources). The tools of transmission of electrical energy (symmetrical three phase transmission). Distribution of electrical energy, consumers' systems. Engineering calculation methods of symmetrical three phase networks. Properties of conducting and magnetic electrotechnical materials. Calculation of magnetic circuits. Operational principles of one and three phase transformers. Principles and methods of generating rotational and translational magnetic fields. Torque production of rotating electrical machines. Design principles and operation of electrical energy converters. Introduction into electrical drives. Modelling and design principles of electromagnetic devices. Physiological effects. Prospects of electrical energy. (6 credits)

Infocommunication

BMEVITMA301

Dr. Géza Gordos

The overall objective of the course is to give an overview about the major sub-topics, methods and solutions characterizing telecommunications in the broadest possible sense of the word. The treatment of the various types of messages (sound/voice, image, video, data) and their basic processing (sampling, digitazing, compression, error correction) is followed by getting acquainted with the transmission channels (copper, fiber, radio) and with the analoge and digital modulation methods that couple messages and chanels. A chapter on infocommunications networks embraces circuit and packet (e.g. IP) based communications and their implementations in legacy and new generation wireline and wireless networks and sevices. Audio and video broadcasting by analog and digital methods using terrestial, satelite and cable facilities concludes the syllabus. (5 credits)

Measurement Technology

BMEVIMIA206

Dr.Gábor Péceli

The aim of the subject is to give insight into metrology, measurement theory and technology, instrumentation. Besides its theoretical aspects it helps the preparation for laboratory practices. Model building and problem solving skills

of the students are developed. The subject focuses on the measurement of electrical quantities, but emphasizes the analogies with non-electrical problems. The main topics are the followings.

1. Basics of measurement. Measurement and modeling, sensors, bridge circuits. 2. Basics of measurement theory. Basic methods and structures. Calculation of measurement error, uncertainty. Statistical methods. Uncertainty calculation based on GUM (Guide to the Expression of Uncertainty in Measurement) 3. Measurement of signals and their main parameters. Measurement in the time and frequency domain. 4. Signal connection and conditioning. Noise sensitivity, impedance-matching, shielding. Rectifiers. Analog-to-digital and digital-to-analog converters. 5. Measurement of frequency and time. Digital counter-based instruments and their extensions. 6. Measurement of basic electric quantities. Measurement of voltage, current, energy, power, impedance. Impedance and connection modeling. Low- and high-precision methods. Bridge circuits. 7. Signal sources. Sine and function generators. Frequency synthesizers, phase-locked loops. 8. Signal analysis tools. Analog and digital oscilloscopes, spectrum analyzers. Fourier analyzers. 9. Calibration of instruments. Calibration processes. Traceability of measurement results. 10. Testing and diagnostics. Automatic instruments for testing and diagnostics. Self-calibrating and self-correcting instruments. (5 credits)

Microelectronics

BMEVIEEA306

Dr. János Mizsei

The main purpose of this subject is to fill the gap between the abstract electronic functions and the physical reality. Basic knowledge will be given by lectures on material science, physics of semiconductors (fundamental properties, doping, majority and minority carriers, basic equations), physiscs, properties and characteristics of electron devices (pn junctions, diodes, bipolar and MOS transistors, junction FETs, thyristors, photovoltaic devices, functional devices included small and large signal behaviour), equivalent circuits and models of electron devices, thermal effects, solide state integrated circuits (bipolar, MOS, BiCMOS), microsystems, relation between construction and technology, realisation of active and passive elements, semiconductor technology from the sand to the encapsulated IC chip (oxidization, photolithography, diffusion, ion implantation, metallization, encapsulation and testing), roadmaps of technology, scale down effects, limits of integration, nanoelectronics.

Based on earlier subjects (Electronics I-II) the integrated realisation of the analog and digital circuits will be discussed (operational amplifiers, A/D, D/A converters, inverters, logic gates). Important part of this subject is to exercise and train the students for numerical calculations and to demonstrate some case studies.

Practical knowledge will be given through laboratory exercises on the computer modelling of electron devices and circuits, CAD tools for IC design too. (5 credits)

Power System Engineering

BMEVIVEA207

Dr. György Varjú

Survey of the electric power generation, transmission and distribution. Evolution of prime movers and fuel in traditional societies. Electrical energy and the quality of life. Build-up and the principles of the symmetric operation of three phase electric power systems. Summary of the characteristics of the active- and reactive-power. Modelling of the network elements (generator, transformer, transmission line, load). Analyses of the symmetrical stationary operation and three-phase short circuit. Managing of multiple voltage level networks, use of the per unit system. Basic principle and analyses of the asymmetrical conditions. Bases of the symmetrical component method. Role and managing of earth return. Managing of network unbalance and harmonic problems. Ways of neutral earthing and their effects on the earth fault currents and over-voltages. Applied neutral earthing practices. Analyses of stationary transmission. Voltage analyses of radial network, power relations in a meshed network. Limits of energy transmission, voltage- and static-stability. Bases of the control of power and frequency (P-f) and reactive-power and voltage (Q-U). Methods of flexible a.c. transmission systems (FACTS). Power quality requirements, voltage quality and quality of the supply. Electric and magnetic fields of power installations and equipments and the involved biological and EMC effects. Numerical examples and case studies. (5 credits)

Signals and Systems 1

BMEVIHVA109

Dr. Imre Sebestyén

Signals, systems and networks.Two-poles, Kirchhoff's laws. Linear resistive networks. The complete and the reduced sets of network equations. Regularity of the network. Superposition principle. Series and parallel connection of resistrors, voltage splitting, current splitting. Delta-Wye transformation. Equivalent generators. Power matching. Node analysis. Loop analysis. Coupled two-poles. Ideal transformer, controlled sources, ideal amplifier, gyrator. Linear two-ports; reciprocity, symmetry passivity. Equivalents of reciprocal and non-reciprocal two-ports. Input and transfer quantities of loaded two-ports. Capacitor, inductor, coupling. Network equations. Regularity. Initial values. State variable description. Solution of the state variable description: free and excited components. First and higher order networks. Asymptotic stability. Dirac impulse. Impulse response and its application. Input-output stability (BIBO). Sinusoidal signal, phasor representation. Impedance, transfer coefficient. Calculation methods. Powers, power matching. Three-phase networks, symmetric and general systems. The transfer characteristic and its graphical representation by the Nyquist- and Bode-plot. Fourier-series form of forced response to periodic excitation. Mean values and other characteristic quantities. Spectral representation of signals, Fourier transforms. Bandwidth of the signal and of the system. Distortionless signal transfer. Band-limited signals, sampling. (6 credits)

Signals and Systems 2

BMEVIHVA200

Dr. Imre Sebestyén

Complex frequency, Laplace-transforms. Transfer function. Pole-zero pattern. Calculation of the response. Review of system functions. Allpass and minimum-phase systems. Non-linear resistive networks, determination of the operating point. Operating line. Dynamic networks. Linearization at the operating point. Piece-wise linearization. Numerical solution methods (Euler). Discrete-time signals, systems and networks. System equation; step-by-step solution; free and excited solution decomposition. Impulse and step excitations. Impulse response and its application, convolution. Input-output stability (BIBO). State variable descripiton and its solution methods. Asymptotic stability. System equation. Solution of the system equation and of the state variable description, connection between them. Signal flow networks, construction of the state variable description. Sinusoidal steady state, phasor description. Transfer characteristic. Network analysis. Fourier representation of periodic discrete-time signals. Spectral representation of disrete-time signals, Fourier transformation. Analysis of discrete-time signals, systems and networks in the complex frequency domain, z-transforms. Transfer function, pole-zero pattern. Finite impulse response, allpass and minimum-phase systems. Network analysis. (6 credits)

Description of B.Sc. Subjects in Electrical Engineering Specialization Studies

The Specialization Study Block contains six courses: Specialization Theoretical Subject 1-3, Laboratory for Specialization, Project Laboratory, and Thesis. To enter into the Specialization Block, the following criteria must be fulfilled : 120 credit ECTS obtained; successful completion of all courses scheduled to semesters 1, 2, and 3 in accordance with the curriculum.

Laboratory 1

BMEVIMIA304

Dr.Tamás Dabóczi

The primary aim of this laboratory course is to improve the skills of the students on the following areas:

o get acquainted with the materials, components and instruments in the area of electrical engineering,

o practice the designing of measurement setups, setting up the measurement, measuring and using the infrastructure of the laboratory,

o practice the evaluation and documentation of the measurement results.

The topics of the measurements:

1. measurement: Get to know the instruments
2. measurement: Basic measurements
3. measurement: Basic digital tools
4. measurement: Signal analysis I.
5. measurement: Signal analysis II.
6. measurement: Investigation of two poles
7. measurement: Investigation of four poles
8. measurement: Investigation of active electronic devices
9. measurement: Investigation of logic circuits
10. measurement: Investigation of synchronous devices
11. measurement: Measurement of programmable peripheries (5 credits)

Laboratory 2

BMEVIMIA305

Dr.Tamás Dabóczi

The Laboratory 2 course is the continuation of Laboratory 1. As such the laboratory aims at further improving the skills of the students in the field of practical knowledge of electrical engineering.

o they improve their knowledge of materials, components and instruments in the area of electrical engineering,

o improve their practice in designing of measurement setups, setting up the measurement, measuring and using the infrastructure of the laboratory,

o improve their practice of evaluation and documentation of the measurement results.

The topics of the measurements:

1. measurement: Building and testing simple electrical circuits
2. measurement: Designing printed circuit boards
3. measurement: Measurement of EMC phenomena
4. measurement: Measurement of electrical power
5. measurement: Investigation of transistor amplifiers
6. measurement: Investigation of instrumentation amplifiers
7. measurement: Investigation of ADC and DAC
8. measurement: System identification and control
9. measurement: Investigation of analog phase locked loop
10. measurement: Investigation of a 900 MHz FSK transceiver/receiver
11. measurement: Logic controllers

(4 credits)

Description of B.Sc. Subjects in Software Engineering Elements of Natural Science

Calculus 1 for Informaticians

BMETE90AX04

Mrs. Dr. Józsefné Fritz

(1) Real sequences. Special limits, number e. Operations on convergent sequences. Monotonic and bounded sequences.

(2) Continuity and differentiability of real functions of a single variable. Elementary functions and their inverses, properties of differentiable functions, mean value theorems, L'Hospital rule, sketching graphs, parametric and polar curves.

(3) Integral of functions of a single variable. Methods of integration, the fundamental theorem of calculus (Newton-Leibniz formula), applications, improper integrals. (7 credits)

Calculus 2 for Informaticians

BMETE90AX05

Mrs. Dr. Józsefné Fritz

(1) Differential equations. Separable d.e., first order linear d.e., higher order linear d.e. of constant coefficients.

(2) Series. Tests for convergence of numerical series, power series, Taylor series.

(3) Functions of several variables. Limits, continuity. Differentiability, directional derivatives, chain rule. Higher partial derivatives and higher differentials. Extreme value problems. Calculation of double and triple integrals. Transformations of integrals, Jacobi matrix.

(4) Analysis of complex functions. Continuity, regularity, Cauchy - Riemann partial differential equations. Elementary functions of complex variable, computation of their values. Complex contour integral. Cauchy - Goursat basic theorem of integrals and its consequences. Integral representation of regular functions and their higher derivatives (Cauchy integral formulae). (7 credits)

Coding Technology

BMEVIHIA209

Dr. István Vajda

Objective: Clear understanding of the basic principles, notions, models, techniques in the field of data compression coding, error control coding, and cryptography security encoding, supported by solving lots of numerical problems. The aim is to develop the ability to apply basic techniques and solve standard design problems.

Data compression coding: Prefix code. Average codeword length and the entropy. Shannon-Fano code, Huffmann code, Lempel-Ziv code. Quantization. Uniform quantization. Lloyd-Max quantizer. Transformation encoder. Predictive encoding. Voice compression. Video compression.

Error control coding: Basic notions of error control (code, codeword, error models, Hamming distance, error correction, error detection, code distance, code parameters). Binary linear code: generator matrix, parity check matrix, systematic

code. Hamming code. Cyclic linear code, generator polynomial, parity check polynomial. CRC detection technique. Nonbinary linear codes. Reed-Solomon code. Encoding of the CD. Code combination techniques (product code, interleaving, cascading). Convolutional code, Viterbi decoding technique. Security coding: Basic notions, encryption, authentication, integrity protection, access control, repudiation. Ideal encryption. Linear encryption. Public key encryption. RSA algorithm. Hash functions. Basic cryptographic protocols: party authentication, integrity protection, key distribution, digital signature, key certificate. Typical security holes in cryptographic primitives and protocols. (5 credits)

Introduction to the Theory of Computing 1

BMEVISZA103

Dr. András Recski

Scalars, vectors, analytic geometry of the 2- and 3-dimensional space. Solvability of systems of linear equations with Gauss elimination. Unicity. Determinants, their properties. Complex numbers. Vector spaces, linear independence, base, dimension. Linear transformations and their matrices, rank, inverse. Eigenvalues and eigenvectors of linear transformations. Quadratic forms, definiteness. Equivalence and cardinality of infinite sets. Countable and continuum. Power set. Basic concepts of combinatorics (permuttions, variations, combinations). Basic concepts of graph theory (vertex, edge, degree, isomorphism). Path, circuit, connectivity, trees. Planar graphs, duality. (5 credits)

Introduction to the Theory of Computing 2

BMEVISZA110

Dr. András Recski

Algorithms in graph theory (minimum cost tree, shortest path, maximum matching, flow problems, topological sorting, PERT method). Higher connectivity numbers of graphs. Graph colouring problems (vertex, edge and map colouring). Euler- and Hamiltonian circuits. Basic concepts in number theory (divisibility, primes, congruences, Euler-Fermat theorem), algorithms in number theory (prime tests, public key criptography). Basic concepts of abstract algebra (operations, structures), semigroups. Groups, their relations to transformations, important special groups, factor group. Rings and fields. (4 credits)

Physics 1i

BMETE11AX03

Dr. Pál Pacher

MECHANICS: Measurements, units, models in physics. Space, time, different frames of references. Motion of a particle in 3D. Newton's laws. Work, kinetic energy, potential energy. Work-energy theorem. Conservation laws in mechanics. Motion in accelerated frames, inertial forces. Newton's law of gravitation. Basics of the theory of special relativity. System of particles, conservation laws. Kinematics and dynamics of a rigid body. Oscillatory motion, resonance. Wave propagation, wave equation, dispersion, the Doppler-effect.

THERMODYNAMICS: Heat and temperature. Heat propagation. Kinetic theory of gases. Laws of thermodynamics. Reversible and irreversible processes, phase transitions. Entropy, microscopic interpretation of entropy. Elements of statistical physics.

STATIC ELECTRIC AND MAGNETIC FIELDS: Electric charge. Electric field, electric flux, electric potential. Basic equations of electrostatics. Applications of Gauss's law. Capacitors, energy of the static electric field. Dielectrics, boundary conditions. Electric current. Magnetic field. Current carrying wire in magnetic field. Magnetic field produced by an electric current, the Biot-Savart law. (4 credits)

Physics 2i

BMETE11AX04

Dr. Pál Pacher

ELECTRODYNAMICS: Faraday's law. Self induction, mutual induction. Magnetic properties of matter. Magnetic data storage. Maxwell equations. Generation, propagation and reflection of electromagnetic waves. Basics of geometrical optics. Wave optics, interference, diffraction. Polarised light.

BASICS OF ATOMIC PHYSICS: Natural and coherent light sources. Physical foundations of optical communication. Matter waves of de Broglie. The Schrödinger equation. The electron structure of atoms. Electron spin. Free-electron theory of metals. Band structure of solids. Superconduction. Quantum-mechanical phenomena in modern electronics. Basics of nuclear physics. Nuclear reactors. Elementary particles. Curiosities in cosmology. (4 credits)

Probability Theory

BMEVISZA208

Dr. László Ketskeméty

Probability: Elements (random experiment, outcomes, sample space, event, probability). Conditional probability, independence of events. The law of total probability and Bayes' rule. Random variables, probability distribution function. Discrete random variables (binomial, geometric, Poisson, hypergeometric). Continuous random variables (uniform, exponential, normal). Expectation and variance. Markov's and Chebyshev's inequalities. Joint distributions and independence. Covariance and correlation coefficient. Linear regression. Law of large numbers. Central limit theorem.

