UNIVERSITY OF DEBRECEN, FACULTY OF INFORMATICS

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COMPUTER SCIENCE ENGINEERING BSC

2024

Mode: Full-time training

Program Coordinator: Dr. Imre Varga (varga.imre@inf.unideb.hu)

Mentor: Dr. Attila Kuki (kuki.attila@inf.unideb.hu)

Qualification requirements

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

Work and Fire Safety and Physical Education

The courses of „Work and Fire Safety" and „Physical Education" are worth 1 - 1 credit, which must be completed in excess of the number of credits required for the diploma as specified in the training and outcome requirements of the degree.

Diploma credit requirements

Natural Science:	45 credits
Human and Economic Knowledge:	15 credits
Compulsory topics:	93 credits
Differentiated knowledge topics:	30 credits
Professional Training:	12 credits
Thesis work:	15 credits
Free choise:	12 credits
Total	**210 credits**
Work and Fire Safety:	1 credit
Physical Education (2 semesters):	2 credits

Natural Science – needed 45 credits

Code	Subject name	Credit	Type and number			Assessment	Prerequisites	Period	Semester
			lec.	practice					
				sem.	lab				
INBMA0101-24 NBMA0101G	Algorithms and Basics of Programming	3		2		PM		1	1
INBMA0102-24 INBMA0102E INBMA0102L	Electronics	6	2		2	E S		1	1
INBMA0104-24 INBMA0104E INBMA0104G	Calculus	6	2	2		E S		1	1
INBMA0105-24 INBMA0105E INBMA0105L	Mathematics for Engineers 1	6	2		2	PM		1	1
INBMA0203-24 INBMA0203E INBMA0203L	Physics	6	2		2	E S		1	1
INBMA0207-17 INBMA0207E INBMA0207G	Data Structures and Algorithms	6	2	2		E S		2	2
INBMA0208-24 INBMA0208E INBMA0208L	Mathematics for Engineers 2	6	2		2	E S	INBMA0104-24 INBMA0105-24	2	2
INBMA0313-17 INBMA0313E INBMA0313L	Probability Theory and Mathematical Statistics	6	2		2	PM	INBMA0104-24 INBMA0105-24	1	3

Human and Economic Knowledge – needed 15 credits

Code	Subject name	Credit	Type and number			Assessment	Prerequisites	Period	Semester
			lec.	practice					
				sem.	lab				
INBMA0314-17 INBMA0314E INBMA0314G	Economics	6	2	2		E S		1	3
INBMA0531-21 INBMA0531E	Fundamentals of Business Law	3	2			E		1	5
INBMA0632-17 INBMA0632E INBMA0632G	Management Basics for Engineers	6	2	2		E S		2	6

Compulsory topics – needed 93 kredits

Code	Subject name	Credit	Type and number			Assessment	Prerequisites	Period	Semester
			lec.	practice					
				sem.	lab				
INBMA0106-24 INBMA0106E INBMA0106G	Introduction into Logic and Computer Science	6	2	2		E S		1	1
INBMA0120-24 INBMA0120L	Operating Systems	3			2	PM		1	1

Code	Subject name	Credit	Type and number			Assessment	Prerequisites	Period	Semester
			lec.	practice					
				sem.	lab				
INBMA0209-24 INBMA0209E INBMA0209L	Digital Design	6	2		2	E S	INBMA0102-24	2	2
INBMA0211-21 INBMA0211E INBMA0211L	Programming Languages 1	6	2		2	E S	INBMA0101-24	2	2
INBMA0315-17 INBMA0315L	Signals and Systems	3			2	PM	INBMA0102-24 INBMA0208-24	1	3
INBMA0316-17 INBMA0316L	Introduction to Graphical Programming Environment	3			2	PM	INBMA0101-24	1	3
INBMA0317-21 INBMA0317G INBMA0317L	Programming Languages 2	6		2	2	PM	INBMA0211-21	1	3
INBMA0318-17 INBMA0318E INBMA0318L	Computer Networks	6	2		2	E S	INBMA0120-24	1	3
INBMA0412-21 INBMA0412E	Computer Architectures	3	2			E	INBMA0209-24	2	4
INBMA0419-17 INBMA0419E	Management of Data Network Systems	3	2			E	INBMA0318-17	2	4
INBMA0421-24 INBMA0421L	System Programming	3			2	PM	INBMA0211-21	2	4
INBMA0422-21 INBMA0422L	Control Systems	3			2	PM	INBMA0315-17	2	4
INBMA0424-17 INBMA0424E	Enterprise Information Systems	3	2			E		2	4
INBMA0425-17 INBMA0425L	Web Solutions	3			2	PM	INBMA0211-21	2	4
INBMA0433-21 INBMA0433E INBMA0433L	Database Systems and Knowledge Representation	6	2		2	PM	INBMA0211-21	2	4
INBMA0434-24 INBMA0434L	IT Security	3			2	PM	INBMA0120-24	2	4
INBMA0435-24 INBMA0435L	Computer Graphics	3			2	PM	INBMA0211-21	2	4
INBMA0523-21 INBMA0523E INBMA0523L	Software Development for Engineers	6	2		2	E S	INBMA0317-21	1	5
INBMA0526-24 INBMA0526E INBMA0526L	Introduction into Artificial Intelligence	6	2		2	E S	INBMA0106-24 INBMA0207-17 INBMA0211-21	1	5
INBMA0527-17 INBMA0527L	Assembly Programming	3			2	PM	INBMA0211-21 INBMA0412-21	1	5
INBMA0528-17 INBMA0528E INBMA0528L	Embedded Systems	6	2		2	E S	INBMA0211-21 INBMA0412-21	1	5
INBMA0630-21 INBMA0630L	Mobile Solutions	3			2	PM	INBMA0317-21	2	6

