UNIVERSITY of DEBRECEN

FACULTY OF INFORMATICS

4028 Debrecen, Kassai út 26., 4002 Debrecen, P.O.Box 400.
☎ (36) 52/518-630, to@inf.unideb.hu

COMPUTER SCIENCE ENGINEERING BSC

Mode:	Full-time training
Program Coordinator:	Dr. István Oniga (oniga.istvan@inf.unideb.hu)
Mentor:	Dr. Attila Kuki (kuki.attila@inf.unideb.hu)
Specialization:	-

General requirements of the diploma are regulated by The Rules and Regulations of The University of Debrecen.

Diploma credit requirements

Natural Science	44 credits
Human and Economic Knowledge	15 credits
Compulsory topics	96 credits
Differentiated knowledge topics	30 credits
Thesis	15 credits
Free choise	10 credits
Work and fire safety training	0 credit
Physical Education (2 semesters)	0 credit
Total (number of credits required to obtain degree)	**210 credits**

Natural Science – needed 44 credits

Code	Subject name	Credit	Type and number			Assessment	Prerequisites	Period	Semester
			lec.	practice					
				sem.	lab				
INBMA0101G	Algorithms and Basics of Programming	2		2		PM		1	1
INBMA0102E INBMA0102L	Electronics	6	2		2	PM		1	1
INBMA0103E INBMA0103L	Physics	6	2		2	E S		1	1
INBMA0104E INBMA0104G	Calculus	6	2	2		E S		1	1
INBMA0105E INBMA0105L	Mathematics for Engineers 1	6	2		2	PM		1	1
INBMA0207E INBMA0207G	Data Structures and Algorithms	6	2	2		E S		2	2
INBMA0208E INBMA0208L	Mathematics for Engineers 2	6	2		2	E S	INBMA0104 INBMA0105	2	2
INBMA0313E INBMA0313L	Probability Theory and Mathematical Statistics	6	2		2	PM	INBMA0104 INBMA0105	1	3

Human and Economic Knowledge – needed 15 credits

Code	Subject name	Credit	Type and number			Assessment	Prerequisites	Period	Semester
			lec.	practice					
				sem.	lab				
INBMA0314E INBMA0314G	Economics	6	2	2		E S		1	3
INBMA0631E	Fundamentals of Business Law	3	2			E		2	6
INBMA0632E INBMA0632G	Management Basics for Engineers	6	2	2		E S		2	6

Compulsory topics – needed 96 kredits

Code	Subject name	Credit	Type and number			Assessment	Prerequisites	Period	Semester
			lec.	practice					
				sem.	lab				
INBMA0106E INBMA0106G	Introduction into Logic and Computer Science	4	2	2		E S		1	1
INBMA0209E INBMA0209G	Digital Design	6	2	2		E S	INBMA0102	2	2
INBMA0210L	Digital Design Laboratory	3			2	PM	INBMA0102	2	2
INBMA0211E INBMA0211L	Programming Languages 1	6	2		2	E S	INBMA0101	2	2

Code	Subject name	Cre-dit	Type and number			Asses-ment	Prerequisites	Period	Semes-ter
			lec.	practice					
				sem.	lab				
INBMA0212E	Computer Architectures	3	2			E		2	2
INBMA0315L	Signals and Systems	3			2	PM	INBMA0102 INBMA0208	1	3
INBMA0316L	Introduction to Graphical Programming Environment	3			2	PM	INBMA0101	1	3
INBMA0317L	Programming Languages 2	6			4	PM	INBMA0101	1	3
INBMA0318E INBMA0318L	Computer Networks	6	2		2	E S	INBMA0212	1	3
INBMA0419E	Management of Data Network Systems	3	2			E	INBMA0318	2	4
INBMA0420L	Operating Systems	3			2	PM		2	4
INBMA0421L	System Programming	3			2	PM	INBMA0211	2	4
INBMA0422E INBMA0422L	Control Systems	6	2		2	PM	INBMA0315	2	4
INBMA0423L	Software Development for Engineers	3			2	PM	INBMA0317	2	4
INBMA0424E	Enterprise Information Systems	3	2			E		2	4
INBMA0425L	Web Solutions	3			2	PM	INBMA0211 OR INBMA0317	2	4
INBMA0526E INBMA0526L	Introduction into Artifical Intelligence	6	2		2	E S	INBMA0106 INBMA0207 INBMA0211	1	5
INBMA0527L	Assembly Programming	3			2	PM	INBMA0211 INBMA0212	1	5
INBMA0528E INBMA0528L	Embedded Systems	6	2		2	E S	INBMA0102 INBMA0212	1	5
INBMA0529G	Modeling and Analysis of Information Technology Systems	2		2		PM	INBMA0313	1	5
INBMA0530L	Mobile Solutions	3			2	PM	INBMA0317	1	5
INBMA0633E INBMA0633L	Database Systems and Knowledge Representation	6	2		2	PM	INBMA0211	2	6
INBMA0634L	IT Security	3			2	PM	INBMA0420	2	6
INBMA0635L	Computer Graphics	3			2	PM	INBMA0211 OR INBMA0317	2	6

Thesis work – needed 15 credits

Code	Subject name	Credit	Type and number			Assessment	Prerequisites	Period	Semester
			lec.	practice					
				sem.	lab				
INBMA0736X	Thesis	15				PM		1	7

Differentiated knowledge topics – needed 30 credits

Code	Subject name	Credit	Type and number			Assessment	Prerequisites	Period	Semester
			lec.	practice					
				sem.	lab				
INBMA9937E INBMA9937L	Microcontrollers	6	2		2	PM	INBMA0209 INBMA0211	2	4
INBMA9938G INBMA9938L	Programming Network Devices 1	6		2	2	PM	INBMA0318	1	5
INBMA9939E INBMA9939L	Programmable Logic Devices	6	2		2	PM	INBMA0209 INBMA0211	1	5
INBMA9940L	Development of Embedded Systems	6			4	PM	INBMA0528 (INBMA9937 OR INBMA9939)	2	6
INBMA9941G INBMA9941L	Programming Network Devices 2	6		2	2	PM	INBMA9938	2	6
INBMA9942E INBMA9942L	Modeling and Performance Evaluation of Networks	6	2		2	PM	INBMA0529	2	6
INBMA9943E INBMA9943L	Telecommunication Systems	6	2		2	PM	INBMA0318	2	6
INBMA9944E INBMA9944L	Sensors and actuators Network	6	2		2	PM	INBMA0318 INBMA9937	1	7

Free choice – needed 10 credits

Code	Subject name	Credit	Type and number			Assessment	Prerequisites	Period	Semester
			lec.	practice					
				sem.	lab				

Exam types:
- E exam
- S sign
- P practical

COMPUTER SCIENCE ENGINEERING BSC

Description of Subjects

Natural Science

ALGORITHMS AND BASIC OF PROGRAMMING

INBMA0101-17

Semester: 1
Type: Seminar
Number of Classes: 0+2+0
Credit: 2
Status: Obligatory
Assessment: Practical mark
Prerequisites: None
Responsible: Dr. Imre Varga

Topics:
Software life-cycle. The algorithm and its properties. Sequence, selection, iteration. Flowchart and pseudo-code. Syntax and semantics. Implementation. Data representation. Variable. Expression. Branching and looping. Usage of arrays. Subprograms.