Statistics: Elements (sample, estimators, unbiased and consistent estimators). Confidence intervals (examples in normal data). Statistical tests (null hypotheses, type I and type II errors, test statistics, critical value, the u- and t-tests). (4 credits)

Theory of Algorithms

BMEVISZA213

Mrs. Dr. Katalin Friedl

Algorithms. Sequential and binary search. Search with some basic data structures, like search tree, AVL tree, B-tree, hash table. Sorting by insertion, merge sort, heap sort, quicksort, bin sort, radix sort and the analysis of these methods. The complexity of sorting. Basic graph theoretical algorithms: BFS, DFS and their applications to determine (strongly) connected components. Algorithms for acyclic graphs. Finding maximal matching in bipartite graphs. Determining shortest paths by methods of Bellman-Ford, Dijkstra, and Ford. Minimal spanning tree algorithms and the union-find data structure. General algorithmic methods: branch and bound, divide and conquere, dynamic programming. Efficient approximation algorithms. Algorithmically hard problems, the notion of NP and NP-completeness. (5 credits)

Description of B.Sc. Subjects in Software Engineering
Fundational Technical Studies

Artificial Intelligence

BMEVIMIA313

Dr.Tadeusz Dobrowieczki

The aim of the subject:

The aim of the subject is a short, yet substantial presentation of the field of artificial intelligence. The principal presented topics are (1) expressing intelligent behavior with computational models, (2) analysis and application of the formal and heuristic methods of artificial intelligence, (3) methods and problems of practical implementations. The

subject is intended to develop the abilities and skills of the students of informatics in the area of:

- studying novel applications of the computing,
- developing effective methods to solve computational problems,
- understanding the technological and conceptual limits of the computer science,
- intellectual understanding of the central role of the algorithm in information systems.

Detailed curriculum:

Agent paradigm: Intelligent system and its environment. Formal modeling and solving of complex problems within agent paradigm. Comparing problem solving methods (search strategies). Heuristics for reducing complexity. Knowledge intensive approach and complexity. Experimenting with the scheduling problems: modeling within the paradigm and solving with the search algorithms.

Planning: Planning as a tool of problem solving. Basic representations for planning. The basics of the modern planning algorithms. Hierarchical and conditional planning. The question of the resource constraints. Integrated planning and execution. Experimenting with the assembly problems: developing plans taking into account various problems of increasing complexity.

Knowledge intensive systems. Formal representation and manipulation of knowledge. Logic based methods. Using first order logic to describe problems and to compute solutions. The functioning of rule-based systems. Inference methods for uncertain knowledge. Probabilistic inference systems. Representing vague meaning with fuzzy sets. Experimenting with the diagnostic problem with knowledge of different levels of uncertainty, using suitable methods, or experimenting with building a fuzzy system (rule-based language, fuzzy software packages, etc.).

Learning. Learning within agent paradigm. Inductive logical learning (decision trees, learning general logical expressions). Learning in neural and Bayesian networks. Reinforcement learning. Genetic algorithms and evolutionary programming. Experimenting with multiple learning problems, using suitable software packages. (5 credits)

Basics of Programming 1

BMEVIEEA100

Dr.András Poppe

This subject introduces the basic methods and tools of computer aided problem solving. The main goal is to provide the students with all the necessary programming knowledge and abilities that are needed during the course of their further studies. The immediate goal is to learn building of portable computer programs. These goals are achieved through the study of a powerful, general purpose, high level programming language: the C language. The practice classes follow the topics of the lectures and discuss further details of the language elements and algorithms.

The main topics of the subject:

First the concepts of computer aided problem solving are introduced: program, algorithm, data representation, specification, coding, documentation, testing, low level and high level programming, syntax and semantics, block diagram. Basic elements of the C language are defined: keywords, identifiers, declaration and definition. The topics of storage classes, rvalue, lvalue, main effect and side effect declarative and executable statements follow. The different data types, data structures are examined, especially the representation of numbers and logical values. Students learn how to build expressions using operators, the precedence and binding of operators and the evaluation of expressions. Expression statements, control statements and loops are explained. How to declare and define functions, their formal and actual parameters. Next topic is global and local variables: scope of variables, the stack, lifetime of local variables, storage classes. Pointers are introduced with arrays and structures (array algorithms: linear and binary search and sort). The multiple choice statement is shown together with the finite state machine model. How does a program communicate; standard input/output, file handling. The idea of recursion is explained via well-known algorithms. Advanced topics of the semester include dynamic data handling, structures and algorithms for linked lists and binary trees and a detailed development study of a software from specification till documentation. Besides language elements and programming concepts some basic algorithms such as sorting are also introduced. (5 credits)

Basics of Programming 2

BMEVIIIA114

Dr. Balázs Goldschmidt

The objectives of this course are to introduce students to the concept of object oriented programming and to provide them the hands-on experience of programming in C++. This semester focuses on leading the students to a deeper understanding of C language, and focus is also put on the steps of solving very complex programming tasks using an object-oriented approach. The latter is achieved via learning the C++ language, assuming a reliable knowledge of C. The practice classes follow the topics of the lectures and discuss further details of the object-oriented concept and the language elements.

First the students learn how the C++ language derives from C. Inline macros, prototypes, default arguments and function overloading are explained. Dynamic memory allocation process of C++, reference type, visibility and scope of data are discussed.

Next the object-oriented concept is introduced via the C++ language. The principles and concepts behind the object oriented programming paradigm are shown with the corresponding C++ syntax. Topics include classes, encapsulation, protection; member functions, constructor/destructor, friend mechanism; operator overloading; inheritance, virtual functions; generic classes.

Last the students are introduced to essential operating system functions and to development and documenting tools. (4 credits)

Computer Architectures

BMEVIHIA210

Dr. Gábor Németh

Notion of computer architecture; relation of hardware and software. Traditional computer architectures. Characteristic processor families.

Memory management methods: block switching, indexed

mapping, virtual memory management, cache memory.

Reduced instruction set computer (RISC). Superscalar architectures.

Periphery handling methods: device level and logical level handling.

Multiprocessor structures: loosely coupled and tightly coupled multiprocessor systems. Coprocessors. Ordering of events. Logical clocks, partial and total ordering, abnormal behaviour. Physical clock, synchronizing conditions. Multiprocessing and multitasking: task handling, protection mechanism, cooperation of the user task and operating system.

Fine grained parallelism. Harvard architecture, instruction and data pipelines, array processors.

Information processing models: control driven, data flow, demand driven and information driven processing.

Instruction level and procedural level data flow architectures. Intelligent networks. Neural networks and associative computers.

Functional specification methods. Orthogonality, inheritance rules. Partitioning of the design model based on functional, information hiding and design-for-test. (5 credits)

Computer Graphics and Image Processing

BMEVIIIA316

Dr. Balázs Cséfalvi

The course presents the fundamentals of computer graphics and image processing and introduces methods of creating, animating, and rendering virtual worlds.

Computer Networks

BMEVIHIA215

Dr. Csaba Attila Szabó

Fundamentals in Computer Networks. Classification. History. Standardization. Convergence. Communication of Remote Processes. Modeling and reference Models: ISO-OSI and TCP/IP. Physical Level Data Transmission. Problems of signal generation, signal transmission and data recovery. Analog transmission: modems, standard serial interfaces. Digital transmission: line encoding, codec. Multiplexing techniques: FDM and TDM. Asynchronous and synchronous transmission. Private and public data networks. ISDN, ADSL, cable TV. Data Link Level Data Transmission. Type of services. Tasks to be solved: framing, error control, flow control, link management. Data link protocols. Data Link Level Data Transmission in LANs. Features of LANs. Special characteristics of the LAN Reference Model. MAC protocols. LLC protocols. Wireless LAN protocols. Network Level Data Transmission. Type of services in packet swithed networks: datagram and virtual circuit. Routing. Congestion control. Interconnection of networks. Gateway, router, bridge, switch, repeater. Internet protocols. Transport Level Data Transmission. Type of services. Elements of protocols. Addressing. Transport connection management. Flow control. Multiplexing. TCP and UDP. Higher Level Services. Session and presentation level services. Application Level Services and Protocols. Application level of TCP/IP Reference Model. DNS. E-mail. Web. Network Management. Reasons of network management. Tasks to be solved. Hardware and software elements. SNMP. (4 credits)

Control Engineering

BMEVIAUA309

Dr. László Keviczky

Modelling and system enginering description of processes: Equilibrium points of nonlinear systems, linearization. State equation of dynamical systems, computation of the transients. Transfer function, poles and zeros, frequency functions, Nyquist and Bode diagrams.

Fundamental ideas of control engineering: The principles of control, feedback control and open loop control. Blokk-diagram algebra and transformations. Set pont control and reference signal tracking, the role of negative feedback. Expectations for actuators and sensors, standard signal domains. Performancies of control systems. Stability criterions. Idea and application of root locus.

General algebraic (polynomial) design methods: Youla parametrization. Approximating inverses. Control of stable and unstable systems. Application of Diophantine equation. Different types of two degree of freedom control structures (IMC: internal model control).

Synthesis of continuous time control systems: Closed control loop, open loop, loop gain, type number. PID controller. Controller parameter design for prescribed steady-state accuracy and phase margin. Control of dead time systems. Robustness investigation of control systems, sensitivity functions. The effect and handling of saturations.

Digital control systems: Sampling theorem of Shannon, holding elements. Discrate time transfer function. Transfer functions and pole-zero configurations of typical elements. Discrete time PID control algorithms. Discrete time controller design based on continuous time methods. Saturation handling.

Control systems in state space: Controllability and observability. Pole assignement by using state feedback, state observer design in continuous and discrete time. Properties of the equivalent closed loop control system. Two step design.

Outlook: Process identification, optimal and robust control design, adaptive control.

The subject consists of lectures (3 hours/week) and 6 excercises (2 hours in every second week). During the exercises typical control system analysis and synthesis tasks will be solved using digital computer and MATLAB™ (Control System Toolbox™). (4 credits)

Databases

BMEVITMA311

Dr. Sándor Gajdos

Database concepts, history, entity-relationship model/diagram, attributes, relation-types, constraints, weak entity sets. Relational database, relational algebra, extended operations, design from E/R model. Tuple relational calculus, domain relational calculus, safe expressions, completeness.

Introduction to ISBL, QUEL, QBE. SQL queries: basic structure, set operations, aggregate functions, NULL values, subqueries, SQL Data Manipulation Language, SQL Data Definition Language. Functional dependencies, logical consequence, Armstong axioms, derivation rules, key, closure, multivalued dependency, decompositions, normal forms. Transaction management: serializability, precedence graph, locks, deadlocks, 2PL, RLOCK/WLOCK, tree protocol, timestamps, logging, UNDO/REDO protocols. (5 credits)

Digital Design 1

BMEVIMIA102

Dr.Endre Selényi

Basis of coding theory, number systems. Boolean algebra and switching functions. Combinational logic design principles and practices: Karnaugh maps, minimization methods, static and dynamic hazards. Logic gates realization. Synchronous sequential logic design principles and practices: state-machine structure, state minimization, state assignment. Asynchronous sequential logic design principles: state reduction and assignment, race problems and hazards. Realization with flip-flops and logic gates. (5 credits)

Digital Design 2

BMEVIMIA111

Dr.Endre Selényi

MSI functions: decoders, multiplexers, comparators, three-state buffers, ALUs, registers, counters, shift registers. Programmable logic devices: ROMs, RAMs, PLAs and PLDs. Data and control structures. Logic design methods for digital control units: phase register, micro programming. Introduction to microprocessors. Architecture and operation of microprocessor: CPU, memory, peripheral equipment, bus systems. I/O organization, interface circuits, and handlers. Introduction to RTL-level hardware design languages. (5 credits)

Electronics

BMEVIEEA307

Mrs. Dr. Márta Kerecsen-Rencz

Introduction to the history of electronics. The present status and trends in microelectronics. Introduction to physics and circuit theory. Calculation of RC circuits. The Bode diagram.

The properties of semiconductor material, calculation of charge carrier densities. Calculations of currents in semiconductors, the continuity equations.

The operation of the p-n junction and the major applications. SPICE modeling and hand calculation methods. Basic logic circuits with diodes. Calculation of circuits containing diodes.

The operation of control sources, the physics of the bipolar transistor, characteristics. Finding the operating point of the bipolar transistor, calculations with simple amplifier circuits. Secondary effects in the operation.

The major characteristics of field effect transistors. The physics of the MOS capacitor, the operation of CCD cameras. Discussion of the types, models, and use of the MOS transistors, major advantages.

The basics of integrated circuits. The role and predictions of roadmaps in microelectronics. Introduction to the fundamentals of VLSI manufacturing. The element set of MOS circuits. The properties of interconnects. The element set of bipolar and BiCMOS circuits. The fundamentals of digital circuits. General characteristics of inverters and basic MOS logical gates. Construction of complex logical gates. The fundamentals of CMOS circuits, basic logic gates and complex gates. The use of transfer gates in MOS and CMOS circuits. Combinational logic with different CMOS realizations, driver circuits I/O circuits, pulse generators and storage elements. The main structures of registers and arithmetic elements. The fundamentals of testing digital circuits.

The operation, classification and main parameters of semiconductor memories.

The basics of analogue integrated circuits, operational amplifiers, real and ideal amplifiers, circuits with operational amplifiers. A/D and D/A converters.

The categories of application specific integrated circuits (ASIC). The design methodologies of integrated circuits.

Graphic peripheral devices; CRT, LCD, plasma displays.

Micro-electro-mechanical (MEMS structures). (5 credits)

Management of Information Systems

BMEVITMA314

Dr. Gábor Magyar

System-level overview and achitectures. Strategic level design, implementation and operation tasks. Life cycle of information systems. Total Cost of Ownership, TCO management. Typical architectures, central, client-server, 3-layer schemas. Quality of Sevices. Reliability, Availability, Serviceability (RAS). Manageability. Asset management, system management, server management, network management,. inventory management, configuration management, power management, Structure of Management Information (SMI). Management Information Base (MIB). Internet Standard MIB, Private MIB. Common Information Model (CIM). Management Object Format (MOF). Simple Network Management Protocol (SNMP). Windows Management Interface (WMI), Web-Based Enterprise Management (WBEM). Standards. Integrated Network and System Management (INSM). Management Information Format (MIF). Desktop Management Task Force (DMTF). Desktop Management Interface (DMI)., Management Interface (MI), Advanced Configuration and Power Interface (ACPI), Boot Integrity Service (BIS). Interoperability issues. Operating tasks. System log, event management, fault management. Data storage management. Scalability basics. Maintenance, maintenance strategies. Documentation standards. Software upgrade. (4 credits)

Measurement Laboratory 1

BMEVIMIA211

Dr.János Hainzmann

Oscilloscope usage practice for investigation of digital circuits. Important characteristics of logic gates and signal-cables. Use of logic state-analyser for monitoring logic networks. Trouble-shooting in digital devices. The Verilog hardware description language, and its use for behavioural description of digital networks. Designing a simple sequential network for FPGA implementation using HDL language, testing of the implemented design. (2 credits)

Measurement Laboratory 2

BMEVIMIA216

Dr.János Hainzmann

In the laboratory the students get familiar with a state of the art microcontroller system. Use of an integrated development system. Writing of simple assembly programs for I/O handling. Peripheral management with polling and with interrupt. Comparing routines written in assembly and in C language. Services of a simple real-time operating system. (2 credit)

Measurement Laboratory 3

BMEVIMIA312

Dr.János Hainzmann

Testing the characteristics of A/D and D/A converters. Measurement of data channel characteristics. Investigation of simple data transfer protocols. Configuration of a PC for network connection. Creating a computer network by a manageable switch, investigation of the network. (2 credits)

Measurement Laboratory 4

BMEVIMIA315

Dr. Csaba Tóth

Investigation of sensors and of signal conditioning circuits. Virtual instrumentation. Creating a data acquisition system by programmable instruments and peripherals. Use of a graphical development environment for designing test, measurement and control software. (2 credits)

Operating Systems

BMEVIMIA219

Mrs. Dr. Annamária Várkonyiné Kóczy

The aim of the course is to introduce the operation and principles of the operating systems, the programming models of the concurrent and distributed systems, and the selection and design criteria of proper systems. The principles and the operation are illustrated through real examples. During the

lectures and the labs associated to the course the mutual influence of the computer hardware and software is also emphasized thus the course results in engineering skills and knowledge in the field of operating systems.