Thesis work – needed 15 credits

Code	Subject name	Credit	Type and number			Assessment	Prerequisites	Period	Semester
			lec.	practice					
				sem.	lab				
INBMA0636-21 INBMA0636X	Thesis 1	6				PM		2	6
INBMA0736-21 INBMA0736X	Thesis 2	9				PM		1	7

Differentiated knowledge topics – needed 30 credits

Code	Subject name	Credit	Type and number			Assessment	Prerequisites	Period	Semester
			lec.	practice					
				sem.	lab				
INBMA9937-17 INBMA9937E INBMA9937L	Microcontrollers	6	2		2	PM	INBMA0209-24 INBMA0211-21	2	4
INBMA9946-17 INBMA9946E	Fundamentals of Information and Coding Theory	3	2			E	INBMA0313-17	2	4
INBMA9929-17 INBMA9929G	Modeling and Analysis of Information Technology Systems	2		2		PM	INBMA0313-17	1	5
INBMA9938-21 INBMA9938L	Programming Network Devices 1	6			4	PM	INBMA0318-17	1	5
INBMA9939-17 INBMA9939E INBMA9939L	Programmable Logic Devices	6	2		2	PM	INBMA0209-24 INBMA0211-21	1	5
INBMA9945-17 INBMA9945L	Scripting Languages	3			2	PM	INBMA0211-21	1	5
NBMA9940-17 INBMA9940L	Development of Embedded Systems	6			4	PM	INBMA0528-17 (INBMA9937-17 OR INBMA9939-17)	2	6
NBMA9941-21 INBMA9941L	Programming Network Devices 2	6			4	PM	INBMA9938-21	2	6
NBMA9942-17 INBMA9942E INBMA9942L	Modeling and Performance Evaluation of Networks	6	2		2	PM	INBMA9929-24	2	6
NBMA9943-17 INBMA9943E INBMA9943L	Telecommunication Systems	6	2		2	PM	INBMA0318-17	2	6
INBMA9947-17 INBMA9947L	Introduction to Cloud Technologies	3			2	PM	INBMA0211-21	2	6
INBMA9997-21 INBMA9997G	Professional Training	12				PM	INBMA0317-21 INBMA0318-17	I	6
NBMA9944-17 INBMA9944E INBMA9944L	Sensors and actuators Network	6	2		2	PM	INBMA0318-17 INBMA9937-17	1	7
INBMA9951-17 INBMA9951L	Basics of Autonomous Vehicles Development	6			4	PM	INBMA0211-21	I	
INBMA9952-17 INBMA9952L	Ethical hacking I.	3			2	PM	INBMA0211-21	I	

Code	Subject name	Cre-dit	Type and number			Asses-ment	Prerequisites	Period	Semes-ter
			lec.	practice					
				sem.	lab				
INBMA9953-17 INBMA9953E	Blockhain technology	3	2			E		I	
INBMA9958-17 INBMA9958L	Introduction to the AWS Cloud	3			2	PM		I	
INBMA9959-21 INBMA9959L	Network and System Security	3			2	PM	INBMA0120-24	I	

Free choice – needed 12 credits

Code	Subject name	Cre-dit	Type and number			Asses-ment	Prerequisites	Period	Semes-ter
			lec.	practice					
				sem.	lab				

Exam types:
E exam
S sign
PM practical

COMPUTER SCIENCE ENGINEERING BSC

Description of Subjects

Natural Science

ALGORITHMS AND BASIC OF PROGRAMMING

INBMA0101-24

Semester: 1
Type: Seminar
Number of Classes: 0+2+0
Credit: 3
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

