Óbuda University
John von Neumann Faculty of Informatics

CURRICULUM OF

Computer Science Engeneering BSc

Budapest, 01 September 2017

CURRICULUM OF THE SPECIALIZATION

1. Specialization:

Computer Science Engineering

2. Area of the course:

Information Technology (IT)

3. Language of the course:

Hungarian

4. Program(s) of the course and duration in semesters, number of contact classes:

Full-time (regular) course	7 semesters	2400 contact classes
Part-time course	7 semesters	1200 contact classes

5. Available specializations:

IOT, embedded systems and robotics	full-time, part-time
Big Data and business intelligence	full-time, part-time
Cloud service technologies and IT security	full-time, part-time
Software design and development	full-time, part-time

6. Number of credits to obtain:

210 credits

7. Educational level and qualification indicated in the degree:

- Educational level: bachelor (baccalaureus, abbreviated: BSc)
- Name of bachelor course: Computer Science Engineering
- Qualification: Computer Science Engineer

8. Classification of academic field according to uniform predicamental system of specialization educational scope:

481

9. Aim of the course:

The aim of the course is to qualify computer science engineers who are competent to install, develop and maintain technical IT and information infrastructure systems and services, and to participate in the design and development tasks of the data and program systems of those, as well as possess the necessary high-level knowledge to pursue the program at master level.

10. The technical competences to be acquired

a) **knowledge**

- Their English language knowledge reaches the level of the training, understanding technical literature, understanding and processing technical texts, accomplishing technical tasks where technical qualification can be needed, as well as of continuous self-education.
- They know the scientific principles and methods (mathematics, physics and other natural sciences) necessary for them to cultivate informatics speciality.
- They know how elements of IT hardware and software systems work, the technology of their realisation, the way to solve tasks during their operation, as well as the possibilities to join informatics and other technical systems.
- They are in possession of an engineering view and rudimentary knowledge of processing the measured signs, modelling, simulating and regulating systems and networks.
- They are aware of the main program paradigms, program languages, development devices. Their knowledge expands on modelling IT systems, forming database systems, constructing, functioning and implementing computer networks, realising user interfaces and graphical applications, features of intelligent systems, peculiarities of mobile application development, managing up-to-date, general operation systems and the viewpoints of IT safety.
- They know the important software development methodologies, the labelling system of IT plans and documents.
- They manage fundamental data security knowledge.
- They know the vocabulary and the peculiarities of IT and engineering in Hungarian and English, at least at a basic level.

b) **skills**

- They make use of scientific principles and methods (mathematics, physics and other natural sciences) necessary to cultivate IT speciality in their engineering work focusing on forming IT systems.
- Using the knowledge acquired during their studies, they are able to install and configure computer and telecommunication networks, averting network errors, operating and improving networks.
- They are able to develop applications, to program client-server and WEB, mobile systems, to develop multiplatform systems.
- They are able to develop corporate IT systems and to implement former developments. Using the knowledge acquired during their studies, they are able to specify and realise embedded systems.
- They are able to acquire deeper technical IT knowledge by themselves based on their acquired rudimentary knowledge, to process the literature, to solve IT problems connected to the area.

- They are able to analyse, specify, design, develop and operate tasks, they apply the development methodologies, troubleshooting, testing and quality assurance procedures.
- They collaborate with IT and electrical engineers in the course of group work, and with the representatives of other specialities in the course of requirement analysis of the given problem and solving it.
- They communicate in Hungarian and English about technical questions and use the formal language of IT in a creative way.
- They educate themselves continuously and keep pace with the development of IT.

***c)* attitude**

- They represent the technical principles of engineering and IT authentically.
- They aim to understand the full technical system beyond their own work areas.
- They are open to learn new methods, program languages and procedures and to acquire these at a skill level.
- They are open to learn other technical fields applying IT devices, and to develop IT solutions to them together with other specialists in the given field.
- When they are in a decision making situation where complex approach is needed, they make their decision with the overall consideration of the measures and ethic norms.
- They understand and feel ownership of the ethical principles and legal concerns of the profession.
- They aim for the efficient and quality work.
- They bear the safety of their colleagues' and costumers' data and information in mind and pay attention to it.