Lecture: Introduction. History of the operating systems. Today's operating systems. General description: Tasks, interfaces, functions, structures, operation. Processes and threads. Process co-operation, synchronization, and communication. Deadlock. Multiprogramming and multiprocessing systems. Queuing and state transition models. CPU scheduling. Memory management. Virtual memory management. Secondary storage management. File management. Periphery handling. Programming interfaces. Protection and security. User level knowledge. Selection criteria and system design. The UNIX operating systems. Internal structure. Scheduling. Signal handling. Process communication. File management. Distributed systems. Basics. Network communication. Distributed file systems. Distributed operating systems. Distributed coordination. Security and protection. Labs: Illustrative examples, case studies, user level knowledge. (4 credits)

Signals and Systems

BMEVIHVA214

Dr. József Pávó

Definition of signals, systems and networks. Classification. Causality, linearity, invariancy. Basic operations on discrete time (DT) and continuous time (CT) signals. Time domain description of DT and CT systems. Impulse response, convolution, input-output (BIBO) stability. State space description, response calculation, asymptotic stasbility. Signal flow networks (SFN). Frequency domain description. Sinusoidal signal, phasor representation. Canonical SFN representations. Nyquist and Bode plots. Periodic signals, Fourier series. Fourier transform, distortionless signal transmission. Complex frequency domain description. Transfer function, pole-zero pattern. Laplace transformation. Special (allpass, minimum-phase FIR) systems. DT simulators of CT systems. (5 credits)

Software Laboratory 1

BMEVIEEA101

Dr.András Poppe

The main goal of this subject is to give the students an opportunity to try their theoretical knowledge in practice, test the algorithms on computers, develop their programming skills, which are inevitable during their future studies. The laboratory classes follow the topics of the lectures and practice classes of Basics of Programming 1. A long-term individual homework assignment helps the students reach the goal of the subject.

The main topics of the laboratory:

First the students get acquainted with the rules and facilities of the university computer centre, with the structure and the services of the university network and with the integrated environment used to build C programs. Students learn editing the source code, compiling, linking and running the program via the "Hello world" example. Number representations are examined; limits of integer and real types. The use of debugging facilities is introduced: step-by-step execution, watching variables. Students develop programs to solve second order equations, to find friendly numbers, to get the greatest common divisor and to generate elements of the Fibonacci series. Next the array handling and sorting algorithms are practised, followed by problems that can be easily solved with a finite state machine model, like /*comment*/ filter, pattern matching. Common file handling problems are covered. Recursive algorithms are tested and the stack is examined during execution. A bigger program is developed, which integrates the handling of files and linked lists. First the list handling algorithms are built; insert, search, delete. In the next laboratory the database program is completed by file handling operations. (2 credits)

Software Laboratory 2

BMEVIIIA115

Dr. Balázs Goldschmidt

The main goal of this subject is to give the students an opportunity to try their theoretical knowledge in practice, test the algorithms on computers, develop their programming skills, which are inevitable during their future studies. The laboratory classes follow the topics of the lectures and practice classes of Basics of Programming 2. A long-term individual homework assignment helps reach the goal of the subject.

The main topics of the laboratory:

Students first learn the non object-oriented features of C++: overloading, default arguments, using cin/cout. Then the concept of objects and classes is approached via a structure and external functions. Different classes are designed and implemented: date, stack, complex number, string etc. Dynamic array of objects and exception handling are examined. Students practice inheritance, virtual member functions, multiple inheritance. Generic classes are introduced and a complex problem is solved using C++. (2 credits)

Software Laboratory 3

BMEVIIIA212

Dr. Balázs Csébfalvi

This subject is an introduction to pure object-oriented programming using the Java language. The major goal is to teach how to write maintainable, reusable, and self-documenting source code in Java. First the main conception and properties of the Java programming language are introduced like the object-oriented paradigm, robustness, security, portable or platform-independent programming, Java Virtual Machine (JVM), dynamic code interpretation, and multi-threading. Afterwards, the basic elements of the Java language are discussed like the explicit and implicit type conversions, dynamic allocation of objects, converting built-in types into objects, generic arrays, strings, controlling and conditional structures, control of data access, abstract classes and methods, static attributes and methods, garbage collection, inheritance and interfaces. High-level and uniform handling of system and user-defined exceptions is explained through illustrative examples of standard input/output operations. Dynamic data structures, like multi-dimensional arrays, linked lists, binary trees are discussed in detail and the usage of the Java collection framework is illustrated. A more general introduction to object-oriented design patterns is presented taking all the case studies from the standard Java class library. Graphics user interfaces and event-controlled interaction are discussed through the Abstract Windowing Toolkit (AWT) library. Finally, the implementation of simple Java applets and game applications are explained step by step form the object-oriented design to the source code. (2 credits)

Software Laboratory 4

BMEVIIIA220

Dr. Zoltán László

This laboratory is the organic continuation of the course "Software technology". The goal is creating an object oriented application with UML (Unified Moodeling Language) description, Java implementation, due to RUP (Rational Unified Process) concepts. Students are working on the project in groups of 3 or 4. Groups formed by the consulent. Students are preparing the documentations due to the schedule given. Documentations must be handed in in pre-definite format.

The project is to be realized in three steps: Skeleton, Prototype, Complete

The goal of the Skeleton version is to verify that object and dinamic models are making up the model of the task. The Skeleton is a program containing all the business objects that are going to take part in the final system. The interfaces of objects are defined only. At the beginning every method writes its name on the screen and calls the methods he needs to fulfil his service. In case calling of methods depend on condition, a question referring to the condition ought to be asked on the screen interactively so the program goes on the way the answer defines. Skeleton must also be able to help checking different scenarios and sequence diagrams.

The goal of the Prototype program is to demonstrate that the program is ready, works correctly, fulfils all tasks. Prototype version is a whole program except of the detailed interface. Prototype is well planned, timing and handling of active objects is completed. All methods of the business objects contain the final algorithms - except of those concerned with appearence. Paying attention to the logic and structure of interface, to the fact how much it reflects and makes visible the functioning of the program is very important.

Complete version of program may differ from prototype only becasuse of the quality of user interface. At evaluation internal structure of realization is more stressed than exteriors. (2 credits)

Software Laboratory 5

BMEVITMA308

Dr. Sándor Gajdos

The course provides practical and technological knowledge related to some selected topics of database management. Topics include: Oracle system, the SQL language, application development using client-server architecture, creation of dynamic web pages using PHP, XML based application development, Oracle portal development. (2 credit)

Software Techniques

BMEVIAUA218

Dr. Hassan Charaf

The class members will be exposed to the techniques of manufacturing object oriented software systems, as well as the most important methods of event-driven programming. Moreover, the students acquire familiarity with the structures and fundamental implementation techniques of graphical user interface and the rapid application development approaches. Presenting the Windows/Linux programming facilities along with the analysis of the roles and the significance of class libraries and their comparison are also among the focused topics. Besides the development-oriented methods, the most important principles of the source code management systems (SourceSafe, ClearCase, CVS, etc.) are also focused because of the important role they play in software life cycles. We also stress the client side development, including but not limited to thick and web-based clients. The conveyed knowledge is illustrated by case studies.

In summary, 'Software Methods' provide the fundamental knowledge to develop software for the most current and popular platforms (e.g. Windows, Linux) with up-to-date tools and technologies. (4 credits)

Software Technology

BMEVIIIA217

Dr.Zoltán László

Software engineering. Historical background. Software crisis. Concept of the technology. Software as a product. Software quality aspects. Software development process. Life cycle models. Software project planning. Riscs, Simple cost models. Scheduling. Requirement analysis and definition. Specification: functional, structural, and dynamical views. Functional description: data-flow modelling. Structural description: data dictionary, entity relationship model. Dynamical description: state transition model. Design concepts: abstraction, information hiding, cohesion, coupling. Software architectures.

Object oriented software development: Object concepts. Object oriented paradigm. UML notation. Use-cases. UML structural diagrams. (Class and object diagrams). Sequence, collaboration, activity diagrams. Component and deployment diagrams. Overview on the Rational Unified Process. Component software, academic concepts: Aspest oriented programming. Verification and validation. applied techniques. Testing. Configuration management. (4 credits)

System Modeling

BMEVIMIA401

Dr. András Pataricza

The course presents the highest level of the design process of information systems, namely the hardware-software co-design and dimensioning of the architecture from a model based perspective. The students will learn the basic concepts of correctness verification, the performance analysis, dependability, and their role in the modeling. They will also get acquainted with practical problems of dimensioning and measurement by completing of their previous knowledge in hardware and software technologies. The course focuses on general models used in various application fields (such as general data processing, business related interactive systems, web based and embedded systems) the main emphasis being placed, however, on the web based applications. (5 credits)

Telecommunication Networks and Services

BMEVITMA310

Dr. Gyula Csopaki

Architecture of telecommunication networks. Network hierarhies, numbering plans, signalling systems and signalling protocols. Telecommunication technologies: wired and wireless access, backbones. Plesiochronous Digital Hierarcy, Syncron Digital Hierarchy, Asyncronous Transfer Mode and optical networks. Telecommunication systems: Public Switced Telephone Networks, Global System Mobile, Voice over IP. Convergence of telecommunication-, computer- and broadcast networks.

Software and hardware elements of telecom systems. Telecom software technology. Specification of telecom software. Infocom services. Teleservices. Message, data, voice and conference services. Content services. Video on Demand, Internet services. Web portals and services, media information systems, electronic commerce, electronic civic centre. Broadband integrated services. Autentication, authorization, and accounting. (4 credits)

Description of B.Sc. Subjects in Software Engineering Specialization Studies

The Specialization Studies Block contains seven courses: Specialization Subject 1-3, Specialization Laboratory 1-2, Project Laboratory, and Thesis. To enter into the Specialization Studies Block, the following criteria must be fulfilled: 120 credit ECTS obtained; successful completion of all courses scheduled to semesters 1, 2, and 3 in accordance with the curriculum.

Description of M.Sc. Subjects in Software Engineering

Applied Computer Science Specialization

System Optimization

BMEVISZM117

Dr. Dávid Szeszlér

Basic concepts of linear programming, Farkas lemma, duality. Integer programming, total unimodularity, applications to matchings in bipartite graphs and network flows. Basic notions of matroid theory, duality, minors, direct sum, sum. Algorithms for matroids. Matroids and graphs, linear representation, geometrical representation. Tutte's theorems. Approximation algorithms (set cover, Steiner-trees, travelling salesman problem). Scheduling algorithms (list scheduling, the algorithms of Hu and Coffman and Graham). Engineering applications: design of reliable networks, design of very large scale integrated (VLSI) circuits, the classical theory of electric networks, rigidity of frameworks. (4 credits)

Stochastics 1 - 2

BMETE90MX43

Dr. Lajos Rónyai, Dr. Bálint Tóth, Dr. András Vetier, Dr. Tamás Szabados, Dr. Balázs Székely

Stochastics 1: Existence proofs and randomness: Erdős' method through examples (2-coloring of hypergarphs, Ramsey numbers) with algorithmic aspects. Turán's theorem. Derandomization. Lovász's local lemma and applications. Analysis of randomized algorithms (expected time of quicksort, Rabin-Miller primality test, Schwartz-Zippel lemma and applications, pattern matching, treaps, minimum spanning trees, computing planar autopartitions and convex hulls). Random walks and algorithms, ranking pages in the internet. Randomness and complexity classes (RP, Las Vegas, interactive protocols, IP, BPP, RL with examples, IP=PSPACE). Zero knowledge proofs. Random graphs (Erdős-Rényi model, Albert-Barabási model). Properties of large networks. Stochastics 2: Review of basic probability theory: random variables, distribution, expectation, covariance matrix, important types of distributions. Types of convergence: stochastic, L^p, almost sure. Borel-Cantelli lemmas. Laws of large numbers, weak convergence of distributions, limit theorems. Generating and characteristic functions and their applications: limit theorems and large deviations (Bernstein inequality, Chernoff bound, Kramer's theorem). Basics of stochastic processes: Markov chains and Markov processes. Markov chains with finite state space: irreducibility, periodicity, linear algebraic tools, stationary measures, ergodicity, reversibility, MCMC. Chains with countable state space: transience, recurrence. Application to birth and death processes and random walks. Basics of continuous time Markov chains: Poisson process, semigroups. Additional topics: percolation, random graphs, phase transition. (4 credits)

Formal Methods

BMEVIMIM100

Dr. István Majzik, Dr. Tamás Bartha

As the complexity of information systems and the costs of potential failures are increasing, it becomes more and more important to prove that the design of the critical system components is correct. One of the typical solutions for the challenge of provenly correct design is the application of formal methods. Mathematically precise modelling and analysis allow the early verification of design choices, the proof of correctness with respect to several requirements, and then the automated software or hardware synthesis. The subject provides an overview of the formal background needed for the elaboration and analysis of the formal models of IT systems and components: the modelling paradigms, the widely used formal modelling languages, and the analysis and simulation based verification techniques. The subject demonstrates the application of formal methods in the field of system-level modelling, software design, verification and synthesis. (4 credits)

Data Security

BMEVIHIM102

Dr. Levente Buttyán, Dr. István Vajda, Boldizsár Bencsáth

Protecting the integrity and confidentiality of data stored and communicated in modern infocommunication systems, as well as protecting those systems themselves against malicious attacks are very important requirements today. The commonly used tools for addressing the problem are based on cryptographic and network security mechanisms. The objective of this course is to give an introduction to these fields. The course covers the following topics: cryptographic algorithms (symmetric and asymmetric key ciphers, hash functions, digital sinatures), authentication and key establishment protocols, network security protocols (SSL, IPSec, WiFi security, etc.), access control principles, firewalls and intrusion detection systems, Denial-of-Service attacks, software security (buffer overflow attacks), malware, spam, botnets. (4 credits)

Languages and Automata

BMEVISZM104

Dr. Katalin Friedl

Finite automata (deterministic and non-deterministic), regular expressions, regular languages, closure properties, pumping lemma for regular languages. Push-down automata, context-free languages, Chomsky and Greibach normal forms, closure properties, pumping lemma for context-free languages. Turing-machines, recursive and recursively enumerable languages, linear bounded automata. Parsers for context-free languages. Time- and space-complexity: P, PSPACE, EXPTIME language classes. Non-deterministic Turing machines, NP language class, NP completeness, NP-complete languages. Kolmogorov complexity: incomputability, Kolmogorov randomness. (4 credits)

Software Architectures

BMEVIAUM105

Dr. Hassan Charaf

This course discusses the software architectures related to the most popular applications, research topics and developments. The course introduces the distributed and highly reliable system architectures and technologies. The course summarizes the most important knowledge related to the object-oriented, component-based and service-based architectures. The course highlights the systematic software reuse and, based on software architectures related research results, analyzes the importance of loosely coupled systems. The goal of the course is to systemize and transfer the knowledge related to the mentioned topics. In the practice of enterprise system development the multi-layer, object-oriented platforms (e.g. Java, .NET) prevail. According to the experiences, these tools and technologies are able to efficiently support system development, but without the appropriate architecture related knowledge, we can face with several problems. The source of

the errors and unsuccessful development is the fact that software developers do not have comprehensive architecture knowledge. Based on it, the second goal of the course is to prepare students for developing enterprise systems. (4 credits)

Engineering Management

BMEVITMM112

Dr. Gyula Sallai, Dr. Imre Abos, Dr. Zsuzsanna Kósa, Dr. Gábor Szücs

Generic and ICT (information and communication technology) specific engineering management in the knowledge economy: principles, methods and real examples for engineering students. Engineering management roles, situations and tools. Strategic, organization and knowledge management. Business and transformation strategies. Complex engineering decision problems. Culture and change management of organizations. Technology, innovation, product and business process management. Models and methods for technology planning, innovation financing, product development, customer relation and risk management. The role of ICT in value creation. Regulatory principles, technical and market regulation of the ICT sector. Ex-ante and ex-post regulation, deployment of competition and ICT convergence, effective management of radio frequencies and numbering resources. (4 credits)