INBMA0102-24

Semester: 1
Type: Lecture / Laboratory
Number of Classes: 2+0+2
Credit: 6
Status: Obligatory
Assessment: Exam
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

CALCULUS

INBMA0104-24

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

Topics:
Sequences of real numbers: boundedness, monotonicity, convergence, the most basic sequences. Series of real numbers: convergence, Cauchy's root test, D'Alembert's ratio test. Elementary functions: exponential, logarithm, trigonometric and hyperbolic functions. Continuity of real functions. Limits of real functions: basic concepts, transfer principle, the most basic function limits. Differentiability of real functions: the concept of differentiability, differentiation rules, higher order derivatives, Taylor's theorem, L'Hospital's rule. Monotonicity, extrema, and convexity of differentiable functions. Indefinite integral: basic integrals, linearity of the integral, integration by parts, integration by substitution. Riemannian integral and its applications: the concept and properties of the Riemannian integral, the Newton-Leibniz formula, improper integrals, applications of the Riemannian integral.

Compulsory/Recommended Readings:

- T. M. Apostol, Calculus. Vol. I: One-variable calculus, with an introduction to linear algebra, Second edition, Blaisdell Publishing Co. Ginn and Co., Waltham, Mass.-Toronto, Ont.-London 1967.
- T. M. Apostol, Calculus. Vol. II: Multi-variable calculus and linear algebra, with applications to differential equations and probability. Second edition, Blaisdell Publishing Co. Ginn and Co., Waltham, Mass.-Toronto, Ont.-London 1969.
- B. Demidovich, and G. Yankovskv, Problems in mathematical analysis. Mir Publishers. 2020.
- E. Mendleson, 3000 Solved Problems in Calculus, McGraw Hill Professional, 1988.
- W. Rudin, Principles of mathematical analysis (Vol. 3). New York: McGraw-hill, 1976.
- G. B. Thomas, R. L. Finney, M. D. Weir, and F. R. Giordano, Thomas' calculus. Reading: Addison-Wesley, 2003.

MATHEMATICS FOR ENGINEERS 1

INBMA0105-24

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

Topics:
Basic functions and their properties (polynomials, absolute value, exponential and trigonometric functions). Complex numbers: algebraic, trigonometric, exponential form, operations with complex numbers in different forms, square root. Basics of linear algebra: vectors in R^n, linear independence, basis, generator system. Matrices, determinant, linear equation systems. Eigenvalue, eigenvector. Numerical methods: features of the floating-point number representation, least square approximations, Lagrange and Hermite interpolation, approximation of the roots of nonlinear equations, approximation of the minimum locus of functions.

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

PHYSICS

INBMA0203-24

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

Topics:
Physical quantities, basics of kinetics and mechanics. Concepts of electrostatics: charge, Coulomb's law, electric field, voltage, potential energy. Direct- and alternating current. Capacitor, resistance, Ohm's law, Kirchoff's law. RC circuit, filters. Work and power of components of circuits. Induction, impedance, RLC circuits. Transformer, electric motor. Electromagnetic waves and their applications. Semiconductors, diode, transistor, integrated circuits. Physics of sensors: measuring temperature, ultrasound sensor, laser distance meter, PIR sensor, accelerometer/gyroscope, phototransistor, RFID. Modern physics.

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

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. Géza Horváth

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

INBMA0208-24

Semester:	2
Type:	Lecture / Laboratory
Number of Classes:	2+0+2
Credit:	6
Status:	Obligatory
Assessment:	Exam
Prerequisites:	INBMA0104-24 (Calculus) and INBMA0105-24 (Mathematics for Engineers 1)
Responsible:	Dr. Patrícia Ágnes Szokol

Topics:
Introduction of differential equations and examples for them (equation of free fall, of harmonic oscillation and of radioactive decay). Classification of differential equations, nth order implicit/explicit ordinary differentail equations (ODE), solution of first order ODE. Definitions of line element and direction field. Initial value problem and initial condition. Elementary solution methods. Homogeneous/inhomogeneous linear differential equations and their solutions. System of equations and higher order equations. Linear equation of order 2 with constant coefficients, their solutions and characteristic equations. Numerical solution of differential equations (successive approximation, Euler's and Runge-Kutta methods). Numerical solution of higher order equations. Approximation of functions by polynomials: power series, Taylor series. Radius of convergence. Fourier series, evaluation of the coefficients for general, even and odd functions. Fourier transform, inverse Fourier transzform and their properties. Discrete/inverse discrete Fourier transform. Definition, evaluation of Laplace transform and their applications for solution of differential equations. Acquirement of MATLAB knowledge concerning the previous topics (drawing of direction fields, numerical solution of first- and higher order differential equations, power series. Evalutaion functions obtained by Fourier-series and Fourier-transform. Determination of Laplace transforms).