Compulsory/Recommended Readings:
- Simon Harris, James Ross: Beginning algorithms, Wiley, 2005, ISBN: 9780764596742
- Narasimha Karumanchi: Data Structures and Algorithmic Thinking with Python, CareerMonk, 2017, ISBN: 8192107590

ELECTRONICS

INBMA0102-17

Semester: 1
Type: Lecture / Laboratory
Number of Classes: 2+0+2
Credit: 6
Status: Obligatory
Assessment: Practical mark
Prerequisites: None
Responsible: Dr. Attila Buchman

Topics:
Semiconductors. Diodes. Transistors. CMOS inverter and logical gates. Rectifiers, DC-DC converters, voltage regulators. Operational amplifier model. Feedback theory and applications. Power amplifiers. Digital to analog and analog to digital conversion. Analóg sensors and actuators.

Compulsory/Recommended Readings:
• Agarwal, Anant, and Jeffrey H. Lang. Foundations of Analog and Digital Electronic Circuits. Morgan Kaufmann Publishers, Elsevier, July 2005.
• Adel S. Sedra, Keneth C. Smith: Microelectronic Circuits, Oxford University Press, 2004, ISBN-0-19-514252-7

PHYSICS

INBMA0103-17

Semester: 1
Type: Lecture / Laboratory
Number of Classes: 2+0+2
Credit: 6
Status: Obligatory
Assessment: Exam
Prerequisites: None
Responsible: Dr. Imre Varga

Topics:
Basic concepts of electric and magnetic phenomena: charge, Coulomb's Law, signal strength, electrostatic capacitors. DC-AC power. Electrical basic laws (Ohm, Kirchoff, Joule). RLC circuits. Semiconductors. Magnetic fields and electromagnetic induction coil and a transformer. The electromagnetic waves. The basic structure of atoms and their light emission, basic concepts of spectroscopy. Optics. Radioactivity and basic concepts of nuclear energy.

Compulsory/Recommended Readings:
• Halliday-Resnick-Walker: Fundamentals of physics (10th. extended edition), John Wiley and Sons, 2013
• Narciso Garcia, Arthur Damask, Steven Schwarz: Physics for Computer Science Students: With Emphasis on Atomic and Semiconductor Physics, Springer, 2012
• Chris Vuille, Raymond A. Serway: College physics (9th edition), Brooks/Cole, Belmont, 2012

CALCULUS

INBMA0104-17

Semester: 1
Type: Lecture / Seminar
Number of Classes: 2+2+0
Credit: 6
Status: Obligatory
Assessment: Exam
Prerequisites: None
Responsible: Dr. Mihály Bessenyei

Topics:
Students know the basic tools of mathematical analysis: sequences, limits, real functions, differentiation and integration.

Compulsory/Recommended Readings:
• Serge Lang, A first course in calculus, Undergraduate Texts in Mathematics, Springer-Verlag, 2012.
• Binmore, K.G.: Mathematical Analysis. A straightforward approach. Cambridge, 1989.
• Thomas' Calculus, Addison Wesley (11th edition, 2005), ISBN: 0-321-24335-8

MATHEMATICS FOR ENGINEERS 1

INBMA0105-17

Semester: 1
Type: Lecture / Laboratory
Number of Classes: 2+0+2
Credit: 6
Status: Obligatory
Assessment: Practical mark
Prerequisites: None
Responsible: Dr. Pál Burai

Topics:
Foundation of discrete mathematics, foundations of linear algebra, foundations of numerical methods.

Compulsory/Recommended Readings:
• Stoyan and Baran: Elementary numerical mathematics for programmers and engineers, Birkhäuser, 2016, ISBN 978-3-319-44659-2
• Ertel: Advanced mathematics for engineers, Hochschule Ravensburg-Weingarten, 2012

DATA STRUCTURES AND ALGORITHMS

INBMA0207-17

Semester: 2
Type: Lecture / Seminar
Number of Classes: 2+2+0
Credit: 6
Status: Obligatory
Assessment: Exam
Prerequisites: None
Responsible: Dr. György Vaszil

Topics:
The course covers commonly used data structures, the algorithms necessary to manipulate them, and introduces the basic concepts of algorithmic complexity. Topics include elementary data structures, searching, sorting; hash tables, trees, graphs; time complexity, parallel algorithms basics.

Compulsory/Recommended Readings:
• Thomas H. Cormen, Charles E. Leiserson, Ronald L. Rivest, Clifford Stein: Introduction to Algorithms. Third Edition. The MIT Press, Cambridge, Massachusetts London, England, 2009
• Donald E. Knuth: The Art of Computer Programming, volume 1. Third edition, Addison-Wesley, 1997
• Donald E. Knuth: The Art of Computer Programming, volume 3. Second edition, Addison-Wesley, 1998
• Seymour Lipschutz: Data Structures, McGraw-Hill, 2014

MATHEMATICS FOR ENGINEERS 2

INBMA0208-17

Semester:	2
Type:	Lecture / Laboratory
Number of Classes:	2+0+2
Credit:	6
Status:	Obligatory
Assessment:	Exam
Prerequisites:	INBMA0104-17 (Calculus) and INBMA0105-17 (Mathematics for Engineers 1)
Responsible:	Dr. Pál Burai

Topics:
Foundation of ordinary differential equations and their numerical methods, Fourier series, Fourier transform, Laplace transform.

Compulsory/Recommended Readings:
• Stoyan and Baran: Elementary numerical mathematics for programmers and engineers, Birkhäuser, 2016, ISBN 978-3-319-44659-2
• Ertel: Advanced mathematics for engineers, Hochschule Ravensburg-Weingarten, 2012

PROBABILITY THEORY AND MATHEMATICAL STATISTICS

INBMA0313-17

Semester:	3
Type:	Lecture / Laboratory
Number of Classes:	2+0+2
Credit:	6
Status:	Obligatory
Assessment:	Practical mark
Prerequisites:	INBMA0104-17 (Calculus) and INBMA0105-17 (Mathematics for Engineers 1)
Responsible:	Dr. István Fazekas

Topics:
Statistical observations. Numerical and graphical characteristics of the sample.
Fitting functions to observations (regression analysis).
Randomness of observations. Event, relative frequency, probability.
Conditional probability, independence of events. Theorem of total probability, the Bayes theorem.
Discrete random variables. Binomial, hypergeometric, and Poisson distributions.
Expectation and variance of discrete random variables. Applications.
The general notion of random variables. Cumulative distribution function, probability density function. Expectation and variance.
Uniform, exponential, normal distributions and their applications.
Joint distributions. Correlation coefficient. Multivariate normal distribution.
Laws of large numbers and the central limit theorem. Their visualizations and applications.
The Poisson process.
Statistical estimators: unbiased and consistent estimators. Confidence intervals.
Testing statistical hypotheses. The u- and the t-tests. Nonparametric tests.
Classifications: linear separation and clustering.