Distributed Systems

BMEVIAUM124

Dr. Hassan Charaf

A comparison of distributed and mainframe systems. Distributed system architectures. In the semester several communication technologies are discussed that are listed in the followings. Low level network communication with sockets. RPC (Remote Procedure Call). Java RMI (Remote Method Invocation). The evolution of binary components (using C++). Component-oriented technologies, like COM (Component Object Model) and CORBA (Common Object Request Broker Architecture). An introduction to Java EE and Microsoft.NET. Service Oriented Architectures (SOA). Communication in heterogeneous environments with XML Web Services. .NET Remoting as an efficient solution to connect .NET platforms. MSMQ (Microsoft Message Queuing) for durable and reliable messaging. WCF (Windows Communication Foundation) as the latest .NET communication technology for SOA environment. Security aspects and solutions (encryption, digital signature, certificates, etc.). Distributed architectures. (4 credits)

Mobil Software Development

BMEVIAUM125

Dr. Bertalan Forstner

The aim of the course is to introduce the basics of application development for smartphone devices for the students. Firtsly it gives an overview of the available mobile platforms and gives definitions for the basic things. It is followed by a Java ME overview and practice on application development for wide range of mobile devices. Then Android, which also runs java applications, is detailed, concentrating on the advanced location-based feautres and advanced user interface capabilities. Besides of Symbian C++ and S60 application architecture, the course also illustrates the usage of Open C/Open C++ for the Symbian platform. Qt, recently aquisited by Nokia, is a user interface layer and also provides platform services that can be applied on Symbian. The last part of the course is about iPhone development with a thorough introduction to Objective C. (4 credits)

Model-Driven Paradigms

BMEVIAUM126

Dr. László Lengyel

Model-driven software development (MDSD) approaches (for example Model-Integrated Computing (MIC) and OMG's Model-Driven Architecture (MDA)) emphasize the use of models at all stages of system development. They have placed model-based approaches to software development into focus. Model transformations appear in many, different situations in a model-based development process. (4 credits)

Service-Oriented Systems

BMEVIAUM208

Dr. Sándor Juhász, Gábor Imre

The subject deals with the different aspects of service-oriented sofware development. The main discussed problems are related to implementing loosely coupled systems. The SOA (Service-Oriented Architecture) paradigm poses continous challenges for software engineers and business analysts. The goal of the subject is to introduce the organizational and technical principles and solutions of the service-oriented architectures. The SOA-based business process management is emphasized along with management and governance issues. (4 credits)

Integrated Information Systems

BMEVIAUM209

Dr. Sándor Juhász

During this course the most important design and implementation aspect of the integrated information systems (enterprise information systems) are presented. The emphasis is put on system integration on data, component, application and workflow level. We handle the high level issues of data storing and processing and management (transaction processing, database interconnection, data cleaning, data warehouses, multi dimensional databases, OLAP). The most frequently used low level distribution and integration architectures (Peer2Peer, SMP, NUMA, Cluster and Supercomputer Systems) and their programming methods will also be presented. The student will learn the basics of middleware integration methods (RPC, transaction processing, message oriented middleware, object and component based architectures and application servers) as well as gain an overview real-life middleware software products. The next part contains the introduction to the most current Internet related integration technologies (XML, XSLT, SOAP, UDDI, Web Services) as well as group work related issues such as document sharing and portal building. The final part of the IIS course deal with distributed development in teams (Source Control Systems) and with the management of information systems. (4 credits

Quality Management

BMEGT20M002

Dr. János Kövesi, Dr. Zsuzsanna Eszter Tóth

Place and role of Quality Management systems in managing companies and other institutions. Introduction of quality management philosophies and quality schools (USA, Japan, EU). Most important features and characteristics of quality management systems in the production-oriented companies. Principles of Quality Management systems in the view of ISO 9000:2000 series of standard. Principles of Total Quality Management. Differences of TQM philosophy between production-oriented companies and service companies. The principle and methods of costumer focus. Identifying key processes. Overview of continuous improvement. Measuring performance. Methods of continuous improvement. Principle and methods of employee empowerment. Role of leaders in

TQM systems. Principle and application of EFQM model in order to improve continuously the overall performance of companies. (2 credits)

Argumentation, Negotiation, Persuasion

BMEGT41MS01

Dr. Tihamér Margitay, Dr. János Tanács, Dr. Gábor Zemplén

Arguments are important in business for two reasons. Decisions between alternatives are based on what reasons we have for and against them; and our point prevails according to the quality and persuasive power of our reasoning. Reasoning is central to decision-making and to having our point accepted. Students learn to analyze, evaluate and criticize persuasive arguments and they also familiarize themselves with the basic tools of negotiating on behalf of their interests. The objective of the course is to help participants to (1) make better decisions (2) work out better options for agreement (3) recognize the tools presented on the course (4) develop more persuasive arguments for their position (5) write clearer and more persuasive reports, proposals etc. (2 credits)

Investments

BMEGT35M004

Dr. Mihály Ormos

The theory of Homo oeconomicus. Utility function. Risk aversion. The role of financial markets. Return calculation and the properties of stock returns. Portfolio theory and the equilibrium of prices on the capital markets (CAPM). Passive portfolio management and the hypothesis of capital market efficiency, the weak form, the semi-strong form and the strong form of markets efficiency. Anomalies of asset pricing. Multifactor equilibrium models (FF). Arbitrage pricing theory (APT). Active portfolio management. Principles of market microstructure. Principles of behavioural finance: heuristic biases, framing effect, and inefficient markets. Investors' behaviour. Remaining puzzles of investment theory. (2 credits)

Management Accounting

BMEGT35M005

Dr. Ágnes Laáb

In the subject the students receive managerial and practice oriented knowledge concerning the traditional cost accounting and the responsibility based accounting principles by learning the methodology, the procedure and settlement of financial transactions . The following topics are included: (1) role of management accounting in corporate governance, (2) expansion of traditional management accounting and its limitations, (3) nature and behaviour of expenses, (4) cost accounting, traditional calculation methods, (5) assets of cost responsibility management, (6) cost responsibility management, (7) economical calculations, standard costing, variance analysis, (8) budgeting, zero based budgeting, (9) job costing, process costing and activity based costing. (2 credits)

System Development Specialization

System Optimization

BMEVISZM117

Dr. Dávid Szeszlér

Basic concepts of linear programming, Farkas lemma, duality. Integer programming, total unimodularity, applications to matchings in bipartite graphs and network flows. Basic notions of matroid theory, duality, minors, direct sum, sum. Algorithms for matroids. Matroids and graphs, linear representation, geometrical representation. Tutte's theorems. Approximation algorithms (set cover, Steiner-trees, travelling salesman problem). Scheduling algorithms (list scheduling, the algorithms of Hu and Coffman and Graham). Engineering applications: design of reliable networks, design of very large scale integrated (VLSI) circuits, the classical theory of electric networks, rigidity of frameworks. (4 credits)

Mathematical Logics + Applied Algebra

BMETE90MX42

Dr. Miklós Ferenczi, Dr. Gábor Sági, Dr. András Simon, Dr. Lajos Rónyai

Mathematical Logics: Formal languages. The language of first order logic. Meta- and object languages. Formalizing sentences. Logical semantics building on set theory. Structures, truth. Consequences. Applications in the Artificial Intelligence. Proof theory. Axiomatizing models. Deduction and refutation systems. Analytic trees, resolution. Consistency and decidability of theories. Proving independency. The elements of logic programming. Mechanical proofs. On the connection of semantics and proof theory, completeness of first order logic. Model method. Incompleteness theorems, on the limits of Logic. On the connection of Logic and Algebra. Non-standard analysis. Introductions of the concept of infinitisemal. Complexity theory, logical characterizations. Applied Algebra: Linear space, subspace, dimension, basis. Linear map, kernel, image, rank, operations with them. Matrices. Determinants, Eigenvalues and eigenvectors. Diagonalization, spectral decomposition. Euclidean spaces, symmetric, self adjoint, unitary, normal, projector operators and their matrices. Jordan normal form. Nonnegative matrices, Frobenius-Perron theorems. Inequalities for the spectral radius. Stochastic matrices. Singular value decomposition, existence, uniqueness, computation, Eckart-Young theorem, applications (least squares method, pseudoinverses, solving homogeneous linear systems). QR-decomposition. Some notable computational applications of linear algebra (indexing with vector spaces, error correcting codes, secret sharing, ranking pages in the internet).Existence proofs and randomness: Erdős' method through examples (2-coloring of hypergarphs, Ramsey numbers) with algorithmic aspects. Turán's theorem. Derandomization. Lovász's local lemma and applications. Analysis of randomized algorithms (expected time of quicksort, Rabin-Miller primality test, Schwartz-Zippel lemma and applications, pattern matching, treaps, minimum spanning trees, computing planar autopartitions and convex hulls). Random walks and algorithms, ranking pages in the internet. Randomness and complexity classes (RP, Las Vegas, interactive protocols, IP, BPP, RL with examples, IP=PSPACE). Zero knowledge proofs. Random graphs (Erdős-Rényi model, Albert-Barabási model). Properties of large networks. (4 credits)

Formal Methods

BMEVIMIM100

Dr. István Majzik, Dr. Tamás Bartha

As the complexity of information systems and the costs of potential failures are increasing, it becomes more and more important to prove that the design of the critical system components is correct. One of the typical solutions for the challenge of provenly correct design is the application of formal methods. Mathematically precise modelling and analysis allow the early verification of design choices, the proof of correctness with respect to several requirements, and then the automated software or hardware synthesis. The subject provides an overview of the formal background needed for the elaboration and analysis of the formal models of IT systems and components: the modelling paradigms, the widely used formal modelling languages, and the analysis and simulation based verification techniques. The subject demonstrates the application of formal methods in the field of system-level modelling, software design, verification and synthesis. (4 credits)

Data Security

BMEVIHIM102

Dr. Levente Buttyán, Dr. István Vajda, Boldizsár Bencsáth

Protecting the integrity and confidentiality of data stored and communicated in modern infocommunication systems, as well as protecting those systems themselves against malicious attacks are very important requirements today. The commonly used tools for addressing the problem are based on cryptographic and network security mechanisms. The objective of this course is to give an introduction to these fields. The course covers the following topics: cryptographic algorithms (symmetric and asymmetric key ciphers, hash functions, digital sinatures), authentication and key establishment protocols, network security protocols (SSL, IPSec, WiFi security, etc.), access control principles, firewalls and intrusion detection systems, Denial-of-Service attacks, software security (buffer overflow attacks), malware, spam, botnets. (4 credits)

Languages and Automata

BMEVISZM104

Dr. Katalin Friedl

Finite automata (deterministic and non-deterministic), regular expressions, regular languages, closure properties, pumping lemma for regular languages. Push-down automata, context-free languages, Chomsky and Greibach normal forms, closure properties, pumping lemma for context-free languages. Turing-machines, recursive and recursively enumerable languages, linear bounded automata. Parsers for context-free languages. Time- and space-complexity: P, PSPACE, EXPTIME language classes. Non-deterministic Turing machines, NP language class, NP completeness, NP-complete languages. Kolmogorov complexity: incomputability, Kolmogorov randomness. (4 credits)

Software Architectures

BMEVIAUM105

Dr. Hassan Charaf

This course discusses the software architectures related to the most popular applications, research topics and developments. The course introduces the distributed and highly reliable system architectures and technologies. The course summarizes the most important knowledge related to the object-oriented, component-based and service-based architectures. The course highlights the systematic software reuse and, based on software architectures related research results, analyzes the importance of loosely coupled systems. The goal of the course is to systemize and transfer the knowledge related to the mentioned topics. In the practice of enterprise system development the multi-layer, object-oriented platforms (e.g. Java, .NET) prevail. According to the experiences, these tools and technologies are able to efficiently support system development, but without the appropriate architecture related knowledge, we can face with several problems. The source of the errors and unsuccessful development is the fact that software developers do not have comprehensive architecture knowledge. Based on it, the second goal of the course is to prepare students for developing enterprise systems. (4 credits)

Engineering Management

BMEVITMM112

Dr. Gyula Sallai, Dr. Imre Abos, Dr. Zsuzsanna Kósa, Dr. Gábor Szücs

Generic and ICT (information and communication technology) specific engineering management in the knowledge economy: principles, methods and real examples for engineering students. Engineering management roles, situations and tools. Strategic, organization and knowledge management. Business and transformation strategies. Complex engineering decision problems. Culture and change management of organizations. Technology, innovation, product and business process management. Models and methods for technology planning, innovation financing, product development, customer relation and risk management. The role of ICT in value creation. Regulatory principles, technical and market regulation of the ICT sector. Ex-ante and ex-post regulation, deployment of competition and ICT convergence, effective management of radio frequencies and numbering resources. (4 credits)

Object-Oriented Development

BMEVIIIM140

Dr. Balázs Goldschmidt, Dr. Zoltán László, Balázs Simon

Architectures, architectural patterns. Component-based design and development, classical example: UNIX. Middleware functionality, standards and services. Idea of RPC (remote procedure call), general problems and solutions, common patterns (proxy, callback, factory, mobile agents). Java RMI (interfaces, classes, security and code migration). Common Object

Parallel and Grid Systems

BMEVIIIM141

Dr. Imre Szeberényi

The parallelization has historically played a vital role in addressing the performance demands of high-end engineering and scientific applications. It has now moved to a main strategy of current hardware and overall systems trends. All computer systems - embedded, game and graphics controllers, high-end supercomputers, and large-scale data centres - are being built using components with an increasing number of processing elements (nodes, chips, cores). The goal of this course to introduce the foundation of parallel computing including the principles of parallel algorithm design, analytical modelling of parallel programs and architectures, PVM and MPI programming models the basic elements of Grid and cloud computing. (4 credits)

Software Testing

BMEVIIIM142

Dr. Katalin Balla

Defining the software testing. Scope and object of testing. Testing and software quality. The basic testing process. Testing in the software development process. Testing in waterfall model, incremental development, spiral model, V-model. Testing in ISO 12207 standard. Test types. Component test, integration test, system test, acceptance test. Testing techniques: static and dynamic testing, black-box-testing, white-box testing. Techniques for different test types. Managing the testing process. Testing OO systems. Testing tools. (4 credits)

Metamodels in Software Design

BMEVIIIM228

Dr. Zoltán László, Balázs Simon

Main concepts of the Model Driven Software Development (MDSD). Role and perspectives of the MDSD in the software engineering. Metamodels and transformations. Layered and multidimensional modeling. Meta Object Facility (MOF) as the basis of metamodeling. The Object Constraint Language (OCL). Basic principles of the Model Driven Architecture (MDA). The MDA standards, and its implementations. Template languages. Simple compiler technologies. Compilers and its models. Model-transformations. Aspects and models. Invasive program development. Managing inherited codes, reverse engineering, re-engineering, refactoring. Improving software quality by model-based transformations. Applying development tools. (4 credits)

Software Quality

BMEVIIIM229

Dr. Katalin Balla

Defining software quality. Product-oriented approach of software quality. Boehm and McCall models. Standard ISO 9126. Process- oriented approach of software quality. Standard ISO 9001:2000. The history, development, structure, usage of the standard. Software process improvement. Staged models. CMM. Continuous models. SPICE / ISO 15504. Integrated models. CMMI. PSP, TSP, other models. Management of software development projects. PM methodologies. tracking, monitoring. Importance of estimation. Risk management in software project. The human factor in software projects. Team-members. Management styles. Software measurement - basic concepts, metrics used. Function point counting. Prerequisites of a successful software process improvement program. (4 credits)

Laboratory for Grid and Object Oriented Development

BMEVIIIM230

Dr. Balázs Goldschmidt, Dr. Imre Szeberényi, Dr. Zoltán László

Using and evaluating GRID applications. Introduction of a simple parallel application. Implementing a complex parallel application. Developing distributed applications with Java RMI. Developing distributed application with CORBA in Java or C++. Developing distributed applications using Web Services in C#, Java or C++. Accessing and using object-oriented databases in Java (objectstore practice). Implementing a simple Java application on RMI for demonstrating the agent concept, implementing agency's SecurityManager, applying security policies. Implementing a simple servlet in J2EE environment (Glassfish, JBoss, etc). Enhancing the servlet with database handling (JDBC or hybernate). (4 credits)

Laboratory for Software Testing and Quality

BMEVIIIM308

Dr. Katalin Balla, Gábor Bóka

Identification of the basic processes executed at a software company. Definition of processes used in software development, according to standard ISO 9001. Choosing a group of processes for improvement, based on the business goals of the organization. Improvement on the chosen processes using CMMI model. Defining software product quality attributes and verifying their values using software testing. Management of testing (planning tests, developing test specifications, test scripts, defining test data, executing tests, monitoring and controlling the testing process, improving the testing process). Testing methods in practice. (4 credits)