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:	INBMA0104-24 (Calculus) and INBMA0105-24 (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.

Human and Economic Knowledge

ECONOMICS

INBMA0314-17

Semester: 3
Type: Lecture / Seminar
Number of Classes: 2+2+0
Credit: 6
Status: Obligatory
Assessment: Exam
Prerequisites: None
Responsible: Dr. Ágnes Szabó-Morvai, Szobonyáné

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

INBMA0531-21

Semester: 5
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

INBMA0106-24

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

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.

OPERATING SYSTEMS

INBMA0120-24

Semester: 1
Type: Laboratory
Number of Classes: 0+0+2
Credit: 3
Status: Obligatory
Assessment: Practical mark
Prerequisites: None
Responsible: Dr. Zoltán Attila Godó

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)

DIGITAL DESIGN

INBMA0209-24

Semester: 2
Type: Lecture / Laboratory
Number of Classes: 2+0+2
Credit: 6
Status: Obligatory
Assessment: Exam
Prerequisites: INBMA0102-24 (Electronics)
Responsible: Dr. István László Oniga

Topics:
Introduction to digital design. Analog and digital signals. Characteristics of logic circuits. Number systems, number representation. Arithmetic operations. Boolean algebra. Logic gates and their schematic symbols. Logic functions and their descriptions. Simplification of logic functions. Specifying two and more level circuits in Verilog, simulation, implementation. Combinational logic networks: encoders, decoders, multiplexers, demultiplexers, comparators, parity checking circuits, adders. Description of a 7-segment decoder in Verilog and its implementation in FPGA circuits. Arithmetic logic units. Sequential logic networks: RS, D, T and JK flip-flops. Synchronous and asynchronous binary and BCD counters. Shift registers. Ring and Johnson counters. Memories. Description of memories in Verilog language, simulation and implementation. Characteristics of logic circuit families. Programmable logic devices. Design of logic networks in Verilog language.

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

INBMA0211-21

Semester: 2
Type: Lecture / Laboratory
Number of Classes: 2+0+2
Credit: 6
Status: Obligatory
Assessment: Exam
Prerequisites: INBMA0101-24 (Algorithms and basics of programming)
Responsible: Dr. László Szathmáry

Topics:
The goal of the course is to learn a procedural programming language, e.g. C. Objective of programming. Neumann architecture. Number systems, number representation, overflow. Evolution of programming languages. Programming paradigms. Building a programming environment. Compiler, interpreter. Variable, constant, named constant. Local and global variables. Scope, lifetime. Conditional statements. Loops. Types. Arithmetic operations, operators, operands. Expressions, boolean expressions. I/O operations (writing to standard output, reading from standard input). Subroutines (functions, procedures). Array data structure; array operations. Multidimensional arrays. Parameter evaluation, parameter passing. Debugging; syntax and semantic errors. Strings; string operations. Command-line arguments. Exit code. Generating random numbers. Pointers; pointer operations. Record data structure. Defining an own type. File handling (reading and writing a text file). Dynamic memory allocation. Stack memory and heap memory. Abstract data type. Dynamic array. Pure functions. Sorting. Recursion, call chain. Writing and using an own library. Using the Makefile. Outlook (introducing a higher level programming language).

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

SIGNALS AND SYSTEMS

INBMA0315-17

Semester:	3
Type:	Laboratory
Number of Classes:	0+0+2
Credit:	3
Status:	Obligatory
Assessment:	Practical mark
Prerequisites:	INBMA0102-24 (Electronics) and INBMA0208-24 (Mathematics for Engineers 2)
Responsible:	Dr. Attila Buchman

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: INBMA0101-24 (Algorithms and basics of programming)
Responsible: Dr. Ádám Tóth

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

INBMA0317-21

Semester: 3
Type: Seminar / Laboratory
Number of Classes: 0+2+2
Credit: 6
Status: Obligatory
Assessment: Practical mark
Prerequisites: INBMA0211-21 (Programming Languages 1)
Responsible: Dr. László Szathmáry

Topics:
The goal of the course is to learn an object-oriented (OO) programming language, e.g. Java. The OO paradigm. Compilation, execution. Primitive types, reference types. Language elements of OO languages. Strings, string operations. Arrays, array operations. Static methods. Classes, objects, instantiation, constructor. Instance variables, instance methods. Command-line arguments. Getter and setter methods. Static attributes. Method overloading. Dynamic array. Type conversions. File handling (reading and writing a text file). Multidimensional arrays. Random numbers. Inheritance, class hierarchy. Access levels. Comparing objects. Polymorphism, method overriding. Abstract classes, abstract methods. Unit testing. Using packages. Exceptions, exception handling. More collections (set, map). Interfaces. Sorting. Generic classes. Functional language elements, data streams (streams, LINQ). Lambda expressions. Serialization.