Compulsory/Recommended Readings:
• D.C. Montgomery, G.C. Runger: Applied Statistics and Probability for Engineers. Wiley, 2003.
• Dirk P. Kroese: A Short Introduction to Probability. University of Queensland, 2009.

ECONOMICS

INBMA0314-17

Semester:	3
Type:	Lecture / Seminar
Number of Classes:	2+2+0
Credit:	6
Status:	Obligatory
Assessment:	Exam
Prerequisites:	None
Responsible:	Dr. Judit Kapás

Topics:
Basic issues and methods of economics. The ten principles of economics. The boundary of production possibilities, opportunity costs. How do the markets work? Supply, demand and government measures. The elasticity of supply and demand. Production costs. Companies in the competitive market. Monopoly. Externalities. The measurement of national income. Measuring the cost of living. Unemployment. Production and economic growth.

Compulsory/Recommended Readings:
• N. Gregory Mankiw (2011). Principles of Economics (6th ed.). Cengage Learning. ISBN 978-0-538-45305-9
• P.T. Boetke, P., & Prychitcko, D Heyne: The Economic Way of Thinking, 12th Ed , 2011.
• Samuelson, Nordhaus: Economics 19th Edition, 2009.

FUNDAMENTALS OF BUSINESS LAW

INBMA0631-17

Semester: 6
Type: Lecture
Number of Classes: 2+0+0
Credit: 3
Status: Obligatory
Assessment: Exam
Prerequisites: None
Responsible: Dr. Géza Károlyi

Topics:
Legal concepts, the structure of the legal system, The system of state agencies, The subject of economic activity (legal capacity of legal entities), The business activity of a natural person, Common rules for companies. The founding of companies, The organizational structure of companies, A general partnership and limited partnership features, The limited liability company, The features of incorporated companies, the securities law characteristics of shares, Other legal persons organizations (cooperatives, NGOs), Termination of companies without succession and succession, Types and Characteristics The procedures insolvency, Property law, acquisition of property, The general rules of civil law contracts.

Compulsory/Recommended Readings:
• Twigg-Flesner, Christian: The Cambridge Companion to European Union Private Law, Cambridge University Press, Cambridge, 2010.
• Ewan Macintyre: Business Law. Pearson Education Limited. ISBN: 978-1-4082-3797-7

MANAGEMENT BASICS FOR ENGINEERS

INBMA0632-17

Semester: 6
Type: Lecture / Seminar
Number of Classes: 2+2+0
Credit: 6
Status: Obligatory
Assessment: Exam
Prerequisites: None
Responsible: Dr. Attila Kuki

Topics:
Basic concepts of managements. Elements of the life cycle. The concept of an enterprise, Foundation of an enterprise, Enterprise stakeholders, enterprise objectives, Case study, Strategic basics, Organizational behavior, leadership, Human resource management, Marketing, Management of value creation processes, Enterprise finance, Strategic management.

Compulsory/Recommended Readings:
- Gillespie: Business Economics, OUP Oxford 2010.
- John Sloman, Kevin Hinde, Dean Garratt: Economics for Business, FT Publishing International; 6 edition, 2013.

Compulsory Topics

INTRODUCTION INTO LOGIC AND COMPUTER SCIENCE

INBMA0106-17

Semester: 1
Type: Lecture / Seminar
Number of Classes: 2+2+0
Credit: 4
Status: Obligatory
Assessment: Exam
Prerequisites: None
Responsible: Dr. László Aszalós

Topics:
Syntax and semantics; interpretation, satistiable, contradictory and valid formulae; entailment, equivalent formulae. CNF, DNF, simplifiation. Boole algebras. Logic calculi, soundness, completeness. Syntax and semantics of the first order language, central logic concepts. Formal languages, finite automata, concept of algorithm.

Compulsory/Recommended Readings:
• Mordechai Ben-Ari: Mathematical Logic for Computer Science, 3rd ed., Springer, 2012.
• Michael Sipser: Introduction to the Theory of Computation, 3rd ed., Cengage Learning, 2012.

DIGITAL DESIGN

INBMA0209-17

Semester: 2
Type: Lecture / Seminar
Number of Classes: 2+2+0
Credit: 6
Status: Obligatory
Assessment: Exam
Prerequisites: INBMA0102-17 (Electronics)
Responsible: Dr. István Oniga

Topics:
Analog and digital signals. Digital circuits parameters. Boolean Algebra. Logic functions. Basic elements, gates, two level networks, SOP realization. Combinational Logic. Arithmetical and logical units. Sequential logic: Latches, Flip-Flops. Asynchronous and synchronous binary and BCD counters. Shift Registers. Memories. A/D and D/A conversion. Integrated Circuit Technologies. Programmable Logic.

Compulsory/Recommended Readings:
• Thomas L. Floyd: Digital Fundamentals, Prentice Hall, 2009, ISBN-10: 0138146462
• John F. Wakerly: Digital Design, Prentice Hall, 2001, ISBN 0-13-089896-1
• M. Morris Mano; Charles R. Kime, Logic and Computer Design Fundamentals, Prentice Hall, 1997.

DIGITAL DESIGN LABORATORY

INBMA0210-17

Semester: 2
Type: Laboratory
Number of Classes: 0+0+2
Credit: 3
Status: Obligatory
Assessment: Practical mark
Prerequisites: INBMA0102-17 (Electronics)
Responsible: Dr. László Tóth

Topics:
Simple logic function design using HDL language (Verilog). Two level digital networks, SOP realization. Combinational and sequential Logic design using HDL codes, simulation and implementation. A/D and D/A convertors simulation. FSM design, simulation and implementation.

Compulsory/Recommended Readings:
- Thomas L. Floyd: Digital Fundamentals, Prentice Hall, 2009, ISBN-10: 0138146462
- John F. Wakerly: Digital Design, Prentice Hall, 2001, ISBN 0-13-089896-1
- M. Morris Mano; Charles R. Kime, Logic and Computer Design Fundamentals, Prentice Hall, 1997.

PROGRAMMING LANGUAGES 1

INBMA0211-17

Semester: 2
Type: Lecture / Laboratory
Number of Classes: 2+0+2
Credit: 6
Status: Obligatory
Assessment: Exam
Prerequisites: INBMA0101-17 (Algorithms and basics of programming)
Responsible: Dr. Márk Kósa

Topics:
Syntax, semantics, compiler, interpreter, language standard, implementation. Evolution and classification of high-level programming languages. About programming paradigms. Formal syntax definition tools. Character set. Lexical units (delimiters, symbolic names, labels, comments, literals). Rules of constructing the source code, the role of space. Data types. Named constants. Variables. Expressions, operands and operators, precedence table. Declaration statements. Executable statements. Assignment, empty statement, jump statements. Two-way and multiple selection. Loop statements, types of loops and their applications. Control statements. Program units. Subprograms (procedures and functions). Parameter evaluation, parameter passing. Block. Scoping, accessibility. Compile unit. Abstract data type. Generic programming. Generic types, generic methods, templates. I/O tools of programming languages, file handling. Basic concepts of exception handling, approaches and tools. Concepts of parallel programming. Services of the runtime system.