IT Security and Management

BMEVIIIM274

Dr. Károly Kondorosi, Szabolcs Szigeti, Gábor Bóka

The course gives an introduction to the basic IT security concepts (threat, security, countermeasure, risk, etc.). It describes the IT security models and the IT security principles (CIA, PreDeCo, etc.). Logical, physical and administrative controls are introduced. Technical aspects and implementations of the important controls are shown (cryptography, firewalls, authentication, etc.). Product based IT security standards (TCSEC, ITSEC, Common Criteria), risk management approaches (CRAMM, ITB 8), organizational IT security approaches (ISO/IEC 17799, ISO/IEC 27001, COBIT, ITIL) and the audit principles and process (ISO 19011) are detailed. Theoretical and practical IT service management is introduced (incident management, problem management, change management, continuity management, access management). (4 credits)

SOA-Based Integration

BMEVIIIM371

Dr. Károly Kondorosi

Typical requirements of developing integrated services. Legal, organizational, cultural context; user requirements, legacy systems, available resources; functional and non-functional requirements. Interoperability, uniformity and standards on structural, semantic, and syntactic levels. Service-oriented architectures. Loosely coupled cooperation with web-services. WS-* standards. WSDL. Higher level functionality: system- and process-management. Persistency-requirements. Secure communication (MQ systems). Enterprise Service Bus (ESB), functionality, infrastructural services, management services. Development methodologies and frameworks. Model driven development. Formal process description, BPEL. Consistency checking of business processes. Controlled SOA. SOA project management, roadmap. Actual topics from development of the Hungarian e-Government services. (4 credits)

Linux-Based System Development

BMEVIIIM339

Dr. Imre Szeberényi

The goal of this course to introduce the Linux based system development for embedded industrial applications. The main topics are: Software architecture of Linux systems. Device drivers, Embedded systems, flash loaders. Development tools, debuggers, emulators, integrated development environments. Test methods. Version control systems, subversion, Wiki, Trac. Logging systems and methods syslog, klog. Benchmarking and profiling: gprof, oprofile. Qt windowing framework in embedded environment. Development with Qt. Qtopia and Opie projects. System integration and embedded Linux systems. Components of OpenEmbeded, EmDebian, Montavista frameworks. (4 credits)

Quality Management

BMEGT20M002

Dr. János Kövesi, Dr. Zsuzsanna Eszter Tóth

Place and role of Quality Management systems in managing companies and other institutions. Introduction of quality management philosophies and quality schools (USA, Japan, EU). Most important features and characteristics of quality management systems in the production-oriented companies. Principles of Quality Management systems in the view of ISO 9000:2000 series of standard. Principles of Total Quality Management. Differences of TQM philosophy between production-oriented companies and service companies. The principle and methods of costumer focus. Identifying key processes. Overview of continuous improvement. Measuring performance. Methods of continuous improvement. Principle and methods of employee empowerment. Role of leaders in TQM systems. Principle and application of EFQM model in order to improve continuously the overall performance of companies. (2 credits)

Argumentation, Negotiation, Persuasion

BMEGT41MS01

Dr. Tihamér Margitay, Dr. János Tanács, Dr. Gábor Zemplén

Arguments are important in business for two reasons. Decisions between alternatives are based on what reasons we have for and against them; and our point prevails according to the quality and persuasive power of our reasoning. Reasoning is central to decision-making and to having our point accepted. Students learn to analyze, evaluate and criticize persuasive arguments and they also familiarize themselves with the basic tools of negotiating on behalf of their interests. The objective of the course is to help participants to

(1) make better decisions (2) work out better options for agreement (3) recognize the tools presented on the course (4) develop more persuasive arguments for their position (5) write clearer and more persuasive reports, proposals etc. (2 credits)

Investments

BMEGT35M004

Dr. Mihály Ormos

The theory of Homo oeconomicus. Utility function. Risk aversion. The role of financial markets. Return calculation and the properties of stock returns. Portfolio theory and the equilibrium of prices on the capital markets (CAPM). Passive portfolio management and the hypothesis of capital market efficiency, the weak form, the semi-strong form and the strong form of markets efficiency. Anomalies of asset pricing. Multifactor equilibrium models (FF). Arbitrage pricing theory (APT). Active portfolio management. Principles of market microstructure. Principles of behavioural finance: heuristic biases, framing effect, and inefficient markets. Investors' behaviour. Remaining puzzles of investment theory. (2 credits)

Management Accounting

BMEGT35M005

Dr. Ágnes Laáb

In the subject the students receive managerial and practice oriented knowledge concerning the traditional cost accounting and the responsibility based accounting principles by learning the methodology, the procedure and settlement of financial transactions . The following topics are included: (1) role of management accounting in corporate governance, (2) expansion of traditional management accounting and its limitations, (3) nature and behaviour of expenses, (4) cost accounting, traditional calculation methods, (5) assets of cost responsibility management, (6) cost responsibility management, (7) economical calculations, standard costing, variance analysis, (8) budgeting, zero based budgeting, (9) job costing, process costing and activity based costing. (2 credits)

Description of M.Sc. Subjects in Electrical Engineering

Embedded Systems Specialization

Physics 3

BMETE11MX01

Dr. György Mihály, András Sólyom

Quantum Mechanics: Experimental antecedents.The Wave function.Time dependent and time independent Schrödinger's equation.Simple problems. Tunneling. Angular momentum. The hidrogen atom. Perturbations. The H. atom. Formal quantum mechanics. Operator calculus. Commutators, canonical conjugates and uncertainity relations. Harmonic oscillator. Selection rules and spectrum of H. The He atom, the independent particle approximation. The exclusion principle. Periodic system of elements. Molecules. molecular orbitals, chemical bonding, H-H bond. Molecules of many atoms. Orbital hybridisation. Conjugated molecules, cyclic conjugated molecules.Rotation and vibration of molecules. Franck-Condon principle, Rayleigh & Raman scattering. Classical and quantum statistics. Solid State Physics: The solid state. Short and long range order.Crystallography. Bonds in crystals..Real and point lattices..Symmetries and Unit cells. The reciprocal lattice. Bravais lattices. X- ray diffraction methods. Electrical conductivity. Drudel model. Sommerfeld model. Band theory of solids.Work function.. Contact potential. The adiabatic principle. Electrons in periodic lattices. Charge carrier characteristics. Crystal momentum. Effective mass.Band theory. The tight binding model. Intrinsic and doped semiconductors. Semiconductor structures. Superconductivity. Thermal properties. The transport equation. Onsager relations. Quantum theory of lattice vibrations. Optical properties. Magnetic and dielectric properties of solids. (5 credits)

Measurement Theory

BMEVIMIM108

Dr. Gábor Péceli

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

Software Design

BMEVIIIM110

Dr. Zoltán László

Software engineering. Historical background. Software crisis. Concept of the technology. Software as a product. Software quality aspects. Software development process. Life cycle models. Software project planning. Riscs, Simple cost models. Scheduling. Requirement analysis and definition. Specification: functional (data-flow modelling), structural (data dictionary, entity relationship model), and dynamical (state transition model) views. Object oriented software development: Object concepts. UML notation: UML structure diagrams, (class and package diagrams), Use-cases, Sequence, communication and activity diagrams. Design concepts: cohesion, coupling. Quality of design. Object oriented design patterns. Verification and validation. Testing. Configuration management. (4 credits)

Advanced Linear Algebra + Stochastics

BMETE90MX30

Dr. Lajos Rónyai, Dr. Horváth Erzsébet, Dr. Bálint Tóth, Dr. András Vetier, Dr. Tamás Szabados, Dr. Balázs Székely

Advanced Linear Algebra: Overview of basic notions of linear algebra, linear space, dimension, linear map, rank, determinant, eigenvalue and eigenvector, characteristic polynomial. The Jordan normal form, functions of matrices, systems of linear differential equations, applications. Euclidean spaces, special matrices. Moore-Penrose inverse and its application to solving matrix equations. Singular value decomposition(SVD), polar decomposition, QR-decomposition. Eigenvalues, singular values, matrix norms, Gershgorin circles, inequalities for the spectral values. Convexity, convex optimization, duality, ellipsoid method, linear matrix inequalities. Nonnegative matrices, Frobenius-Perron theorem, stochastic matrices. Some important applications of linear algebra. Stochastics: Review of basic probability theory: random

variables, distribution, expectation, covariance matrix, important types of distributions. Generating and characteristic functions and their applications: limit theorems and large deviations (Bernstein inequality, Chernoff bound, Kramer's theorem). Basics of mathematical statistics: samples, estimates, hypotheses, important tests, regressions. Basics of stochastic processes: Markov chains and Markov processes. Markov chains with finite state space: irreducibility, periodicity, linear algebraic tools, stationary measures, ergodicity, reversibility, MCMC. Chains with countable state space: transience, recurrence. Application to birth and death processes and random walks. Basics of continuous time Markov chains: Poisson process, semigroups. Weakly stationary processes: spectral theory, Gauss processes, interpolation, prediction and filtering. (6 credits)

Nanoscience

BMEVIETM114

Dr. Gábor Harsányi, Dr. László Jakab, László Milán Molnár

Basic terms in nanoscience (nanosize, quantum effects, diffusion, scattering phenomena, transport, bottom-up and top-down techniques, self-assembly and self-organization). Carbon nanostructures (crystal structure, solid state physics, macroscopic properties - mechanical, electric, microscopic background of macro properties). Applications of carbon (building blocks for electronics, composites, grapheme, nanotubes). 1,2 and 3D nanostructures, applications in photonics (laser diodes, transistor, magnetic coatings, sensors). Special material systems (biomolecules, DNA, proteins). Tools of observation, experimental and metrology (microscopes - optical microscope, scanning electron microscope, transmission electron microscope, scanning probe microscopes, near-field optical microscope) (5 credits)

Engineering Management

BMEVITMM112

Dr. Gyula Sallai, Dr. Imre Abos, Dr. Zsuzsanna Kósa, Dr. Gábor Szücs

Generic and ICT (information and communication technology) specific engineering management in the knowledge economy: principles, methods and real examples for engineering students. Engineering management roles, situations and tools. Strategic, organization and knowledge management. Business and transformation strategies. Complex engineering decision problems. Culture and change management of organizations. Technology, innovation, product and business process management. Models and methods for technology planning, innovation financing, product development, customer relation and risk management. The role of ICT in value creation. Regulatory principles, technical and market regulation of the ICT sector. Ex-ante and ex-post regulation, deployment of competition and ICT convergence, effective management of radio frequencies and numbering resources. (4 credits)

System Architectures

BMEVIMIM149

Dr. Béla Fehér

The main goal of the subject to present the main modules of the design platform of embedded system architectures. The components are discussed in an application oriented way, with comparison and selection information. The focus is on the interfacing to the physical processes, and other information systems. The first part is introducing the signal conditioning and input stages, including the programmable gain, A/D and isolating stages. The course presents the typical sensor I/O solutions and the necessary interfacing circuits, including the intelligent TEDS solutions also. The main part of the lecture is devoted to the System on a Chip (SoC) architectures and their composition. A small review of the main controller architectures presents the most important families, like RISC, DSP, VLIW type of processors. The on chip communication bus architecture are evaluated deeply, including the AMBA, CoreConnect and Wishbone systems. The concept of NoC is demonstrated by real word application examples. The wireless sensor node systems are analyzed from the communication and energy efficiency point. All components and processes are evaluated from the power requirement point of view. The final part of the subject is introduces the modern test and development technologies, including the in system debugging methodologies. (4 credits)

Software Technology for Embedded Systems

BMEVIMIM150

Dr. Tamás Kovácsházy

This subject deals with the modern methods and technologies applied during the development of embedded software. The subject assumes the possession of basic software development background from the students, such as C language programming and object-oriented programming. The subject aims to extend this fundamental knowledge with the specific knowledge and skills required to develop embedded software, and prepare the students for a systematic software development. It presents the methods and technologies that make possible to develop high-quality embedded software. The discussed modern methods and technologies include, among others, design patterns, parallel programming, event-driven and time-driven programming, specific software architectures, object-oriented software development, model-driven software development, embedded databases, declarative systems, and 4GL development environments. (4 credits)

Real-Time and Safety-Critical Systems

BMEVIMIM151

Dr. Tamás Dabóczi, Dr. István Majzik

The first part of the course deals with embedded systems having a strong requirement of guaranteed reaction to an external event (real time systems). In such systems exceeding the time limit might have catastrophic causes. The course gives an insight into the specialties of real time systems and into their design principles. It will deal with specialties of software design, scheduling algorithms, scheduling analysis, timing problems in sensor networks (synchronization of local clocks), and real time embedded operating systems. The second half of the subject deals with embedded systems that are safety critical, i.e., the operation of the system may contribute to hazards or (in certain operational conditions) accidents. These systems are typically found in medical devices, vehicle control or industrial process control applications. The lectures present the peculiarities of the system development process (that is often regulated by domain-specific standards), including the methods and techniques of the architecture design, the dependability and safety analysis, and the systematic testing and debugging. (4 credits)

Information Processing

BMEVIMIM237

Dr. István Kollár, Dr. Béla Pataki

This subject deals with characterization, extraction and complex processing of information (measured signals, measured quantities, etc.), collected about the surrounding world. Physical quantities are related to the quantities stored in the computer, possibilities of information extraction are discussed. In relation to embedded systems, fast methods of partial information extraction are also treated. These methods are sometimes autonomous, sometimes human controlled by humans. Students accomplished this subject should be (1) able to evaluate the information included and extractable

from the measured signals, (2) aware of basic engineering descriptions of signals and systems, methods of modelling, (3) capable to use basic computer-based methods of information extraction, (4) able to analyse existing systems, by examining modelling and representation errors, efficiency of information extraction, run time, etc., (5) capable to design such systems, (6) able to understand, handle and use information from heterogenious sensor systems. (4 credits)

Embedded System Design

BMEVIMIM238

Dr. Endre Selényi, Mr. Balázs Scherer, Dr. István Zoltán

Methods of system design: Waterfall model, spiral model, V model. Requirement analysis. Hardware/Software codesign. Design aspects for embedded systems: typical hardware structure, selections of HW/SW components, energy conscious design. Electromagnetic compatibility: emission and immunity, mains filter, input/output filters, passive and active shielding. Construction of components and devices of embedded systems. Overview of European standards for safety, safety analysis, special design methods to assure the required level of safety. A case study: design of a complex embedded system. Requirements analysis, analysis of the technological process, elaboration of the system architecture. Elaboration of automated test setups, virtual instrumentation. Standard Commands for Programmable Instrumentation (SCPI), embedding measurement equipment via GPIB bus. (4 credits)

Laboratory for System Architectures

BMEVIMIM239

Dr. Béla Fehér

The aim of the measurements is to learn in detail some information processing algorithms and their software tools frequently used in embedded systems. During the measurements the students utilize the elementary signal processing tools (e.g. averaging, filtering, discrete Fourier transform), but the aim is the development and investigation of complex systems. The subject consists of 5 measurements, each one is 8 hours long. The measurements are based on signal processing boards (equipped by Analog Devices DSPs), and the "mitmót", the modular microcontroller-based platform developed at the Department of Measurement and Information Systems. Most of the exercises are based on real physical systems or their model. The software background is provided by LabView, Matlab, and the Visual DSP++ development system. (4 credits)

Laboratory for Information Processing

BMEVIMIM322

Dr. László Sujbert

The aim of the measurements is to learn in detail some information processing algorithms and their software tools frequently used in embedded systems. During the measurements the students utilize the elementary signal processing tools (e.g. averaging, filtering, discrete Fourier transform), but the aim is the development and investigation of complex systems. The subject consists of 5 measurements, each one is 8 hours long. The measurements are based on signal processing boards (equipped by Analog Devices DSPs), and the "mitmót", the modular microcontroller-based platform developed at the Department of Measurement and Information Systems. Most of the exercises are based on real physical systems or their model. The software background is provided by LabView, Matlab, and the Visual DSP++ development system. (4 credits)

Interfacing Embedded Systems to Information Systems

BMEVIMIM343

Dr. Tamás Kovácsházy

The subject aims to introduce technologies applied to interface embedded systems and information systems. Therefore, the subject presents the modern communication interfaces of embedded systems in detail, including their hardware and software architecture, their implementations and their corresponding resource requirements. As examples, USB, IEEE802.x, IEEE802.15.x, TCP/IP and their higher layer application protocols (such as CORBA, DCOM, HTTP, XML, web services, SNMP, FTP) are used. In addition, the system architecture and components of complex information systems consisting embedded devices are explored extensively. (4 credits)