Compulsory/Recommended Readings:
- Y. Daniel Liang: Introduction to Java Programming, 11th edition, Pearson, 2017.
- Head First Java (2nd ed.), O'Reilly, 2009.
- The C# Player's Guide (3rd ed.), Starbound, 2016.
- Dan Clark: Beginning C# Object-Oriented Programming, Apress, 2013
- RB Whitaker: The C# Player's Guide (3rd ed.), Starbound, 2016

COMPUTER NETWORKS

INBMA0318-17

Semester: 3
Type: Lecture / Laboratory
Number of Classes: 2+0+2
Credit: 6
Status: Obligatory
Assessment: Exam
Prerequisites: INBMA0120-24 (Operating Systems)
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.

COMPUTER ARCHITECTURES

INBMA0412-21

Semester: 4
Type: Lecture
Number of Classes: 2+0+0
Credit: 3
Status: Obligatory
Assessment: Exam
Prerequisites: INBMA0209-24 (Digital Design)
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

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

SYSTEM PROGRAMMING

INBMA0421-24

Semester: 4
Type: Laboratory
Number of Classes: 0+0+2
Credit: 3
Status: Obligatory
Assessment: Practical mark
Prerequisites: INBMA0211-21 (Programming languages 1)
Responsible: Dr. Imre Varga

Topics:
Program running environment, environment variables, command-line arguments. Time handling. Pseudo-random number generation and applications. Address arithmetics. Dynamic memory allocation and its application in the representation of data structures. Text and binary files. Directory handling and inode information. Processes and the fork. Signaling and pipes. Basics of socket programming. Basics of parallel programming based on shared memory.

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

INBMA0422-21

Semester: 4
Type: Laboratory
Number of Classes: 0+0+2
Credit: 3
Status: Obligatory
Assessment: Practical mark
Prerequisites: INBMA0315-17 (Signals and systems)
Responsible: Dr. József Sütő

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

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: INBMA0211-21 (Programming languages 1)
Responsible: Dr. Attila Tamás 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.

DATABASE SYSTEMS AND KNOWLEDGE REPRESENTATION

INBMA0433-21

Semester: 4
Type: Lecture / Laboratory
Number of Classes: 2+0+2
Credit: 6
Status: Obligatory
Assessment: Practical mark
Prerequisites: INBMA0211-21 (Programming languages 1)
Responsible: Dr. Márton Ispány

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

INBMA0434-24

Semester: 4
Type: Laboratory
Number of Classes: 0+0+2
Credit: 3
Status: Obligatory
Assessment: Practical mark
Prerequisites: INBMA0120-24 (Operating systems)
Responsible: Dr. Csanád Bertók

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

INBMA0435-24

Semester: 4
Type: Laboratory
Number of Classes: 0+0+2
Credit: 3
Status: Obligatory
Assessment: Practical mark
Prerequisites: INBMA0211-21 (Programming languages 1)
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

SOFTWARE DEVELOPMENT FOR ENGINEERS

INBMA0523-21

Semester: 5
Type: Lecture / Laboratory
Number of Classes: 2+0+2
Credit: 6
Status: Obligatory
Assessment: Exam
Prerequisites: INBMA0317-21 (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. Patterns of software development. OO planning principles and design patterns. MVC. Testing principles. Data management. GUI development basics. Clean code.

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

INTRODUCTION INTO ARTIFICIAL INTELLIGENCE

INBMA0526-24

Semester:	5
Type:	Lecture / Laboratory
Number of Classes:	2+0+2
Credit:	6
Status:	Obligatory
Assessment:	Exam
Prerequisites:	INBMA0106-24 (Introduction into logic and computer science) and INBMA0207-17 (Data structures and algorithms) and INBMA0211-21 (Programming languages 1)
Responsible:	Dr. Balázs Harangi

Topics:
Intelligent agents, representing state-space, search with noninformed and heuristic algorithms. Constraint Satisfaction Problem, Two Person Games, winning strategy. Logical and probabilistic reasoning, learning from examples, statistical learning, neural networks, deep learning.

Compulsory/Recommended Readings:
- Peter Norvig, Stuart J. Russel: Artificial Intelligence: a Modern Approach, 3rd edition, Pearson, 2009.
- Pedro Domingos: The Master Algorithm, Basic Books; 1 edition 2015

ASSEMBLY PROGRAMMING

INBMA0527-17

Semester: 5
Type: Laboratory
Number of Classes: 0+0+2
Credit: 3
Status: Obligatory
Assessment: Practical mark
Prerequisites: INBMA0211-21 (Programming languages 1) and INBMA0412-21 (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: INBMA0211-21 (Programming Languages 1) and INBMA0412-21 (Computer architectures)
Responsible: Dr. József Sütő

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.