Compulsory/Recommended Readings:
• Robert W. Sebesta: Concepts of Programming Languages, 11th edition, Pearson, 2016, ISBN-13: 978-1292100555.
• Ivor Horton: Beginning C, 5th edition, Apress, 2013, ISBN-13: 978-1430248811.
• Brian W. Kernighan, Dennis M. Ritchie: C Programming Language, 2nd edition, Prentice Hall, 1988, ISBN-13: 978-0131103627.

COMPUTER ARCHITECTURES

INBMA0212-17

Semester: 2
Type: Lecture
Number of Classes: 2+0+0
Credit: 3
Status: Obligatory
Assessment: Exam
Prerequisites: None
Responsible: Dr. Imre Varga

Topics:
Layers of computer architecture. Digital representation of data. The CPU. Intel x86 architecture. Assembly level instructions, addressing modes, machine code. Memory hierarchy, cache. Relationship of the hardware and the operating system. I/O, interrupt handling, DMA. Peripherals and interfaces. Modern parallel architectures. Not Intel-based architectures.

Compulsory/Recommended Readings:
• Andrew S. Tanenbaum, Todd Austin: Structured Computer Organization (6th Edition), Pearson, 2013, ISBN: 978-0132916523
• Nick Carter: Schaum's outline of computer architecture, McGraw-Hill, 2002, ISBN: 9780071362078

SIGNALS AND SYSTEMS

INBMA0315-17

Semester:	3
Type:	Laboratory
Number of Classes:	0+0+2
Credit:	3
Status:	Obligatory
Assessment:	Practical mark
Prerequisites:	INBMA0102-17 (Electronics) and INBMA0208-17 (Mathematics for Engineers 2)
Responsible:	Dr. László Tóth

Topics:
The subject is responsible for acquiring the necessary knowledge to study and analyze signals and systems such as; classification of signals and systems, system functions, measurement and discretization, measurement error and error propagation, convolution and deconvolution, Fourier-transform, Nyquist-Shannon sampling theorem, modulations, Laplace-transform, Z-transform, transfer function, bode plot and filters.

Compulsory/Recommended Readings:
- Luis F. Chaparro, Signals and Systems Using MATLAB, Elsevier 2011
- David McMahon, Signals & Systems Demystified, McGraw-Hill, 2006

INTRODUCTION TO GRAPHICAL PROGRAMMING ENVIRONMENT

INBMA0316-17

Semester: 3
Type: Laboratory
Number of Classes: 0+0+2
Credit: 3
Status: Obligatory
Assessment: Practical mark
Prerequisites: INBMA0101-17 (Algorithms and basics of programming)
Responsible: Dr. Tamás Bérczes

Topics:
Introduction of user environments front and back panel, toolbar, palettes, help system. Basics: Graphical displays and controls. Programming structures: sequence of events, loops, conditional structures, formula nodes. Data structures: data types, arrays, strings, clusters and operations. Basic Tasks: Signal Generation, Analysis and visualization Using signal processing and graphics package types, file operations, instrument control and asset management. Fundamental program structures: state machines, event-driven programming, producer-consumer. Network communication. Additional software packages: image and signal processing.

Compulsory/Recommended Readings:
• National Instruments, LabView, http://www.ni.com/labview/
• J. Travis, J. Kring: LabVIEW for Everyone: Graphical Programming Made Easy and Fun, Prentice Hall Professional, 2007.

PROGRAMMING LANGUAGES 2

INBMA0317-17

Semester: 3
Type: Laboratory
Number of Classes: 0+0+4
Credit: 6
Status: Obligatory
Assessment: Practical mark
Prerequisites: INBMA0101-17 (Algorithms and basics of programming)
Responsible: Dr. Márk Kósa

Topics:
Basic concepts of object-oriented paradigm. Class, object, instantiation. Inheritance, class hierarchy. Polymorphism, method overloading. Scoping. Information hiding, accessibility levels. Abstract classes and interfaces. Modeling tools and languages. UML and its class diagram. Programming language elements of object-oriented languages: character set, lexical units, expressions, statements. The type system of object-oriented languages (e.g., Java, C#). Members of types: fields, (named) constants, properties, methods, events, operators, indexers, constructors, destructors, embedded types. Interfaces. Collections. I/O, file handling. Serialization. Functional language elements. Lambda expressions. Handling data streams. Exception handling. Reflection. Language elements supporting compilation and code generation (annotations, attributes). Unit testing.

Compulsory/Recommended Readings:
• Robert W. Sebesta: Concepts of Programming Languages, 11th edition, Pearson, 2016, ISBN-13: 978-1292100555.
• Y. Daniel Liang: Introduction to Java Programming, 10th edition, Pearson, 2014, ISBN-13: 978-0133813463.
• Dan Clark: Beginning C# Object-Oriented Programming, Apress, 2013, ISBN-13: 978-1430249351.

COMPUTER NETWORKS

INBMA0318-17

Semester: 3
Type: Lecture / Laboratory
Number of Classes: 2+0+2
Credit: 6
Status: Obligatory
Assessment: Exam
Prerequisites: INBMA0212-17 (Computer architectures)
Responsible: Dr. Zoltán Gál

Topics:
Basic notions, history of the data networks, classification of the networks. Layered architecture, network reference models (OSI, TCP/IP, hybrid), intermediate network nodes. Elements and characteristics of the physical layer. Signal coding and modulation technics. Data network topologies.
Elements and characteristics of the data link layer. Mechanisms of the MAC sublayer. Static and dynamic channel access: FDM, TDM, ALOHA, slotted ALOHA, CDMA. LAN communication technologies: Ethernet (IEEE 802.3), token ring (IEEE 802.5). WAN communication technologies: SLIP, PPP, ISDN, ATM, DSL. IP network protocol: structure of the datagram, addressing system (classes, VLSM, CIDR), datagram switching. Dual addressing mechanisms: ARP, RARP, BOOTP, DHCP. IP address translation mechanisms: NAT, PAT. Ipv6 addressing. Static and dynamic routing: DV, RIPv1, RIPv2, IGRP, EIGRP, Link-state routing, Dijkstra algorithm, IS-IS, OSPF, Inter-Area OSPF, DR, ABR functions. Transport layer protocols: segment structures of the UDP and TCP. TCP link management. Application layer protocols: DNS, FTP, TELNET, HTTP, SMTP, NTP, SNMP, RMON.