***d)* their autonomy and responsibility**

- They feel responsibility for IT system analysing, developing and operating activity individually and in groups.
- They reveal the deficiencies of the applied technologies, the process risks and initiate the measures reducing these.
- In the possession of expertise their attitude is safety conscious, they bear the potential dangers and attack opportunities in mind and get ready to avert them.

11. Main areas of the course:

	Credits
Natural sciences	**42**
Economics and human sciences	**18**
Professional core curriculum	**77**
Specialization	**48**
Optional subjects	**10**
Thesis	**15**
Altogether:	**210**

12. Criterion requirements:

Physical education: The fulfilment of a 2-semester physical education is a criterion requirement for each full-time BSc student. The subject is announced in semesters 2 and 3 with 2 lessons/week in the sample curriculum.

Subjects to be accomplished in a foreign language: Each full-time BSc student – with a Hungarian training language – has to enrol for two English or German technical courses as criterion subjects announced by the university and they have to accomplish the prescribed testing. If the student has not accomplished the criterion subject in English, (s)he has to justify his/her basic English language knowledge according to the relevant provisions in the Study and Exam regulations.

Technical language requirements: Each full-time BSc student has to enrol for two English or German technical courses as criterion subjects announced by the university and they have to accomplish the prescribed testing. If the student has not accomplished the criterion subject in English, (s)he has to justify his/her basic English language knowledge. While the student does not satisfy his/her obligation, the final certificate cannot be handed over without proving the language knowledge, his/her student status pauses.

Internship: Internship is a project-structured practice of at least 8 weeks (containing 320 work hours) fulfilled alone or in teamwork at a suitable organization or at the University's training place.

13. Foreign language requirements (to obtain a BSc degree):

To obtain a BSc degree it is compulsory to have a state accredited intermediate foreign language complex exam (B2) or a school leaving exam or a certificate equivalent to that.

14. Checking the knowledge

a) during the semester with written or oral presentation, written test, or assessing home assignment (plan, measurement minutes etc.), with practical mark or signature,
b) passing a pre-examination during the semester,
c) passing an exam or a comprehensive exam in the exam period and
d) with final examination.

15. Conditions to take the final exam:

a) Obtaining the final certificate.

b) Thesis approved by a reviewer.

Admission to the final examination is subject to the obtainment of a final certificate.
The final certificate is issued to students having fulfilled all educational and exam requirements and the specified internship depicted in the curriculum– except for fulfilling language requirements and preparing the thesis –and obtained the necessary amount of credits.

16. Components of the final exam:

The final exam comprises the defense of the thesis and oral exams specified in the curriculum (with preparation time at least 30 minutes per subject), which have to be taken on the same day. Simultaneously one student takes exam in front of the examination board.
Subjects which are worth altogether at least 20 and up to 30 credit points can be selected for the final exam.

The candidates get the questions with 30 days before the final exam.

The candidate may start the exam if the final exam committee accepted his/her thesis with a minimum grade 2. The conditions of correcting insufficient thesis are identified by the competent institute.

17. Result of the final examination (F):

The overall result of the final examination is the average of grades obtained for the thesis (Th) and the subjects of the oral part of the final exam ($S_1, S_2, \ldots, S_m$):

$$F = (Th + S_1 + S_2 + \ldots + S_m)/(1+m).$$

18. Conditions to issue the degree:

a) Successful final exam,

b) Fulfilling foreign language requirements.

19. Option for dual program

The dual program is connected to the university full-time BSc program in the interest of emitting specialists living up to expectations of the company (economic partnership, enterprise, institution) which has a contractual cooperation with the student and the university. The conditions of the dual program are included in the contracts between the university and the company, as well as between the company and the student.

20. Option for cooperation program:

The cooperation program is a voluntary, supplementary (one- or two-semester) module attached to the regular training of the University in which a business organization, an enterprise or an institution cooperates with the University in order to provide internship for students according to the aim of the course.