MOBILE SOLUTIONS

INBMA0630-21

Semester: 6
Type: Laboratory
Number of Classes: 0+0+2
Credit: 3
Status: Obligatory
Assessment: Practical mark
Prerequisites: INBMA0317-21 (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

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: INBMA0209-24 (Digital design) and INBMA0211-21 (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.

FUNDAMENTALS OF INFORMATION AND CODING THEORY

INBMA9946-17

Semester: 4
Type: Lecture
Number of Classes: 2+0+0
Credit: 3
Status: Optional
Assessment: Exam
Prerequisites: INBMA0313-17 (Probability Theory and Mathematical Statistics)
Responsible: Dr. Sándor Baran

Topics:
General scheme of telecommunication systems. Fundamentals of source coding (uniquely decipherable and prefix codes, efficiency, basic encoding algorithms). Universal source coding, Lempel-Ziv algorithms. Measure of information, entropy, conditional entropy, mutual information and their properties. Channel capacity. Search strategies. Encoding of general information sources, block encoding. Differential entropy. Fundamentals of error correcting coding. Linear codes.

Compulsory/Recommended Readings:
- Cover, Thomas M. and Thomas, Joy A.: Elements of Information Theory. Wiley, 2006.
- Togneri, Roberto and de Silva, Christopher J. S.: Fundamentals of Information Theory and Coding Design. Chapman & Hall/CRC, 2006.
- Ash, Robert B.: Information Theory. Dover Publications, 1990.

MODELING AND ANALYSIS OF INFORMATION TECHNOLOGY SYSTEMS

INBMA9929-24

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

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.

PROGRAMMING NETWORK DEVICES 1

INBMA9938-21

Semester: 5
Type: Laboratory
Number of Classes: 0+0+4
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. Protocol models. Physical layer. Twisted-pair communication standards, termination and testing tasks. Data Link layer. Ethernet. Network layer. Number systems. Address resolution. IPv4/IPv6 configuration. IPv4/IPv6 subnetting. Transport layer. UDP. TCP. Application layer. Network security fundamentals. Introduction to switched networks. Basic switching concepts and configuration. VLANs. Inter-VLAN routing. STP. Link aggregation (EtherChannel). DHCPv4. DHCPv6. FHRP (HSRP). LAN design problems (exercises).

Compulsory/Recommended Readings:
- Wendell, Odom: CCNA 200-301 Volume 1 Official Cert Guide, Cisco Press, 2020., ISBN: 978-0-13-579273-5.
- Wendell, Odom: CCNA 200-301 Volume 2 Official Cert Guide, Cisco Press, 2020., ISBN: 978-1-58714-713-5
- Scott, Empson: CCNA 200-301 Portable Command Guide, 5th Edition, Cisco Press, 2020, ISBN: 978-0-13-593782-2.
- Cisco Networking Academy: https://www.netacad.com/

PROGRAMMABLE LOGIC DEVICES

INBMA9939-17

Semester:	5
Type:	Lecture / Laboratory
Number of Classes:	2+0+2
Credit:	6
Status:	Optional
Assessment:	Practical mark
Prerequisites:	INBMA0209-24 (Digital design) and INBMA0211-21 (Programming languages 1)
Responsible:	Dr. István László 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.

SCRIPTING LANGUAGES

INBMA9945-17

Semester: 5
Type: Laboratory
Number of Classes: 0+0+2
Credit: 3
Status: Optional
Assessment: Practical mark
Prerequisites: INBMA0211-21 (Programming languages 1)
Responsible: Dr. László Szathmáry

Topics:
Features of scripting languages. Classification of scripting languages. Fundamental data structures of scripting languages: string, dynamic array, associative array. Advanced string handling, regular expressions. Writing command-line applications. Replacing Bash scripts with higher level scripting languages. Connection with the operating system. Mixing procedural and object-oriented approaches. Functional and parallel programming in scripting languages. Connecting to databases. Writing simple graphical user interfaces (GUIs). Writing web applications with scripting languages.
After this course, students will be able to implement simple programs in a modern scripting language.