Compulsory/Recommended Readings:

• RFC Documents: http://www.rfc-editor.org
• A. S. Tanenbaum, D. J. Wetherall: Computer Networks, 5th edition, Pearson, 2011.
• James F Kurose; Keith W Ross: Computer networking: a top-down approach, Pearson, 2017.

MANAGEMENT OF DATA NETWORK SYSTEMS

INBMA0419-17

Semester: 4
Type: Lecture
Number of Classes: 2+0+0
Credit: 3
Status: Obligatory
Assessment: Exam
Prerequisites: INBMA318-17 (Computer Networks)
Responsible: Dr. Zoltán Gál

Topics:
Basics of the network management. Task of the network management. Functions of the network management technics and subsystems. Overview of the network management tools in production. Architecture and operation of the SNMP and RMON technologies. Structure and operation of the MRTG, Nagios, Spectrum network management softwares. Analysis and interpretation of the monitored general data traffics. Analysis and interpretation of the monitored time critical data traffics. Management of the application layer services. Interpretation of the QoS/QoE/GoS parameters at the service provider. Practical aspects of the designs and operation of the network management systems in production.

Compulsory/Recommended Readings:
• S. Shipway: Using MRTG with RRDtool and Routers2: Third Edition, Cheshire Cat Publishing, 2013.
• Verma, Dinesh Chandra, "Principles of Computer Systems and Network Management", Springer, 2009.
• https://www.nagios.org/projects/nagios-config-tools/
Nagios Enterprises, LLC
• http://oss.oetiker.ch/mrtg/
• https://sms-sgs.ic.gc.ca/eic/site/sms-sgs-prod.nsf/eng/home

OPERATING SYSTEMS

INBMA0420-17

Semester: 4
Type: Laboratory
Number of Classes: 0+0+2
Credit: 3
Status: Obligatory
Assessment: Practical mark
Prerequisites: None
Responsible: Dr. Tamás Krausz

Topics:
Concepts, tasks, and components of an operating system. Classification of the operating systems. Historical overview. Hardware, architectures.. Operating systems network management. Testing commands Files and file systems. Special files under Unix. Redirection. Unix file systems.. Process management. Signals. Priority, priority handling. Scheduling. Disk handling. NAS and SAN. Security.Virtualization. Cloud computing. Mobile operating systems.

Compulsory/Recommended Readings:
• Silbershatz, Galvin, Gagne: Operating system concepts Wiley; 9 edition (October 10, 2012)
• Andrews, West, Dark: A+ Guide to IT Technical Support (Hardware and Software) Course Technology; 9 edition (January 1, 2016)
• Garrido, Schlesinger, Hoganson: Principles of Modern Operating Systems, Jones & Bartlett Learning; 2 edition (October 10, 2011)

SYSTEM PROGRAMMING

INBMA0421-17

Semester: 4
Type: Laboratory
Number of Classes: 0+0+2
Credit: 3
Status: Obligatory
Assessment: Practical mark
Prerequisites: INBMA0211-17 (Programming languages 1)
Responsible: Dr. Imre Varga

Topics:
Program running environment. Binary files. Directory- and inode-handling. Fork. Signaling. Socket programming, Parallel programing based on shared memory model.

Compulsory/Recommended Readings:
• Niel Matthew, Richard Stones: Beginning Linux programing, Wiley, 2004, ISBN: 978-0-7645-4497-2
• Barbara Chapman, Gabriele Jost, Ruud van der Pas: Using OpenMP: Portable Shared Memory Parallel Programming, MIT Press, 2008, ISBN: 9780262533027
• Michael J. Donahoo, Kenneth L. Calvert: TCP/IP Sockets in C, Elsevier, 2009, ISBN: 9780123745408

CONTROL SYSTEMS

INBMA0422-17

Semester: 4
Type: Lecture / Laboratory
Number of Classes: 2+0+2
Credit: 6
Status: Obligatory
Assessment: Practical mark
Prerequisites: INBMA0315-17 (Signals and systems)
Responsible: Dr. László Tóth

Topics:
The subject is responsible for acquiring the necessary knowledge related to the control systems such as; principles of control, feedback control and open loop control; set point control and reference signal tracking; role of negative feedback; synthesis of continuous time control systems; losed control loop, open loop, loop gain, type number; gain and phase margin. PI, PD, PID controllers, Nyquist and Bode diagrams; digital control systems: sampling theorem of Shannon, holding elements; discrete time transfer function; transfer functions and polezero configurations of typical elements; impulse response of sampling systems and typical components; linear systems and their description in time- and frequency domains; signal transfer in control systems; requirements for control systems; continuous signal linear control systems; performances of control systems. Stability criterions. Idea and application of root locus.

Compulsory/Recommended Readings:
• Wolfgang Altmann, Practical process control for engineers and technicians, Elsevier/Newnes 2005
• Karl Johan Aström, Richard M. Murray. Feedback systems: an introduction for scientists and engineers. Princeton University Press, 2008

SOFTWARE DEVELOPMENT FOR ENGINEERS

INBMA0423-17

Semester: 4
Type: Laboratory
Number of Classes: 0+0+2
Credit: 3
Status: Obligatory
Assessment: Practical mark
Prerequisites: INBMA0317-17 (Programming languages 2)
Responsible: Dr. Gergely Kocsis

Topics:
The aim of the subject is to provide an introduction to the technologies and methodologies applied during the development of multi-actor programming projects.
One goal is to make the student being involved to a project similar to real ones during the semester.
As a project the student can chose between desktop and multiplatform/mobile application development.
During the semester the student get introduction to the following topics: Agile software development methods and tools. Requirement engineering. Build automation and project management. Version control. OO planning principles and design patterns. MVC. Testing principles. Data management. GUI development basics.

Compulsory/Recommended Readings:

• Tomek Kaczanowski: Practical Unit Testing with Junit and Mockito, Tomasz Kaczanowski, 2013 ISBN 8393489393
• Ian Sommerville: Software Engineering, PEARSON EDUCACION, 10th(!) edition edition, 2015 ISBN-10: 0133943038
• Kenneth S. Rubin: Essential Scrum: A Practical Guide to the Most Popular Agile Process (Addison-Wesley Signature Series (Cohn)), ISBN 978-0-13-704329-3
• Edward Crookshanks: Practical Software Development Techniques ISBN 978-1-4842-0728-4
• Andrew Stellman, Jennifer Greene: Learning Agile: Understanding Scrum, XP, Lean, and Kanban, 2014 ISBN 10:1-4493-3192-0

ENTERPRISE INFORMATION SYSTEMS

INBMA0424-17

Semester: 4
Type: Lecture
Number of Classes: 2+0+0
Credit: 3
Status: Obligatory
Assessment: Exam
Prerequisites: None
Responsible: Dr. Attila Kuki

Topics:
Information systems, life cycle, dimensions, architecture levels, Categories of information systems, management information systems, Basic concepts of system engineering, different paradigms, Classical methodologies, waterfall (structured) models, Iterative models (evolution, spiral, incremental), Basics of UML, most important diagrams, Modeling system life cycle by UML – structure diagrams, Modeling system life cycle by UML – nt he r diagrams, Elements of the Unified Process, Enterprise information processes – technological and economical processes, Abstract models for an enterprise – the five layer model, Different approaches for designing the enterprise layers, Enterprise information systems – Case studies.