21. Date of effect: 01 September 2017

Budapest, 28 November 2016

András Molnár, Ph.D. habil
associate professor, dean

Contents

NATURAL SCIENCES

Name: **Mathematics I – Calculus I**		***NEPTUN-code:*** *NMXAN1EBNE*	***Number of periods/week:*** full-time: 3 lec + 3 sem + 0 lab
Credit: 6 ***Requirement:*** mid-term mark		***Prerequisite:*** -	
Responsible: Aurél GALÁNTAI, DSc.	***Position:*** professor	***Faculty and Institute name:*** John von Neumann Faculty of Informatics Institute of Applied Mathematics	
Way of assessment: - mid-term tests			
Competences			
Course description:			
The aim of the course is to bring up students' mathematical skills to an even level, introduce them to the methods of higher mathematics, to the use of Matlab software, and get them acquainted with the elements of one-variable calculus. Course material: number sets, algebraic expressions, equations and inequalities. Trigonometry. Complex numbers. Vectors and operations. Matrices and operations. Relations and functions, elementary discussion, sketching, elementary functions. Converging series. Continuity and limits of functions. One-variable differential calculus, differentiation rules, applications, curve sketching. Definite integral. Symbolic and numerical integration techniques, applications.			
Literature			
József Kovács, Gábor Takács, Miklós Takács: Analysis. Tankönyvkiadó, Budapest, 1991 (in Hungarian) György Baróti Dr – Miklós Kis – Edit Schmidt – Zsuzsanna Lukács dr. Sréterné: Mathematical Task Collections. BMF KKVFK, Budapest, 2000 (in Hungarian)			

<table>
<tr><td colspan="2">Name:
Calculus II</td><td>NEPTUN-code:
NMXAN2EBNE</td><td>Number of periods/week:
full-time: 3 lec + 3 sem + 0 lab</td></tr>
<tr><td colspan="2">Credit: 6
Requirement: exam</td><td colspan="2">Prerequisite:
NMXAN1EBNE Mathematics I – Calculus I</td></tr>
<tr><td>Responsible:
István VAJDA, Ph.D.</td><td>Position:
senior lecturer</td><td colspan="2">Faculty and Institute name:
John von Neumann Faculty of Informatics
Institute of Applied Mathematics</td></tr>
<tr><td colspan="4">Way of assessment:
- mid-term tests and written or oral examination</td></tr>
<tr><td colspan="4">Competences</td></tr>
<tr><td colspan="4"></td></tr>
<tr><td colspan="4">Course descrition:</td></tr>
<tr><td colspan="4">The aim of the course is to extend students' skills to apply techniques of one- and multivariable calculus, and further develop their ability to efficiently use Matlab in solving practical problems.
Course material: integration by parts and by substitution, applications. Improper integral. Laplace-transform, applications. Numerical and function series. Curves in planes and spaces. Continuity and limits of multivariable functions, partial and total differentiability. Extreme values of multivariable functions. Symbolic and numerical integration of two-variable functions. The concept and solution of differential equations, applications.</td></tr>
<tr><td colspan="4">Literature</td></tr>
<tr><td colspan="4">József Kovács, Gábor Takács, Miklós Takács: Calculus, Nemzeti Tankönyvkiadó, 2001 (in Hungarian)
György Baróti Dr., Miklós Kis, Edit Schmidt, Zsuzsanna Lukács Dr. Sréterné: Mathematical Tasks Collections, BMF KKVFK, 2000 (in Hungarian)
Fekete-Zalay: Multivariate Analysis Functions, Műszaki Könyvkiadó, 2007 (in Hungarian)</td></tr>
</table>