Compulsory/Recommended Readings:
- Guido van Rossum: Python Tutorial, 2020
- Brian d Foy, Tom Christiansen, et al.: Programming Perl, O'Reilly, 2012
- David Flanagan, Yukihiro Matsumoto: The Ruby Programming Language, O'Reilly, 2008

DEVELOPMENT OF EMBEDDED SYSTEMS

INBMA9940-17

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. József Sütő

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

INBMA9941-21

Semester: 6
Type: Laboratory
Number of Classes: 0+0+4
Credit: 6
Status: Optional
Assessment: Practical mark
Prerequisites: INBMA9938-21 (Programming network devices 1)
Responsible: Dr. Szabolcs Szilágyi

Topics:
LAN security concepts. Switch security configuration. WLAN concepts. WLAN configuration. Routing concepts. IP static routing. Troubleshoot static and default routes. Single-area OSPFv2 concepts. Single-area OSPFv2 configuration. Network security concepts. ACL concepts. ACLs for IPv4 configuration. NAT for IPv4. WAN concepts. VPN and IPsec concepts. QoS concepts. Network management. Network design. Network Troubleshooting. Network virtualization. Network automation.

Compulsory/Recommended Readings:
- Wendell, Odom: CCNA 200-301 Volume 1 Official Cert Guide, Cisco Press, 2020., ISBN: 978-0-13-579273-5.
- Wendell, Odom: CCNA 200-301 Volume 2 Official Cert Guide, Cisco Press, 2020., ISBN: 978-1-58714-713-5
- Scott, Empson: CCNA 200-301 Portable Command Guide, 5th Edition, Cisco Press, 2020, ISBN: 978-0-13-593782-2.
- Cisco Networking Academy: https://www.netacad.com/

MODELING AND PERFORMANCE EVALUATION OF NETWORKS

INBMA9942-17

Semester: 6
Type: Lecture / Laboratory
Number of Classes: 2+0+2
Credit: 6
Status: Optional
Assessment: Practical mark
Prerequisites: INBMA9929-24 (Modeling and Analysis of Information Technology Systems)
Responsible: Dr. Attila Kuki

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

INBMA9943-17

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 Márton 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.

INTRODUCTION TO CLOUD TECHNOLOGIES

INBMA9947-17

Semester: 6
Type: Laboratory
Number of Classes: 0+0+2
Credit: 3
Status: Optional
Assessment: Practical mark
Prerequisites: INBMA0211-21 (Programming Languages 1)
Responsible: Dr. Tamás Márton Bérczes

Topics:
During the course, students will be introduced to the following areas:
Essential components of cloud infrastructure, monitoring groups, resources, and resource groups; Computing services, network management, storage and database management services; Virtualization services such as Azure Virtual Machines, Azure Container Instances, or Azure Kubernetes Service; Cloud database services; Storage services such as Azure Blob Storage, Azure Disk Storage, Azure File Storage; Identity management; Control and privacy functions.
Upon completion of the course, students will have the opportunity to earn the "AZ-900: Microsoft Azure Fundamentals" Certificate.

Compulsory/Recommended Readings:
- https://docs.microsoft.com/hu-hu/learn/certifications/exams/az-900

SENSORS AND ACTUATORS NETWORK

INBMA9944-17

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. Gergely Kocsis

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

BASICS OF AUTONOMOUS VEHICLES DEVELOPMENT

INBMA9951-17

Semester:
Type: Laboratory
Number of Classes: 0+0+4
Credit: 6
Status: Optional
Assessment: Practical mark
Prerequisites: INBMA0211-21 (Programming Languages 1)
Responsible: Dr. József Sütő

Topics:
Within the framework of the subject, students learn about the theoretical and practical backgrounds of modern image processing methods, machine learning methods, and neural networks related to self-driving cars with the help of technology-related software and development environments. The course seeks to introduce advanced simulation technologies in a practice-oriented form of education. The course pays special attention to more complex solutions such as sensor integration, sensor fusion, advanced localization technologies, optimization, system integration, and complex traffic situation analysis. Students work on projects that allow them to work in an application-oriented environment within the deployment process.
Keywords: Python, Keras, Tensorflow, Pytorch, GPU, NVIDIA, BASH, Linux, CNN, RNN, Carla, Unreal Engine

Compulsory/Recommended Readings:
- I. Goodfellow, Y. Bengio, A. Courville: Deep Learning, MIT Press, 2016
- Francois Chollet: Deep Learning with Python, Manning Publications, 2017
- Sensing and Control for Autonomous Vehicles - Applications to Land, Water and Air Vehicles, SPRINGER, 2017

ETHICAL HACKING I.

INBMA9952-17

Semester:
Type: Laboratory
Number of Classes: 0+0+2
Credit: 3
Status: Optional
Assessment: Practical mark
Prerequisites: INBMA0211-21 (Programming Languages 1)
Responsible: Dr. Csanád Bertók

Topics:
Advanced Linux management: BASH scripting, pipes. Basic principles and tools: bind shell, reverse shell, SSH, netcat, socat, msfvenom. Active information gathering: nmap. Vulnerability scanning and exploit databases: exploit-DG, gtfobins, searchsploit. Buffer overflow attacks: Immunity Debugger, gdb, SUID bits. Automatic and semi-automatic tools: Nessus, LinPEAS, WinPEAS, Metasploit, Nikto. Hash and password online and offline attacks: hashcat, john the ripper, THC hydra, wpscan, Burp Suite. Network analysis and exploitation: Wireshark, aircrack-ng, dirbuster, gobuster.