Compulsory/Recommended Readings:
• Larman C.: Applying UML and Patterns: An Introduction to Object-Oriented Analysis and Design and Iterative Development, Prentice Hall; 3 edition (October 30, 2004).
• Dennis A., Wixom B.H., Tegarden D.: Systems Analysis and Design with UML, Wiley; 4 edition (February 1, 2012)
• Sommerville: Software Engineering, Pearson; 10 edition (April 3, 2015).

WEB SOLUTIONS

INBMA0425-17

Semester:	4
Type:	Laboratory
Number of Classes:	0+0+2
Credit:	3
Status:	Obligatory
Assessment:	Practical mark
Prerequisites:	INBMA0211-17 (Programming languages 1) or INBMA0317-17 (Programming languages 2)
Responsible:	Dr. Attila Adamkó

Topics:
The basics and elements of HTML. Constructing a simple webpage in practice with HTML elements. The basics of formatting with style sheets. Spectacular transformations and animations. The basics of web script solutions: simple functions, control structures, data processing. PHP basics: data types, control structures, data processing, file management. Sensor reading through a web interface. Controlling through a web interface. Remote administration systems through a web interface. Project work (constructing a webpage by yourself).

Compulsory/Recommended Readings:
• Julie C. Meloni, Michael Morrison: SAMS Teach Yourself HTML and CSS in 24 Hour. 2010 by SAMS Publishing.
• Matthew MacDonald: Creating a Website: The Missing Manual. O'Reilly Media.
• Robin Nixon: Learning PHP, MySQL, JavaScript, and CSS. O'Reilly Media.

INTRODUCTION INTO ARTIFICIAL INTELLIGENCE

INBMA0526-17

Semester:	5
Type:	Lecture / Laboratory
Number of Classes:	2+0+2
Credit:	6
Status:	Obligatory
Assessment:	Exam
Prerequisites:	INBMA0106-17 (Introduction into logic and computer science) and INBMA0207-17 (Data structures and algorithms) and INBMA0211-17 (Programming languages 1)
Responsible:	Dr. László Aszalós

Topics:
Intelligent agents, representing state-space, search with noninformed and heuristic algorithms. Constraint Satisfaction Problem, Two Person Games, winning strategy. Planning, decision trees, learning algorithms.

Compulsory/Recommended Readings:
• Peter Norvig, Stuart J. Russel: Artificial Intelligence: a Modern Approach, Pearson; 3 edition, 2010.
• Pedro Domingos: The Master Algorithm, Basic Books; 1 edition2015

ASSEMBLY PROGRAMMING

INBMA0527-17

Semester: 5
Type: Laboratory
Number of Classes: 0+0+2
Credit: 3
Status: Obligatory
Assessment: Practical mark
Prerequisites: INBMA0211-17 (Programming languages 1) and INBMA0212-17 (Computer architectures)
Responsible: Dr. Imre Varga

Topics:
Basics of assembly programming. X86 architecture. Data moving, constants, variables. Arithmetic and logic operations. Control flow (branching and looping). The stack. Calling subprograms, parameter passing. Local variable. System call. Optimizing. Inline assembly.

Compulsory/Recommended Readings:
• Richard Blum: Professional Assembly Language, Wiley Publishing, 2005, ISBN: 9780764579011
• Joseph Cavanagh: X86 Assembly Language and C Fundamentals, CRC Press, 2013, ISBN: 9781466568242

EMBEDDED SYSTEMS

INBMA0528-17

Semester:	5
Type:	Lecture / Laboratory
Number of Classes:	2+0+2
Credit:	6
Status:	Obligatory
Assessment:	Exam
Prerequisites:	INBMA0102-17 (Electronics) and INBMA0212-17 (Computer architectures)
Responsible:	Dr. László Tóth

Topics:
Introduction, definitions, typical application and requirements for embedded systems. The concept of reactive and real-time systems. Embedded systems architecture. Hardware and software layers. The processor implementation options: Processor technology, implementation techniques and design technologies. Typically peripherals for embedded systems. Signal converters (A / D and D / A) and signal conditioning. Communication protocols: I2C, SPI, RS232, RS422, RS485, MODBUS, PROFIBUS, CAN. Wireless communication protocols. Embedded software: system software layer and application layer. Example application: Implementation of a system with multiple sensors and actuators. Implementation of embedded systems using microcontrollers. Examples and case studies.

Compulsory/Recommended Readings:
• Tammy Noergaard: Embedded Systems Architecture, 2nd Edition, Elsevier, 2012, ISBN: 9780123821966,
• Peter Marwedel, Embedded System Design, 2nd Edition, Springer 2011, XXI, ISBN 978-94-007-0257-8,
• Vahid, Frank; Givargis, Tony: Embedded System Design – A Unified Hardware/Software Introduction, John Wiley & Sons, 2002, ISBN 0-471-38678-2.

MODELING AND ANALYSIS OF INFORMATION TECHNOLOGY SYSTEMS

INBMA0529-17

Semester: 5
Type: Seminar
Number of Classes: 0+2+0
Credit: 2
Status: Obligatory
Assessment: Practical mark
Prerequisites: INBMA0313-17 (Probability theory and mathematical statistics)
Responsible: Dr. János Sztrik

Topics:
Discrete distributions and their applications, continuous distributions and their applications, exponential distributions and its properties. Convolution of continuous distributions, Erlang-distribution. Series systems, parallel systems. Distributions derived from the exponential.
Generation of random numbers. Generating function and its properties, Laplace –tensform and its properties. Markov-chains, birth-and-death processes.

Compulsory/Recommended Readings:
• B. Haverkort: Performance of computer communication systems: a model-based approach, New York, John Wiley and Sons, 1998
• R. Jain: The Art of Computer Systems Performance Analysis, New York, John Wiley and Sons, 1991
• K.S. Trivedi: Probability and Statistics with Reliability, Queueing and Computer Science Applications, Prentice-Hall, Englewood Cliffs, 1982.

MOBILE SOLUTIONS

INBMA0530-17

Semester: 5
Type: Laboratory
Number of Classes: 0+0+2
Credit: 3
Status: Obligatory
Assessment: Practical mark
Prerequisites: INBMA0317-17 (Programming languages 2)
Responsible: Dr. Gergely Kocsis

Topics:
The aim of the subject is to introduce a mobile platform and the basics of application development for the students.
During the semester the following topics will be introduced: The mobile development environment. The user interface. Persistent data storing. Sensors and locations services. Low and high level network communication. Communication solutions. Multimedia solutions. API calling. Performance tuning. Other mobile platforms and solutions.