High-Performance Microcontrollers

BMEVIMIM342

Balázs Scherer

The main goal of the subject is to introduce the new era of 32 bit microcontrollers to students, who are already familiar with 8bit micros. The lectures briefly overview the main differences between 8bit and 32bit micros. New peripherals like USB, Ethernet MAC, DMA, which are not used in 8 bit micros are also introduced. The software development process of such hard performance micros is also demonstrated during the lectures. Students successfully finishing this subject will be able to: (1) be familiar and understand the trends of the last 10 years of microcontroller market, (2) have basic knowledge of some of the most important 32bit microcontroller core families like ARM, MIPS, PowerPC; got detailed knowledge on ARM cores ARM7, ARM9 and ARM Cortex variants. (4) know the main internal function block of a 32bit microcontroller, (5) got overview on the new sophisticated peripheral types of 32bit microcontrollers like USB, Ethernet, (6) be familiar with embedded real-time kernels like FreeRTOS or eCos, (7) develop applications with 32bit microcontrollers. (4 credits)

Digital Filters

BMEVIMIM278

Dr. László Sujbert

The subject deals with the analysis, design and implementation of linear, time-invariant discrete-time filters. Application of digital filters requires deep knowledge of many theoretical and practical details. These problems are usually not discussed in detail in other courses. The aim of the subject is to give the most detailed review of the topic, from the mathematical basics to the programming methods. Although the learning of the theoretical background is inevitable, it is also an important goal to deliver practical skills. Therefore the review of the corresponding Matlab functions, and the digital signal processor based support of the implementation are also included in the program of the subject. Students fulfilled the requirements of the subject are familiar with the possibilities of the application of digital filters; they can carry out the complete analysis of a filter with given transfer function; they know the most important design methods for finite and infinite impulse response filters. Having the high-level theoretical knowledge the students can use the high-level software support (Matlab functions); they can select the appropriate structure for the implementation. The students fulfilled the course are able to implement digital filters, especially using digital signal processors. (4 credits)

Quality Management

BMEGT20M002

Dr. János Kövesi, Dr. Zsuzsanna Eszter Tóth

Place and role of Quality Management systems in managing companies and other institutions. Introduction of quality management philosophies and quality schools (USA, Japan, EU). Most important features and characteristics of quality management systems in the production-oriented companies. Principles of Quality Management systems in the view of ISO 9000:2000 series of standard. Principles of Total Quality Management. Differences of TQM philosophy between production-oriented companies and service companies. The principle and methods of costumer focus. Identifying key processes. Overview of continuous improvement. Measuring performance. Methods of continuous improvement. Principle and methods of employee empowerment. Role of leaders in TQM systems. Principle and application of EFQM model in order to improve continuously the overall performance of companies. (2 credits)

Argumentation, Negotiation, Persuasion

BMEGT41MS01

Dr. Tihamér Margitay, Dr. János Tanács, Dr. Gábor Zemplén

Arguments are important in business for two reasons. Decisions between alternatives are based on what reasons we have for and against them; and our point prevails according to the quality and persuasive power of our reasoning. Reasoning is central to decision-making and to having our point accepted. Students learn to analyze, evaluate and criticize persuasive arguments and they also familiarize themselves with the basic tools of negotiating on behalf of their interests. The objective of the course is to help participants to (1) make better decisions (2) work out better options for agreement (3) recognize the tools presented on the course (4) develop more persuasive arguments for their position (5) write clearer and more persuasive reports, proposals etc. (2 credits)

Investments

BMEGT35M004

Dr. Mihály Ormos

The theory of Homo oeconomicus. Utility function. Risk aversion. The role of financial markets. Return calculation and the properties of stock returns. Portfolio theory and the equilibrium of prices on the capital markets (CAPM). Passive portfolio management and the hypothesis of capital market efficiency, the weak form, the semi-strong form and the strong form of markets efficiency. Anomalies of asset pricing. Multifactor equilibrium models (FF). Arbitrage pricing theory (APT). Active portfolio management. Principles of market microstructure. Principles of behavioural finance: heuristic biases, framing effect, and inefficient markets. Investors' behaviour. Remaining puzzles of investment theory. (2 credits)

Management Accounting

BMEGT35M005

Dr. Ágnes Laáb

In the subject the students receive managerial and practice oriented knowledge concerning the traditional cost accounting and the responsibility based accounting principles by learning the methodology, the procedure and settlement of financial transactions . The following topics are included: (1) role of management accounting in corporate governance, (2) expansion of traditional management accounting and its limitations, (3) nature and behaviour of expenses, (4) cost accounting, traditional calculation methods, (5) assets of cost responsibility management, (6) cost responsibility management, (7) economical calculations, standard costing, variance analysis, (8) budgeting, zero based budgeting, (9) job costing, process costing and activity based costing. (2 credits)

Infocommunication Systems Specialization

Physics 3

BMETE11MX01

Dr. György Mihály, András Sólyom

Quantum Mechanics: Experimental antecedents.The Wave function.Time dependent and time independent Schrödinger's equation.Simple problems. Tunneling. Angular momentum. The hidrogen atom. Perturbations. The H. atom. Formal quantum mechanics. Operator calculus. Commutators, canonical conjugates and uncertainity relations. Harmonic oscillator. Selection rules and spectrum of H. The He atom, the independent particle approximation. The exclusion principle. Periodic system of elements. Molecules. molecular orbitals, chemical bonding, H-H bond. Molecules of many atoms. Orbital hybridisation. Conjugated molecules, cyclic conjugated molecules.Rotation and vibration of molecules. Franck-Condon principle, Rayleigh & Raman scattering. Classical and quantum statistics. Solid State Physics: The solid state. Short and long range order.Crystallography. Bonds in crystals..Real and point lattices..Symmetries and Unit cells. The reciprocal lattice. Bravais lattices. X- ray diffraction methods. Electrical conductivity. Drudel model. Sommerfeld model. Band theory of solids.Work function.. Contact potential. The adiabatic principle. Electrons in periodic lattices. Charge carrier characteristics. Crystal momentum. Effective mass.Band theory. The tight binding model. Intrinsic and doped semiconductors. Semiconductor structures. Superconductivity. Thermal properties. The transport equation. Onsager relations. Quantum theory of lattice vibrations. Optical properties. Magnetic and dielectric properties of solids.(5 credits)

Communication Theory

BMEVIHVM107

Dr. István Frigyes, Dr. János Bitó

Widespread concepts and tasks of communication can be described with a more or less uniform theory. The aim of this subject is to introduce basic concepts and mind of this theory. It deals with basic concepts of decision- and estimation theory, of information theory and of digital communication. Application of these concepts is illustrated by examples taken from radio communication and optical communication. Main topics discussed are: Mathematical introduction: basic notions of stochastic processes; the complex envelope. Basics of decision theory and estimation theory. Transmission of digital and analog signals over analog channels. Basics of information theory. Properties of channels, channel coding, channel capacity. (4 credits)

Software Design

BMEVIIIM110

Dr. Zoltán László

Software engineering. Historical background. Software crisis. Concept of the technology. Software as a product. Software quality aspects. Software development process. Life cycle models. Software project planning. Riscs, Simple cost models. Scheduling. Requirement analysis and definition. Specification: functional (data-flow modelling), structural (data dictionary, entity relationship model), and dynamical (state transition model) views. Object oriented software development: Object concepts. UML notation: UML structure diagrams, (class and package diagrams), Use-cases, Sequence, communication and activity diagrams. Design concepts: cohesion, coupling. Quality of design. Object oriented design patterns. Verification and validation. Testing. Configuration management. (4 credits)

Combinatorial Optimization + Stochastics

BMETE90MX38

Dr. András Recski, Dr. Bálint Tóth, Dr. András Vetier, Dr. Tamás Szabados, Dr. Balázs Székely

Combinatorial Optimization: Basic concepts of linear programming, Farkas lemma, duality. Integer programming, total unimodularity, applications to matchings in bipartite graphs and network flows.Basic notions of matroid theory, duality, minors, direct sum, sum. Algorithms for matroids. Matroids and graphs, linear representation, Tutte's theorems. Approximation algorithms (set cover, Steiner-trees, travelling salesman problem). Scheduling algorithms (list scheduling, the algorithms of Hu and Coffman and Graham). Engineering applications: design of reliable networks, design of very large scale integrated (VLSI) circuits, the classical theory of electric networks. Stochastics: Review of basic probability theory: random variables, distribution, expectation, covariance matrix, important types of distributions. Generating and characteristic functions and their applications: limit theorems and large deviations (Bernstein inequality, Chernoff bound, Kramer's theorem). Basics of mathematical statistics: samples, estimates, hypotheses, important tests, regressions. Basics of stochastic processes: Markov chains and Markov processes. Markov chains with finite state space: irreducibility, periodicity, linear algebraic tools, stationary measures, ergodicity, reversibility, MCMC. Chains with countable state space: transience, recurrence. Application to birth and death processes and random walks. Basics of continuous time Markov chains: Poisson process, semigroups. Weakly stationary processes: spectral theory, Gauss processes, interpolation, prediction and filtering. (6 credits)

Photonic Devices

BMEVIETM113

Dr. László Jakab, László Molnár

Physical basics of photonics (optical properties and quantities, passive and active optical components). Light-emitting and light-sensing devices (non-coherent light sources and detectors, incandescent: luminescent lamps, light-emitting diodes, photodiodes, solar panels; coherent sources: solid-state lasers, laser diodes) Passive components and properties (optical glasses, crystals and polymers). Active optical components (modulators, deflectors, polarizers, filters, frequency converters, switches). Solitons in data transfer. Liquid crystals. Light-sensitive materials, compounds, and optical memory (silver-halogenides, data recording and reading, magneto-optics). Optical transfer and optical data processing (optical cables, image processing, sensors). (5 credits)

Engineering Management

BMEVITMM112

Dr. Gyula Sallai, Dr. Imre Abos, Dr. Zsuzsanna Kósa, Dr. Gábor Szücs

Generic and ICT (information and communication technology) specific engineering management in the knowledge economy: principles, methods and real examples for engineering students. Engineering management roles, situations and tools. Strategic, organization and knowledge management. Business and transformation strategies. Complex engineering decision problems. Culture and change management of organizations. Technology, innovation, product and business process management. Models and methods for technology planning, innovation financing, product development, customer relation and risk management. The role of ICT in value creation. Regulatory principles, technical and market regulation of the ICT sector. Ex-ante and ex-post regulation, deployment of competition and ICT convergence, effective management of radio frequencies and numbering resources. (4 credits)

Wireline and Wireless Transmission Technologies

BMEVITMM155

Dr. József Biró, dr. László Osváth

Characterization of transmission on wire. Distortions, possibility of duplex communication, echo cancellation. Attenuation of wireless links, two-path and multi-path fading. Moving transmitter/receiver, Doppler effect, Doppler spreading. Elements of optical networks. Transmission on fiber, attenuation, chromatic and polarization mode dispersion, nonlinear effects. Quality of signals, BER, Q-factor, SNR, OSNR. Modulation methods: real and complex PAM (CAP, QAM) systems. OFDM and DMT as robust and flexible modulation procedures. Bit allocation, signal processing. Compensation of dispersion, equalization methods. Pre-equalization. Error correcting algebraic coding. DFT over finite fields. Reed-Solomon codes. Correcting of erasures and symbol errors. Extensions. (4 credits)

Convergent Networks and Services

BMEVITMM156

Dr. Rolland Vida, Csaba Lukovszki

Network architectures. Infrastructural networks: fixed, wireless and mobile access networks; aggregation, metro, regional and provider backbone networks and their roles. Infrastructure-less networks; wireless mobile ad hoc networks (MANET), sensor networks, mesh networks, moving networks (NEMO), vehicular networks (VANET), opportunistic networking). End points and their characteristics; device, user, and service mobility; mobility models, nomadic networking. Convergence in the network; the concept of fixed-mobile convergence, horizontal and vertical handovers, next generation networks (NGN). Convergence at the end nodes. Multimode devices, Generic Access Network (GAN - UMA). Convergence in the services; the IP Multimedia Subsystem, SÍP signaling, Parlay/OSA. IPTV over wired and wireless access networks, VoIP connections in IMS systems, PSTN/VoIP gateway. (4 credits)

Network and Service Management

BMEVITMM157

Dr. Róbert Szabó

Introduction to network management: motivations, players and complexities in network management: technical, organizational and business. Cases studies in network management: ISP, enterprise and a service provider; overview of different management tools. Basics of network management: devices, management systems, management networks and management support organizations. The different dimensions of network management. Network management functions and reference models. Management information and modeling of management information. Communication patterns in network management. SNMPv1, v2, v3, RMON-1, RMON-2. CLI, syslog, netconf and netflow as management protocols. Scaling the network management problem: complexities, hierarchies and management styles. Policy based management. Service management and service level agreements. (4 credits)

Human-Computer Interaction

BMEVITMM224

Dr. Géza Németh

Introduction. Modalities between humans and the environment. Speech interfaces, speech communication. Visual interfaces; basic notions and methods of iterative design. User interface techniques; directives, golden rules. User interface principles and examples. Menu systems, text dialgue, graphical interface. Usability of websites; special user spaces (e.g.,

multimedia, groupware). Usability for everyone (W3C WAI). User interfaces on mobile devices; general principles, OS-related questions, modality-related problems. Evaluation of user interfaces; evaluation criteria and methods. Case studies. Presentation of practical tasks. (4 credits)

Network Planning

BMEVITMM215

Dr. Markosz Maliosz

Tasks, methods and algorithms for planning, design and configuration of core and access networks. Input and output of the planning, objectives of the design, cost function curves. Traffic descriptors, topologies and topology models, Optimization problems and algorithms, linear programming, heuristics (simulated annealing, tabu search, genetic algorithm, simulated allocation). Capacity planning, traffic separation, Quality of Service, Traffic Engineering, scalability. Network reliability, dedicated and shared protection, p cycles, Shared Risk Link Group, restoration. Wireless access network design: RF spectrum management, fix and dynamic channel allocation, strategies for access point placement. Future Internet technologies. (4 credits)

Laboratory for Infocommunications I.

BMEVITMM245

Pál Kovács, Tamás Marosits, György Horváth

The goal of this course is to supplement the theoretical knowledge acquired during the other courses of this specialization with practical elements. It includes measurements on the following topics: baseband digital transmission on copper lines and optical fiber; line coding, eye diagram, error ratio, HDSL (High bitrate Digital Subscriber Loop). Data transmission over access networks (from the dial-up modem to the Digital Subscriber Line (DSL). Equalization of digital line segments (echo cancellation). IP data transmission over ATM networks. Analysis of Passive Optical Networks (PON). Analysis of local area computer networks (Ethernet - IEEE 802.3). Analysis of an ISDN-VOIP (SIP, H323) gateway (characteristics of the voice channel, signaling conversion, routing). (4 credits)

Laboratory for Infocommunications II.