Compulsory/Recommended Readings:
- Ric Messier – CEH v10 Certified Ethical Hacker Study Guide, ISBN-13: 978-1119533191
- Peter Kim – The Hacker Playbook (1,2,3): Practical Guide to Penetration Testing

BLOCKHAIN TECHNOLOGY

INBMA9953-17

Semester:
Type: Lecture
Number of Classes: 2+0+0
Credit: 3
Status: Optional
Assessment: Exam
Prerequisites: None
Responsible: Dr. Andrea Pintér-Huszti

Topics:
The primary aim of the course is to help students learn the basics of blockchain technology.

Week 1: Introduction to the basics of the blockchain - the history of the blockchain, the properties of the blockchain, the CAP theorem, the problem of Byzantine generals
Week 2: The cryptographic background of the blockchain - hash functions
Week 3: Blockchain structure and operation
Week 4: Blockchain transactions
Week 5: Blockchain consensus mechanisms
Week 6: Blockchain related applications - cryptocurrencies
Week 7: Blockchain related applications - contracts
Week 8: Technical challenges of the blockchain, suggestions and improvements
Week 9: Case studies: Ripple, WeTrade, Santander, Lo3 energy, Smartresume
Week 10: Blockchain-based applications
Week 11: The future of blockchains
Week 12: End-term Test

Compulsory/Recommended Readings:

- Nakamoto, Satoshi. "Re: Bitcoin P2P e-cash paper." The Cryptography Mailing List (2008).
- Swan, Melanie. Blockchain: Blueprint for a new economy. " O'Reilly Media, Inc.", 2015.
- Lacity, Mary C. Blockchain foundations: for the internet of value. Epic Books, 2020.

INTRODUCTION TO THE AWS CLOUD

INBMA9958-17

Semester:
Type: Laboratory
Number of Classes: 0+0+2
Credit: 3
Status: Optional
Assessment: Practical mark
Prerequisites: None
Responsible: Dr. Ádám Tóth

Topics:
In this course, students will learn the basic concepts of the AWS cloud; the AWS pricing philosophy; the global infrastructure components of AWS; and the security and compliance measures of the AWS cloud, including AWS identity and access management (IAM). You will learn how to build an AWS virtual private cloud; the use of Amazon Elastic Compute Cloud (EC2), AWS Lambda, and AWS Elastic Beanstalk; the differences between Amazon S3, Amazon EBS, Amazon EFS, and Amazon S3 Glacier; and the use of AWS database services (Amazon Relational Database Service (RDS), Amazon DynamoDB, Amazon Redshift, and Amazon Aurora). Students learn the principles of the AWS Cloud architecture and key concepts related to elastic load balancing (ELB), Amazon CloudWatch and auto scaling.
This course helps prepare students for the AWS Cloud Practitioner certification exam.

Compulsory/Recommended Readings:
- https://docs.aws.amazon.com/
- https://aws.amazon.com/whitepapers/
- https://d0.awsstatic.com/whitepapers/aws-overview.pdf
- https://d1.awsstatic.com/whitepapers/AWS_Cloud_Best_Practices.pdf
- https://d0.awsstatic.com/whitepapers/aws_pricing_overview.pdf
- https://media.amazonwebservices.com/AWS_TCO_Web_Applications.pdf

NETWORK AND SYSTEM SECURITY

INBMA9959-21

Semester:
Type: Laboratory
Number of Classes: 0+0+2
Credit: 3
Status: Optional
Assessment: Practical mark
Prerequisites: INBMA0120-24 (Operating Systems)
Responsible: Dr. Csanád Bertók

Topics:
Description of blue teaming, basic tasks, objectives, tools. Demonstartion of virtualization techniques (Hypervisors, LXC, VM). Creating a virtual environment packed with typical blue teaming tools: firewalls, routers, load balancing. Demonstration of frequent host-based firewall settings, port forwarding. Basic concepts and creation of DMZ. Deployment of reverse proxy, VPN, Radius server. Deployment of different HIDS, NIDS and other monitoring tools: SNMP and Agent-based monitoring. Creation of SSH Bastion hosts, limiting access. Basics of permissions, logging and log evaluation.

Compulsory/Recommended Readings:
- Don Murdoch: Blue Team Handbook: SOC, SIEM, and Threat Hunting (V1.02): A Condensed Guide for the Security Operations Team and Threat Hunter
- Alan White & Ben Clark: Blue Team Field Manual (BTFM) (RTFM)