Compulsory/Recommended Readings:
• Bill Phillips, Chris Stewart, Brian Hardy, Kristin Marsicano, Android Programming: The Big Nerd Ranch Guide (2nd Edition) (2015) Big Nerd Ranch LTD, ISBN-10: 0134171454
• Kyle Mew: Android 5 Programming by Example, Packt Publishing, 2015 ISBN 139781785288449
• Android API Guides, https://developer.android.com/guide/index.html

DATABASE SYSTEMS AND KNOWLEDGE REPRESENTATION

INBGA0633-17

Semester: 6
Type: Lecture / Laboratory
Number of Classes: 2+0+2
Credit: 6
Status: Obligatory
Assessment: Practical mark
Prerequisites: INBMA0211-17 (Programming languages 1)
Responsible: Dr. Tamás Bérczes

Topics:
Basic knowledge and methods related to the operation, use and implementation of Database Management Systems. Database acquisition design. Entity-Relationship (ER) model design using ER diagrams. Relational data model, relation, schema attributes. Relational algebra. Data definition (DDL) and data manipulation (DML) properties of languages. Relational query optimization and evaluation. Cost-based optimization.

Compulsory/Recommended Readings:
• Silberschatz, H. F. Korth, S. Sudarshan: Database System Concepts, 6th Edition, 2010
• Carlos Coronel, Steven Morris: Database Systems: Design, Implementation, & Management, Cengage Learning; 11 edition, 2014

IT SECURITY

INBGA0634-17

Semester: 6
Type: Laboratory
Number of Classes: 0+0+2
Credit: 3
Status: Obligatory
Assessment: Practical mark
Prerequisites: INBMA0420-17 (Operating systems)
Responsible: Dr. Andrea Huszti

Topics:
File access control, Encrypted File System, Configure users, groups, and authentication, SSH authentication, key generation, Wireshark network packet analyzer, OpenSSL cryptographic library.

Compulsory/Recommended Readings:
• Daniel J. Barrett, Richard E. Silverman, Robert G. Byrnes: SSH, the Secure Shell, The Definitive Guide, O'Reilly, 2005, ISBN 978-0-596-00895-6,
• Ivan Ristić: OpenSSL Cookbook, Second Edition, Feisty Duck, London, 2015

COMPUTER GRAPHICS

INBGA0635-17

Semester:	6
Type:	Laboratory
Number of Classes:	0+0+2
Credit:	3
Status:	Obligatory
Assessment:	Practical mark
Prerequisites:	INBMA0211-17 (Programming languages 1) or INBMA0317-17 (Programming languages 2)
Responsible:	Dr. Róbert Tornai

Topics:
The graphical possibilities of the used programming and shading language. Drawing basic primitives. Overview of the necessary algebraic and geometric elements. Equations of lines, circles and planes. Distance of spatial objects. Homogeneous coordinates. Incremental algorithms for drawing lines and circles. Filling and clipping algorithms. Simple motions and animations. 2D transformations. Window to Viewport transformation. Hermite arcs. GMT formula. Bézier curves. Joining curves. Viewing. Orthogonal projection, central projection, axonometric projection. 3D transformations. Coordinate transformations. Viewing frustum. Illumination models. Ambient, diffuse and specular lights. Surface shading. Flat shading. Gouraud shading. Phong shading. Visualizing surfaces generated by two variable (scalar valued) functions. Visualizing surfaces based on their parametric equation systems. Visibility.

Compulsory/Recommended Readings:

• John F. Hughes, Andries van Dam, Morgan McGuire, David F. Sklar, James D. Foley, Steven K. Feiner, Kurt Akeley: Computer graphics: principles and practice (3rd Edition). Addison-Wesley Professional, 2014., ISBN: 978-0321399526
• Donald D. Hearn, M. Pauline Baker: Computer graphics with OpenGL (3rd Edition). Prentice Hall, 2003., ISBN: 978-0130153906
• Steve Marschner, Peter Shirley: Fundamentals of Computer Graphics (4th Edition), A K Peters/CRC Press, 2015., ISBN-13: 978-1482229394
• Sumanta Guha: Computer Graphics through OpenGL: From Theory to Experiments (2nd Edition), A K Peters/CRC Press, 2014., ISBN: 978-1482258394

Differentiated knowledge topics

MICROCONTROLLERS

INBMA9937-17

Semester:	4
Type:	Lecture / Laboratory
Number of Classes:	2+0+2
Credit:	6
Status:	Optional
Assessment:	Practical mark
Prerequisites:	INBMA0209-17 (Digital design) and INBMA0211-17 (Programming languages 1)
Responsible:	Dr. Attila Buchman

Topics:
Functional block diagram of the 8 bit microcontroller. Address and Data buses. CPU, Ports and GPIO. I/O interfacing and programming. Memory mapping. ROM/Flash and RAM. Von Neumann and Harvard Architectures. Machine Language. Assembly Language. Core Registers. Higher lewel programming.

Compulsory/Recommended Readings:
• Muhammad Ali Mazidi, Sarmad Naimi, Sepehr Naimi: AVR Microcontroller and Embedded Systems: Using Assembly and C, Pearson Education, Limited, 2013,
• Steven F. Barrett, Daniel J. Pack, Atmel AVR Microcontroller Primer: Programming and Interfacing, Synthesis Lectures on Digital Circuits and Systems, 2007.

PROGRAMMING NETWORK DEVICES 1

INBMA9938-17

Semester: 5
Type: Seminar / Laboratory
Number of Classes: 0+2+2
Credit: 6
Status: Optional
Assessment: Practical mark
Prerequisites: INBMA0318-17 (Computer networks)
Responsible: Dr. Szabolcs Szilágyi

Topics:
Explore the corporate networks. Network devices. Configure the network operating system. Physical layer. Twisted-pair communication standards, termination and testing tasks. Data Link layer. Ethernet. Network layer. IP configuration. IP subnetting. Transport layer. UDP. TCP. Application layer. Introduction to switched networks. Basic switching concepts and configuration. VLANs. Inter-VLAN routing. Static and dynamic routing (RIP). Single-area OSPF. Standard and extended access control lists. DHCP. Network Address Translation for Ipv4 (NAT). LAN design problems (exercises).

Compulsory/Recommended Readings:
• Wendell, Odom: CCENT/CCNA ICND1 100-105 Official Cert Guide, Cisco Press, 2016., ISBN: 978-1-58720-580-4,
• Scott, Empson: CCNA Routing and Switching Portable Command Guide, 4th Edition, Cisco Press, 2016, ISBN: 978-1-58720-588-0.
• Cisco Networking Academy: https://www.netacad.com/

PROGRAMMABLE LOGIC DEVICES

INBGA9939-17

Semester:	5
Type:	Lecture / Laboratory
Number of Classes:	2+0+2
Credit:	6
Status:	Optional
Assessment:	Practical mark
Prerequisites:	INBMA0209-17 (Digital design) and INBMA0211-17 (Programming languages 1)
Responsible:	Dr. István Oniga

Topics:
Implementation possibilities of digital circuits. Simple PLDs (PAL, PLA, GAL, PROM). Complex PLDs (CPLD, FPGA). Hardware programming concept. Integrated development environments for PLDs. Design flow from specification to implementation. Design entry based on schematic or hardware description languages (VHDL, Verilog). Verilog language description of simple digital circuits. Simulation using testbenches. RTL design. Sequential circuits design, counters, registers. FSM design using FPGA circuits. Design example using HDL.