BMEVITMM311

Pál Kovács, Tamás Marosits, György Horváth

The goal of this course is to supplement the theoretical knowledge acquired during the other courses of this specialization with practical elements. It includes measurements on the following topics: ADSL (Asymmetric Digital Subscriber Line) network management, automatic speech recognition, Voice over IP (VoIP) traffic measurements, analysis of voice coding solutions, network simulation, analysis of the operation and management of SDH networks, programming of web interfaces, analysis of image coding solutions. (4 credits)

Information and Network Security

BMEVITMM280

Dr. Gábor Fehér

The goal of the lecture is to give theoretical and practical knowledge on recent information and network security. Attacks and threats. Introduction to cryptography. Ciphering, block ciphers and stream ciphers (DES, 3DES, AES, RC4). Asymmetric key encryption (RSA). Cryptographic hash functions. Keyed hash functions. Key management protocols. Digital signature. Protection of the networked communication. Attacks to the communication. Encryption protocols (IPSec, TLS/SSL). Virtual private networks. Firewalls, Network Address Translation, Intrusion Detection Systems, Honeypots. Vulnerability assessment. Protection of WiFi wireless networks. WEP, WPA, 802.11i protocols. (4 credits)

Optical Networks

BMEVITM347

Dr. Markosz Maliosz

Architecture and services of modern and next generation optical telecommunication systems. Application of optical networking in broadband IP core, metro and access networks. Optical network elements, physical impairments in optical transmission, modeling, simulation. WDM, (R)OADM, OXC, 1-10-100 GigabitEthernet systems, OBS, OPS. All optical networks. Passive Optical Networks. SONET/SDH, ATM, MPLS, T MPLS, GMPLS, ASON. Resource management, traffic grooming, routing and wavelength assignment. Planning principles of optical networks. Characterization of services over optical networks, trends, applications (GRID, VoD, etc.), Economical aspects of operation and management, CAPEX, OPEX. (4 credits)

Performance Analysis of Infocommunication Systems

BMEVITMM325

Dr. Sándor Molnár

Traffic modeling and basic notions of performance analysis. Fractal description of the traffic. Design and statistical analysis of performance measurements. Simulation methods in performance analysis. Over-provisioning and managed bandwidth, characteristics of streaming and elastic traffic, traffic shaping, packet and burst level congestion, call admission control (CAC) mechanisms and traffic engineering. Traffic measurements and modeling for applications on the Internet: web, P2P, gaming, VoIP, etc. Identifying the traffic of P2P applications, analyzing gaming and VoIP traffic. Performance analysis of the TCP/IP protocol stack; measurements, metrics, fairness study. Modeling and performance analysis of TCP. Adaptive queue management (AQM) methods, fast TCP variants. Basic design principles of the next generation Internet: the GENI approach, energy efficiency, identifier-locator split. (4 credits)

Project Laboratory 1

BMEVITMM807

Dr. Rolland Vida

Students work on their own, but with the help of a supervisor, on a topic chosen from a set of topics related to the specialization. During the two semesters of this course the students solve a complex engineering problem, and as a result provide a stand-alone engineering work. During these semesters the students get acquainted with all the important phases of engineering, and solve the particular subtasks as autonomously as they can. Regarding its syllabus, this course is similar for all the specializations. (5 credits)

Project Laboratory 2

BMEVITMM857

Dr. Rolland Vida

Students work on their own, but with the help of a supervisor, on a topic chosen from a set of topics related to the specialization. During the two semesters of this course the students solve a complex engineering problem, and as a result provide a stand-alone engineering work. During these semesters the students get acquainted with all the important phases of engineering, and solve the particular subtasks as autonomously as they can. Regarding its syllabus, this course is similar for all the specializations. (5 credits)

Thesis Project 1

BMEVITMM907

Dr. Rolland Vida

In order to obtain the MSc diploma, the student has to prepare an MSc dissertation. The dissertation has to prove that the student is capable of autonomous engineering work, knows about and knows how to apply the different engineering methods, is able to interpret the problem to be solved, and is capable of evaluating and analyzing the chosen solution. The program of the first semester starts with a study of the related literature and the creation of a system workplan. Some progress in solving the problem is also expected, proportional to the available time period. In the second semester the work has to be finished, and the dissertation has to be written. (10 credits)

Thesis Project 2

BMEVITMM957

Dr. Rolland Vida

In order to obtain the MSc diploma, the student has to prepare an MSc dissertation. The dissertation has to prove that the student is capable of autonomous engineering work, knows about and knows how to apply the different engineering methods, is able to interpret the problem to be solved, and is capable of evaluating and analyzing the chosen solution. The program of the first semester starts with a study of the related literature and the creation of a system workplan. Some progress in solving the problem is also expected, proportional to the available time period. In the second semester the work has to be finished, and the dissertation has to be written. (20 credits)

Quality Management

BMEGT20M002

Dr. János Kövesi, Dr. Zsuzsanna Eszter Tóth

Place and role of Quality Management systems in managing companies and other institutions. Introduction of quality management philosophies and quality schools (USA, Japan, EU). Most important features and characteristics of quality management systems in the production-oriented companies. Principles of Quality Management systems in the view of ISO 9000:2000 series of standard. Principles of Total Quality Management. Differences of TQM philosophy between production-oriented companies and service companies. The principle and methods of costumer focus. Identifying key processes. Overview of continuous improvement. Measuring performance. Methods of continuous improvement. Principle and methods of employee empowerment. Role of leaders in TQM systems. Principle and application of EFQM model in order to improve continuously the overall performance of companies. (2 credits)

Argumentation, Negotiation, Persuasion

BMEGT41MS01

Dr. Tihamér Margitay, Dr. János Tanács, Dr. Gábor Zemplén

Arguments are important in business for two reasons. Decisions between alternatives are based on what reasons we have for and against them; and our point prevails according to the quality and persuasive power of our reasoning. Reasoning is central to decision-making and to having our point accepted. Students learn to analyze, evaluate and criticize persuasive arguments and they also familiarize themselves with the basic tools of negotiating on behalf of their interests. The objective of the course is to help participants to (1) make better decisions (2) work out better options for agreement (3) recognize the tools presented on the course (4) develop more persuasive arguments for their position (5) write clearer and more persuasive reports, proposals etc. (2 credits)

Investments

BMEGT35M004

Dr. Mihály Ormos

The theory of Homo oeconomicus. Utility function. Risk aversion. The role of financial markets. Return calculation and the properties of stock returns. Portfolio theory and the equilibrium of prices on the capital markets (CAPM). Passive portfolio management and the hypothesis of capital market efficiency, the weak form, the semi-strong form and the strong form of markets efficiency. Anomalies of asset pricing. Multifactor equilibrium models (FF). Arbitrage pricing theory (APT). Active portfolio management. Principles of market microstructure. Principles of behavioural finance: heuristic biases, framing effect, and inefficient markets. Investors' behaviour. Remaining puzzles of investment theory. (2 credits)

Management Accounting

BMEGT35M005

Dr. Ágnes Laáb

In the subject the students receive managerial and practice oriented knowledge concerning the traditional cost accounting and the responsibility based accounting principles by learning the methodology, the procedure and settlement of financial transactions . The following topics are included: (1) role of management accounting in corporate governance, (2) expansion of traditional management accounting and its limitations, (3) nature and behaviour of expenses, (4) cost accounting, traditional calculation methods, (5) assets of cost responsibility management, (6) cost responsibility management, (7) economical calculations, standard costing, variance analysis, (8) budgeting, zero based budgeting, (9) job costing, process costing and activity based costing. (2 credits)

Electrical Machines and Drives Specialization

Physics 3

BMETE11MX01

Dr. György Mihály, András Sólyom

Quantum Mechanics: Experimental antecedents. The Wave function. Time dependent and time independent Schrödinger's equation. Simple problems. Tunneling. Angular momentum. The hidrogen atom. Perturbations. The H. atom. Formal quantum mechanics. Operator calculus. Commutators, canonical conjugates and uncertainity relations. Harmonic oscillator. Selection rules and spectrum of H. The He atom, the independent particle approximation. The exclusion principle. Periodic system of elements. Molecules. molecular orbitals, chemical bonding, H-H bond. Molecules of many atoms. Orbital hybridisation. Conjugated molecules, cyclic conjugated molecules. Rotation and vibration of molecules. Franck-Condon principle, Rayleigh & Raman scattering. Classical and quantum statistics. Solid State Physics: The solid state. Short and long range order.Crystallography. Bonds in crystals..Real and point lattices.. Symmetries and Unit cells. The reciprocal lattice. Bravais lattices. X- ray diffraction methods. Electrical conductivity. Drudel model. Sommerfeld model. Band theory of solids. Work function. Contact potential. The adiabatic principle. Electrons in periodic lattices. Charge carrier characteristics. Crystal momentum. Effective mass. Band theory. The tight binding model. Intrinsic and doped semiconductors. Semiconductor structures. Superconductivity. Thermal properties. The transport equation. Onsager relations. Quantum theory of lattice vibrations. Optical properties. Magnetic and dielectric properties of solids. (5 credits)

Alternating Current Systems

BMEVIVEM111

Dr. Berta István, Dr. Kádár István, Szabó László

Linear and nonlinear RLC circuits, steady state analysis using phase variables and symmetrical components, harmonics, power and energy. Switching transients, resonance. Influence of transformers and unbalanced loads in 3 phase networks. Principle and application of Park-vector theory. Physical background, definition. Investigation of multiphase systems, harmonic analysis. Park-vector diagrams in static and rotating coordinates, oscilloscopic visualization. Alternating electrostatic field. Basics, analytic and numerical calculation. Properties of insulators, thermal and frequency dependence. Layered insulators, cables. High voltage generation and measurement. Electric losses. Alternating magnetic field. Basics, energy, forces, self- and mutual inductance, leakage. Properties of ferromagnetic, permanent magnetic and superconducting materials. Magnetic losses. (4 credits)

Measurement Theory

BMEVIMIM108

Dr. Gábor Péceli

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

Advanced Linear Algebra + Analysis

BMETE90MX39

Dr. Miklós Horváth, Dr. Antal Járai, Dr. Lajos Rónyai

Advanced linear algebra: Survey of basic linear algebra. Moor-Penrose inverse and applications. Norms and matrix functions. Matrices with nonnegative entries. Singular value decomposition, its applications. QR decomposition. Linear matrix inequalities. Further applications of linear algebra in informatics. Analysis: Numerical optimization, numerical methods. Hardy spaces. Poisson- and Couchy integrals. Paley-Wiener theorem. Wavelet transformation, wavelet analysis. Elements of differential geometry. Lie derivation. Frobenius theorem. Banach-, Brouwer- and Schauder fixpoint theorems. Pontryagin maximum principle. Applications. Bellmann equations, Tyihonov functional. (6 credits)

Electrical Insulations and Discharges

BMEVIVEM116

Dr. István Berta, Dr. István Kiss, Ádám Tamus, Bálint Németh

Introduction into the insulation engineering. Stresses of insulators (environmental, mechanical, chemical, electrical). Basic phenomena due to the stresses. Polarisation, conductance. Ageing, damaging, wetting of insulators. Introduction into modern insulation diagnostics. Selection of insulators, replacing them during live maintenance. Physics of electric discharges, ionizing processes, electric arc. Partial discharges: corona, surface discharges, inner discharges, treeing. Sparkover, breakdown. Electrostatic discharges. Danger caused by electrical and electrostatic discharges (damages, fires, explosions). Industrial application of discharges. (4 credits)

Engineering Management

BMEVITMM112

Dr. Gyula Sallai, Dr. Imre Abos, Dr. Zsuzsanna Kósa, Dr. Gábor Szücs

Generic and ICT (information and communication technology) specific engineering management in the knowledge economy: principles, methods and real examples for engineering students. Engineering management roles, situations and tools. Strategic, organization and knowledge management. Business and transformation strategies. Complex engineering decision problems. Culture and change management of organizations. Technology, innovation, product and business process management. Models and methods for technology planning, innovation financing, product development, customer relation and risk management. The role of ICT in value creation. Regulatory principles, technical and market regulation of the ICT sector. Ex-ante and ex-post regulation, deployment of competition and ICT convergence, effective management of radio frequencies and numbering resources. (4 credits)

Theory and Design of Electric Machines

BMEVIVEM173

Dr. István Vajda

Basics of unified electric machines theory. Theory and methods of calculating symmetrical, asymmetrical and transient regimes. Medthods of machine design, basic concepts of magnetic circuits, investigating saturation. Efforts inside electric machines, utilization of machines, calculating noise and vibration, insulations. Windings of electric machines, reducing harmonics, calculating leakage. Calculating steady-state and transient heat, cooling, lifetime. Characteristics of permanent magnets,designing permanent magnet machines, permanent magnet small-size machines, torque fructuation, reducing tooth-torque. Basics of finite element methods, methods for meshing, boundary conditions, calculating magnetic field, forces, machine parameters. Introduction of market-available field calculation programs. (4 credits)

Electrical Equipment and Insulation

BMEVIVEM174

Dr. István Kiss, Ádám Tamus

Low voltage mechanic and electronic switches, contactors, contactor-combinations. Selection of mechanical contactors. Overload protection of motors. Protection against short circuit. Fuses and their selection. Low voltage current limiting circuit breakers and medium voltage vacuum circuit breakers. Protection systems, selective operation switchgears. Low and medium voltage disconnectors, device-combinations. Properties, construction details and dimensioning of insulations applied in electric machines. Ageing of insulations. Insulation diagnostics of electric machines. Electric, magnetic and electromagnetic transients produced by the electrical machines and drives, basic of protection methods. Selection and application of surge protective devices, noise protection devices. EMC tests of electric machines and drives. EMC control measurements for testing. Practical examples. (4 credits)

Control of Electrical Drives

BMEVIVEM175

Dr. Károly Veszprémi

Kinetics of electrical drives. Current control methods of line-commutated converter and chopper-fed DC drives. Park-vector equations of induction and synchronous motors. Field oriented current vector control of voltage-source inverter-fed induction motor drive. Direct torque and flux control. Field oriented current vector control of current-source inverter-fed induction motor drive. Current vector control of double-fed

induction motor drive. Optimal self-regulation and control of converter-fed synchronous motor drive. Field oriented control of permanent magnet sinusoid field synchronous motor drive. Current control methods of switched reluctance and stepping motor drives. Speed, position, sensorless, energy-saving, network-friendly control, multi-machine control, application oriented integrated circuit (ASIC) and microcomputer control. Practical application examples. (4 credits)

Electrical Systems of Renewable Energies

BMEVIVEM262

Dr. Károly Veszprémi, Dr. István Vajda, Dr. Mátyás Hunyár

The renewable energies and their application for electric power generation. The physical principles of superconductivity. Production of superconducting materials. Application of superconductors in electric power industry. The principles of direct energy conversion. Practically applied equipments of direct energy conversion, technical, economical and environmental demands. Energy storages: principles, tasks, practical implementation, application fields. Electrical, mechanical and chemical energy storage. Wind-turbine generators: main and ancillary circuits, optimal controls, design methods. Hydroelectric power plants and pumped storage power generation. Photoelectric systems, maximum power point tracking. Heat pumps. Utilization of geothermal energy. (4 credits)

Electric Vehicles

BMEVIVEM263

Zalán Kohári

Classes of electric vehicles. Traction force vs. velocity characteristic and traction power. Requirements for control of traction force, traveling velocity and break force. Structure of electric vehicles, tasks of main and ancillary operation. Energy supply for contact-line electrically driven rail vehicles, multi-current mode trains and motor-coaches. Electric drives and development directions of typical locomotives. Traveling and break control of electric locomotives. Electric power supply and controlled electric drives of urban trams, trolleys and underground trains. Typical types and development directions. Electric structure, energy supply, drives and development directions of electric and hybrid cars. Special vehicles, vehicles with linear motor drive and levitation. Protection and roadworthiness equipments of vehicles. Ancillary equipments of vehicles. Electric vehicles in the future. (4 credits)

Laboratory for Electrical Machines and Drives 1

BMEVIVEM264

Dr. Károly Veszprémi

Practical application of the theory by laboratory exercises in the following fields: The isolation of electrical machines. Electrical switching devices in electrical machine systems. Measurement of the magnetic field in electrical machines. Winding systems of electrical machines. Synchronous machines. Induction machines. Thyristor converter-fed speed controlled DC drive. DC chopper-fed DC drive. Electric vehicle drive with series excited dc machine. Frequency converter-fed induction motor drive with field-oriented control. Two-axis CNC drive system. (4 credits)

Laboratory for Electrical Machines and Drives 2

BMEVIVEM319

Dr. Károly Veszprémi

Servo and Robot Drives

BMEVIVEM287

Dr. László Számel, Dr. Sándor Halász

Structure of electric servo and robot drives. Control methods of multi-machine systems. Solutions for DC motor servo drives, torque and current control methods. Electronic circuits and methods of current vector control of synchronous motor servo drives. Current vector control methods of field oriented controlled induction motor servo drives. Regulation and control of stepping motor drives. Methods of speed and position control. Position and synchronism control for multi-machine (machine tools and robots) systems. Control methods of robot drives. Control, protection of servo drives, drive buses. Intelligent, low power, special drives, special sensors, application oriented integrated circuits. (4 credits)

Modelling and Simulation

BMEVIVEM365

Dr. István Kádár, Károly Németh

Lectures: Application of systems theory for electrical machines. State variables of dynamic systems with concentrated parameters, state space method. Application of coupled circuit theory for electrical machines. Analogy of electrical and mechanical systems. Computer methods for solving nonlinear, variable coefficient equations. State equations of electrical machines and solution methods. Modelling of semiconductor schemes. Electrical and mechanical transient models. Modelling of three-phase AC machines in phase coordinates and using space-vectors. Effects of the spatial harmonics and magnetic saturation of stator core. Exercises: MATLAB simulation of synchronous motor drive transients. Investigations using PSPICE network simulation program: one-phase generator and three-phase synchronous generator with rectifiers. (4 credits)