Compulsory/Recommended Readings:

• Pong P. Chu, FPGA Prototyping By Verilog Examples: Xilinx Spartan-3 Version, ISBN: 978-0-470-18532-2,
• John F. Wakerl: Digital Design, Prentice Hall, 2001, ISBN 0-13-089896-1,
• R. E. Haskell, D. M. Hanna, Learning by example using Verilog. Advanced digila Design. , LBE Books, 2009,
• Clive Maxfield, The Design Warrior's Guide to FPGAs. Devices, Tools and Flows, ISBN:0750676043.

DEVELOPMENT OF EMBEDDED SYSTEMS

INBGA9940-17

Semester:	6
Type:	Laboratory
Number of Classes:	0+0+4
Credit:	6
Status:	Optional
Assessment:	Practical mark
Prerequisites:	INBMA0528-17 (Embedded systems) and (INBMA9937-17 (Microcontrollers) or INBMA9939-17 (Programmable logic devices))
Responsible:	Dr. Gergely Kocsis

Topics:
Design and implementation of a system with multiple sensors and actuators. Presentation of example and case studies. System design. Performing experiments and evaluation of results. Carrying out control measurements. Design, implementation and testing of the final solution. Documentation. Project presentation and evaluation.

Compulsory/Recommended Readings:
• Tammy Noergaard: Embedded Systems Architecture, 2nd Edition, Elsevier, 2012, ISBN: 9780123821966,
• Peter Marwedel, Embedded System Design, 2nd Edition, Springer 2011, XXI, ISBN 978-94-007-0257-8,
• Vahid, Frank; Givargis, Tony: Embedded System Design – A Unified Hardware/Software Introduction, John Wiley & Sons, 2002, ISBN 0-471-38678-2.

PROGRAMMING NETWORK DEVICES 2

INBGA9941-17

Semester: 6
Type: Seminar / Laboratory
Number of Classes: 0+2+2
Credit: 6
Status: Optional
Assessment: Practical mark
Prerequisites: INBMA9938-17 (Programming network devices 1)
Responsible: Dr. Szabolcs Szilágyi

Topics:
Scaling networks. LAN redundancy. Link aggregation. Wireless LANs. Adjust and troubleshoot single-area OSPF. Multiarea OSPF. EIGRP. EIGRP advanced configurations and troubleshooting. IOS images and licensing. Hierarchical network design. Connection to the WAN. Point-to-point connections. Frame Relay. Broadband solutions. Securing site-to-site connectivity. Monitoring and troubleshooting the network.

Compulsory/Recommended Readings:
• Wendell, Odom: CCNA Routing and Switching ICND2 200-105 Official Cert Guide, Cisco Press, 2016., ISBN: 978-1-58720-579-8
• Scott, Empson: CCNA Routing and Switching Portable Command Guide, 4th Edition, Cisco Press, 2016, ISBN: 978-1-58720-588-0
• Cisco Networking Academy: https://www.netacad.com/

MODELING AND PERFORMANCE EVALUATION OF NETWORKS

INBGA9942-17

Semester:	6
Type:	Lecture / Laboratory
Number of Classes:	2+0+2
Credit:	6
Status:	Optional
Assessment:	Practical mark
Prerequisites:	INBMA0529-17 (Modeling and Analysis of Information Technology Systems)
Responsible:	Dr. János Sztrik

Topics:
Queueing systems, M/M/1 systems, M/M/1 queueing networks, Queueing systems with balking customers, multiple server systems, finite capacity systems. Priority systems, Erlang-loss systems, M/G/1 systems. Engset-loss systems, finite-source queueing systems.

Compulsory/Recommended Readings:

• B. Haverkort: Performance of computer communication systems: a model-based approach, New York, John Wiley and Sons, 1998.
• R. Jain: The Art of Computer Systems Performance Analysis, New York, John Wiley and Sons, 1991.
• K. S. Trivedi: Probability and Statistics with Reliability, Queueing and Computer Science Applications, Prentice-Hall, Englewood Cliffs, 1982.

TELECOMMUNICATION SYSTEMS

INBGA9943-17

Semester: 6
Type: Lecture / Laboratory
Number of Classes: 2+0+2
Credit: 6
Status: Optional
Assessment: Practical mark
Prerequisites: INBMA0318-17 (Computer networks)
Responsible: Dr. Tamás Bérczes

Topics:
Physical transmission: wired and wireless transmission, terrestrial and satellite communications, optical transmission. Classification of telecommunication networks. Analog and digital audio transmission. ISDN, ADSL, xDSL triple play. Cable television systems. Cable TV Internet access. Optical access networks. Voice over IP (VoIP). Mobile communications, GSM systems: 1G, GSM (2G), UMTS, LTE, 5G, closed-circuit networks. GPS system. Satellite communications.

Compulsory/Recommended Readings:
• S. S. Jones, Editor: The Basics of Telecommunications, International Engineering Consortium, Chicago, 2004
• J. C. Bellamy: Digital Telephony. Wiley, New York, 2000.
• A. S. Tanenbaum, D. J. Wetherall: Computer Networks, 5th edition, Pearson, 2011.

SENSORS AND ACTUATORS NETWORK

INBGA9944-17

Semester:	7
Type:	Lecture / Laboratory
Number of Classes:	2+0+2
Credit:	6
Status:	Optional
Assessment:	Practical mark
Prerequisites:	INBMA0318-17 (Computer networks) and INBMA9937-17 (Microcontrollers)
Responsible:	Dr. László Tóth

Topics:
Sensors: classification, propreties, phisycal principles. Sensors used in desktop and mobile computing devices. Actuators: classification, propreties, phisycal principles. Sensor network architectures. IEEE 802.15.4.standard. Network layer, energy and location-aware routing; attribute-based addressing, clustering; Data-driven operation. Transport Layer: TCP-like protocols, application-layer protocols (SMP, TADAP, SQDDP) standardization issues (ZigBee). Typical sensor networking applications, case studies (health, engineering applications, environmental protection, smart home, etc).

Compulsory/Recommended Readings:
• Edgar H., Jr. Callaway, Edgar H. Callaway, Wireless Sensor Networks: Architectures and Protocols, Auerbach Publications, 2003
• H. Karl, A. Willig, „Protocols and Architectures for Wireless Sensor Networks", John Wiley & Sons Ltd, 2005