Microcomputer Controlled Drives

BMEVIVEM366

Dr. Károly Veszprémi

Hardware and software components of servo-drive systems. Processing the signals of the used sensors, digitalization, signal transfer through standard buses. Microprocessor-, microcontroller- and signalprocessor-based microcomputers. Digital firing controllers, pulse width modulators. System-level principles. Software tools of signal processing: estimations, filters, identifications, observers. Digital control algorithms, implementation of limitations and adaptivity. Real-time programming. Application examples: Microcomputer controlled DC, AC and step motor servo-drives. Application of modern control methods: field-oriented control, sensorless control, direct controls, soft-computing methods (fuzzy, neural-networks, genetic algorithms. (4 credits)

Quality Management

BMEGT20M002

Dr. János Kövesi, Dr. Zsuzsanna Eszter Tóth

Place and role of Quality Management systems in managing companies and other institutions. Introduction of quality management philosophies and quality schools (USA, Japan, EU). Most important features and characteristics of quality management systems in the production-oriented companies. Principles of Quality Management systems in the view of ISO 9000:2000 series of standard. Principles of Total Quality Management. Differences of TQM philosophy between production-oriented companies and service companies. The principle and methods of costumer focus. Identifying key processes. Overview of continuous improvement. Measuring performance. Methods of continuous improvement. Principle and methods of employee empowerment. Role of leaders in TQM systems. Principle and application of EFQM model in order to improve continuously the overall performance of companies. (2 credits)

Argumentation, Negotiation, Persuasion

BMEGT41MS01

Dr. Tihamér Margitay, Dr. János Tanács, Dr. Gábor Zemplén

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Investments

BMEGT35M004

Dr. Mihály Ormos

The theory of Homo oeconomicus. Utility function. Risk aversion. The role of financial markets. Return calculation and the properties of stock returns. Portfolio theory and the equilibrium of prices on the capital markets (CAPM). Passive portfolio management and the hypothesis of capital market efficiency, the weak form, the semi-strong form and the strong form of markets efficiency. Anomalies of asset pricing. Multifactor equilibrium models (FF). Arbitrage pricing theory (APT). Active portfolio management. Principles of market microstructure. Principles of behavioural finance: heuristic biases, framing effect, and inefficient markets. Investors' behaviour. Remaining puzzles of investment theory. (2 credits)

Management Accounting

BMEGT35M005

Dr. Ágnes Laáb

In the subject the students receive managerial and practice oriented knowledge concerning the traditional cost accounting and the responsibility based accounting principles by learning the methodology, the procedure and settlement of financial transactions . The following topics are included: (1) role of management accounting in corporate governance, (2) expansion of traditional management accounting and its limitations, (3) nature and behaviour of expenses, (4) cost accounting, traditional calculation methods, (5) assets of cost responsibility management, (6) cost responsibility management, (7) economical calculations, standard costing, variance analysis, (8) budgeting, zero based budgeting, (9) job costing, process costing and activity based costing. (2 credits)

Description of Curriculum of M.Sc. Subjects in Business Information Systems Analytical Business Intelligence Specialization

The Master of Science in Business Information Systems with specialization in Analytical Business Intelligence is designed to give students a thorough understanding of the tools, methods, applications and practice of advanced analytics used in the business life. It is both focused and practical in its orientation, with the goal to provide an education that is directly applicable to positions in industry. It is an integrated, interdisciplinary curriculum consisting of courses developed exclusively for business and industrial applications. The major highlight is on data mining, forecasting, optimization, text analytics, databases, data visualization, data privacy and security, and customer analytics, among other areas. Students gain hands-on experience with the same complex tools used in industry today.

Mathematical Statistics

The course is intended to introduce the basic principles and methods of probability theory and mathematical statistics. In the course of laboratory practices the methods are illustrated by using the mathematical statistical software package of IBM SPSS. Key Words: Theory of Estimation, Theory of Hypotheses, Parametric Tests, Nonparametric Tests, Regressions, Linear regressions, Multiple Linear Regressions, Polynomial Regressions, Nonlinear Regressions, Factor Analysis, Time Series, Box-Jenkins Analysis.

Operation Research

The course is concerned with operations research models in the economy. It also focuses on the theory necessary for the solution of the arising problems. It teaches the use of modeling languages, optimization packages in operations research. Main principles of linear and nonlinear programming. The use of the solver function of Excel. Duality. Game theory. Quadratic programming. Portfolio analysis. Scheduling. Location problems. Modeling languages (GAMS, AMPL). Solvers (MOSEK, XpressMP). Multi-objective programming. Queuing theory.

Accounting

The course is intended to equalize the accounting knowledge of the students attending the Analytical Business Intelligence specialization with different backgrounds. The syllabus includes the following areas: International and Hungarian accounting systems (IFRS, HAS), reporting, statements. Understanding of book-keeping, valuation, closing. The relationship of finance and accounting. Accounting data in financial decision making. Data correction and transformation. Cash flow statement as the primary source of decision making.

Controlling

Financial management is one of the most developing areas of business life today, which could enhance the ability of the company of creating value with special focus on the support of the managerial decision-making process, analysis and control. The syllabus includes the following areas: The conceptual framework of controlling. The development of the controlling concept, controlling systems. The place of controlling in the organization. The controlling cycle. The role and position of the controller in the organization. The functions of financial controlling. The role of financial controlling in the company's controlling system and the most threatening barriers to facilitate successful financial controlling. Cash flow, Net Present Value and business valuation. Different techniques for investment appraisals. The external need of financial sources, credit and loan management. The uses and sources of cash. Liquidity management. Balance sheet and capital structure management. Cash management with special emphasis on the external and internal organizational issues. The aims and functions of budgeting. The structure and content of the budget. Different types of budgets: sales budget and production budget, the budget of expenses and expenditures. Capital expenditure budget and financial planning. The management of the sales activity and the receivables. Management of the procurement process and the suppliers. The annual budgeted balance sheet, P&L and cash flow. Short term financial planning. Budgeted liquidity ratios. Monitoring of financial activity. The financial reporting system.

E-Law

The course gives an overview of the two basic topics of information society law: (i) the law of electronic commerce; and (ii) the fundamentals of the Hungarian and European press and electronic media law. The syllabus includes the following areas: Effects of the developing information society on the legal system - a general overview. Internet usage, electronic communication and the new media - fundamentals of law. Intellectual property rights in the context of the Internet usage, data protection and personal rights, defamation and civil law liability. Legal questions of the Internet-based commerce, consumers' protection. Press law. The structure of modern media laws, organization and supervision of the mass medias. Legal problems of public and private radio and television: a comparative overview. Competition law and mass communication. Mass communication and advertisement: commercials in the medias. The regulation of the new electronic communication technologies. Special competition rules on service providers in a dominant market position. The conflict of fundamental rights on the mass communication and on the economics.

Project Management

Introduction to the basic definitions and terminology of project management and acquiring the fundamental techniques and methods related to the field. The aim of this course is to introduce the students to the basic definitions and fundamental tools, techniques and methods of project management. The most important areas are: basic definitions, organizational structures, key roles in projects, network planning, network analysis: critical path calculation, float calculation (Critical Path Method, Program Evaluation Technique, Metra Potential Method), monitoring and control, resource allocation. After introducing the fundamental concepts and conception of project management, computer aided applications will be emphasized.

Finance

This subject summarizes the main principles of economic decision making in a corporate structure. The course presents the methods, algorithms, techniques, and tools for corporate

financial management at a masters' level. The syllabus includes the following areas: Separation of Ownership and Management, Shareholder's value, principle-agent problem, revenues and cost. Dividend policy, and its indifference. Patterns of Corporate Financing. Debt Policy and Financing Decisions. Markowitz Portfolio Theory. Risk and Return Relationship. Testing the CAPM. The opportunity cost. Net Present Value and its competitors and their theoretical background. Other indicators.

Data Security

The course is concerned with the methods, algorithms, techniques, and tools of data security and cryptography. After studying the theoretical aspects of cryptographic algorithms and protocols, these techniques are integrated to solve data security problems in information systems. The most important areas are: security risk and sources of risk. Pillars of data security: algorithmic, physical, procedural approaches. Cryptographic primitives: Basic notions of encryption, symmetric and asymmetric (public key) encryption, one-time pad. Substitution-permutation type encryption algorithms (DES, AES). Standard block cipher modes. Public key encryption: RSA, discrete exponentiation and ElGamal encryption. Cryptographic hash functions. Cryptographic protocols: User authentication: password based authentication, one way function, challenge response principle, user authentication protocols. Integrity protection: MAC, keyed hash protocols. Digital signature. Key management: classification, protocols based on symmetric key -, public key technology, public key certificate. Provable security: an introduction. Applications: Kerberos, IPSEC, SSL/TLS, electronic payment, PKI technology, VPN. Principle and practice of computer and network security: access control, intrusion detection, firewalls, denial of service, malicious codes on Internet, security management.

Network and Database Technologies

Distributed and cooperative databases are the basis of current information systems. This course gives an insight to both modern telecommunication networks services and database systems by focusing on practical and theoretical aspects of databases as utility services including integration, migration, communication and management issues. The syllabus includes the following areas: The structure of telecommunication networks. Future Internet architectures (content based addressing). Database applications and the traditional network layer model. Multi-database systems: interoperability, autonomy, system and data independency. Level of heterogeneity: representation, language, attainability, connectivity. Levels of integrations. Middleware transaction manager and clustering techniques. Weak and close union. Server-client and peer-to-peer database systems (P2P). Distributed Hash Table (DHT), distributed searching, scalability. Chord rings, P2P networks optimized for network topologies. Transaction-management in private environment: lock management, recovery, failure diagnosis and repair, reliability, fault tolerance. Global, local, export, federal, external federated schemes. Query and save procedure: query, filter, merge. Value, date, money, marked label, and language translation and integration. Data cleaning. Query optimization in distributed environments. CBO, RBO. Anonymity and the legal aspects of connectivity. Web-database. Distributed database systems in mobile environment.

Data Mining Techniques

The course is concerned with the essential tools and concepts of data mining. In the course of laboratory practices the students get acquainted with the application of the most widespread data mining software packages. The syllabus includes the following areas: General introduction to data mining. Pre-processing, data-transformation, similarity measures. Frequent set search. Association rules. Feature indicators. Classification, nearest neighbor method, decision rules, decision trees. Clustering, classical clustering goal-functions, typology of clustering algorithms, partitioning-, hierarchical- and density based algorithms

Specialization: Analytical Business Intelligence

Business and Financial Analytics

The core subject of the course is investment finance. Specific topics include security pricing, risk and return, portfolio theory and derivatives. Introduction to finance and types of securities; Securities market; Risk and return; Present value; Security pricing; Asset pricing models; Portfolio theory; Options and their influences ; Analytics of fixed-income securities Loan pricing and credit scoring; Analytics for security and portfolio selection; Forecasting returns; Security market analytics Modelling data-intensive problems in complexity Predicting bankruptcy from financial distress characterization models; loan pricing and credit scoring; corporate bond pricing; pricing of asset-backed securities using option adjusted spreads; security and portfolio selection, including forecasting returns; and the analysis of security markets. At the end of the module students will achieve skills to handle everyday business situations of investing asking a loan.

Customer Analytics

The course is concerned with introducing the students to the theoretical and practical aspects of analyzing customer data. It also focuses on business practices for analytics and data mining algorithms. The course is based on two-week cycles with three theoretical lectures and one practical laboratory. The synopsis presents the seven cycles during the course. The most important areas are: data mining of telecommunication data (churn, campaign optimization, social networks, fraud), analysis of web visitors, behavioural credit scoring and other data mining aspects of finance, similar products, cross- and up-selling, recommender systems, customer value calculations.

Trend Analysis and Visualization

The syllabus includes the following areas: Principles and applications of ARIMA (auto-regressive integrated moving average) models for time series. Mapping thematic models for forecasting issues and their usable applications. Supporting the use of industrial standard tools. Understanding the role of visualization and its advantage in data representation; identifying potential feedbacks to the preparatory and analytic phase of the modelling. Data preparation topics, model features, diagnostics; Time Series Forecasting Systems, forecasting models. Regression with time series errors. Trends and Seasonality. Multivariate non-stationary regression Exponential Smoothing Interventions; Parameters ant their exact values (analysis of transport functions) Differentiation, multi-

dimensional regression. Regression for time series based on estimation. Advanced topics on co integration. ARCH models, forecasting time series. Role of the human perception, design, aesthetics, their strength to catch human knowledge. Managing large datasets; role of human perception in information presentation. Aesthetics to avoid distortion of information. Assisted visualization design; visualization of changing viewpoints, implicit tracking. Real examples with on-line analytic processing (OLAP), system for offering. The power of aesthetics for knowledge retention, Implicit tracking of viewer's interests; Principles of visual narrative. Analytical reasoning techniques, Data representations and transformations, Visual representations and interaction techniques, Generalized multidimensional scaling, Perceptual mapping, Business Decision Mapping.

Media and Text Mining

The course is concerned with introducing the students to the identification, assessment and analysis of the intelligent information search systems and multimedia retrieval systems. It also focuses on content handling techniques, where contents may either be text or media, or both. The syllabus includes the following areas: Metadata systems and standards. Task types in Media and Text Mining: search, classification, clustering, forecasting. Methods for media and text analysis, search techniques, indexing, ranking procedures. Web Mining. PageRank, webgraph methods, HITS, Boolesearch. Dimension reduction methods, feature extraction and selection techniques, chi-square, eigenvalue based methods, ICA. Text analysis. Stemming algorithms, Porter stemmer, Lovins stemmer. Language detection, language dependency. Shallow and deep parsing. POS tagging. Syntax tree parsers, dependency graph parser. Stanford tools. Gini index. C4.5, C5.0, Random Forest. Automatic text processing at enterprises. Text and media classification, clustering. Relation extraction from text. Co-occurrence, pattern-matching. Convolution kernels with SVM in relation extraction. Gathering business news, information extraction from the news. Hierarchical taxonomy systems, Catalogue search, thesaurus. Folksonomy. Concept mining. Annotation. Sentiment analysis. Classification of pictures, videos. Discretization. CBIR, Line detection, skeletonization. Image and time series in multimedia. Media-indexing. Probability models in video and audio searches. Developing media retrieval and search systems in enterprises. Marketing applications, online media applications.

Risk Analysis and Management

The course is concerned with the identification, assessment and analysis of the different forms of enterprise risk. It also focuses on the techniques of handling and avoiding risks in order to help the decision maker with different strategies in risk mitigation. The syllabus includes the following areas: Identification of errors and hazardous elements prone to failure. Construction of risk indicators and identifying key risk factors. Developing risk reporting plans, action plans and applying risk mitigation techniques. Stochastic risk models. Behavioural simulation, algorithmic tools of risk analysis. Variance reduction and fine tuning. Evaluation of simulation results. Optimization problems, scenario analysis, Cox law. The role and identification of episodes. Testing mechanisms, testing plans, stress test. Risk estimation models and procedures. Stochastic reliability models, survival functions, lifecycle distributions, hazard. Case dependent inference, and error-model based risk estimation methods.

Processing of Personal and Public Data

The objective of the course is to make students aware of the requirements regarding the storing, processing, forwarding and making accessible of personal data and data of public interest, as well as the applicable IT solutions corresponding to these requirements. The syllabus includes the definition criteria of personal data and data of public interest according to Hungarian and European law; the basic principles of processing personal data; examples of applying these principles in Hungarian and EU environment; the formal and essential criteria of informed consent. Data mining and purpose specificity, PPDM (Privacy Preserving Data Mining), separation levels of data processing systems, requirements and solutions regarding logging, internal access, and archiving, as well as data processing requirements of electronic personal identification and identity management will also be discussed. Students will become acquainted with basic concepts and architectures of Privacy Enhancing Technologies (PET), user-centric, integrated identity management in networks (PRIME), and data protection requirements of electronic personal identification and e-government services. Application of OAI based systems handling data of public interest, especially the structure and functioning of the Central Electronic List of Public Information and the Single Public Information Retrieval System will also be presented.