<table>
<tr><td colspan="2">Name:
Discrete Mathematics and Linear Algebra I</td><td>NEPTUN-code:
NMXDM1EBNE</td><td>Number of periods/week:
full-time: 3 lec + 2 sem + 0 lab</td></tr>
<tr><td colspan="2">Credit: 6
Requirement: exam</td><td colspan="2">Prerequisite:
-</td></tr>
<tr><td>Responsible:
Magdolna SZŐKE, Ph.D.</td><td>Position:
senior lecturer</td><td colspan="2">Faculty and Institute name:
John von Neumann Faculty of Informatics
Institute of Applied Mathematics</td></tr>
<tr><td colspan="4">Way of assessment:
- signature requirements: at least 50% compliance of mid-term papers
- exam-mark: according to the result of the exam</td></tr>
<tr><td colspan="4">Competences</td></tr>
<tr><td colspan="4"></td></tr>
<tr><td colspan="4">Course descrition:</td></tr>
<tr><td colspan="4">Cartesian coordinate systems, vectors and vector operations, scalar and vector product, equations of straight lines and planes. Matrices and matrix operations, inverse matrix. Matrix representation of systems of linear equation. Methods for solving systems of linear equations.
Operations on sets. Power sets. Cartesian product.
Binary relation, inverse relation. Composition of relations. Partial functions and functions: 'onto', 'into' and 'one to one' functions. Cardinality.
Propositional calculus, operations. Disjunctive and conjunctive normal forms.
Logical arguments. Predicate logic. Rules for the quantifiers. Semantics. Interpretations. Model.</td></tr>
<tr><td colspan="4">Literature</td></tr>
<tr><td colspan="4">János Bagyinszki – Anna György: Discrete Mathematics for College Students, Typotex, Budapest, 2002 (in Hungarian)
Anna György – Péter Kárász– Szabolcs Sergyán – István Vajda – Ágnes Záborszky: Discrete Mathematics Examples, BMF-NIK-5003, Budapest, 2003 (in Hungarian)
György Baróti Dr., Miklós Kis, Edit Schmidt, Zsuzsanna Lukács Dr. Sréterné: Mathematical Tasks Collections, BMF KKVFK, 2000 (in Hungarian)</td></tr>
</table>

<table>
<tr><td colspan="2">Name:
Discrete Mathematics and Linear Algebra II</td><td>NEPTUN-code:
NMXDM2EBNE</td><td>Number of periods/week:
full-time: 3 lec + 2 sem + 0 lab</td></tr>
<tr><td colspan="2">Credit: 5
Requirement: exam</td><td colspan="2">Prerequisite:
NMXDM1EBNE Discrete Mathematics and Linear Algebra I</td></tr>
<tr><td>Responsible:
Magdolna SZŐKE, Ph.D.</td><td>Position:
senior lecturer</td><td colspan="2">Faculty and Institute name:
John von Neumann Faculty of Informatics
Institute of Applied Mathematics</td></tr>
<tr><td colspan="4">Way of assessment:
- signature requirements: at least 50% compliance of mid-term papers
- exam-mark: according to the result of the exam</td></tr>
<tr><td colspan="4">Competences</td></tr>
<tr><td colspan="4"></td></tr>
<tr><td colspan="4">Course descrition:</td></tr>
<tr><td colspan="4">Binary relations, equivalence classes, partial ordering, lattices. Boolean algebras.
Elements of combinatorics (permutations, combinations). Proof by induction.
Graphs, trees, applications. Planar graphs, graph colouring.
Vector spaces. Linear independence. Bases and dimension. Algorithm for changing of basis-vectors.
Linear transformations. Representation of linear transformations by matrices. Rank of matrix. Eigenvalues and eigenvectors.
Algebraic structures: groups, rings, fields.</td></tr>
<tr><td colspan="4">Literature</td></tr>
<tr><td colspan="4">János Bagyinszki – Anna György: Discrete Mathematics for College Students, Typotex, Budapest, 2002 (in Hungarian)
Anna György – Péter Kárász– Szabolcs Sergyán – István Vajda – Ágnes Záborszky: Discrete Mathematics Examples, BMF-NIK-5003, Budapest, 2003 (in Hungarian)
László Lovász, József Pelikán, Katalin Vesztergombi: Discrete Mathematics, Typotex, Budapest, 2006 (in Hungarian, electronic notes)</td></tr>
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<table>
<tr><td colspan="2">Name:
Probability Theory and Mathematical Statistics</td><td>NEPTUN-code:
NMXVS1EBNE</td><td>Number of periods/week:
full-time: 2 lec + 2 sem + 0 lab</td></tr>
<tr><td>Credit: 5
Requirement: exam</td><td colspan="3">Prerequisite:
NMXDM2EBNE Discrete Mathematics and Linear Algebra II
NMXAN2EBNE Calculus II</td></tr>
<tr><td>Responsible:
Péter KÁRÁSZ, Ph.D.</td><td>Position:
associate professor</td><td colspan="2">Faculty and Institute name:
John von Neumann Faculty of Informatics
Institute of Applied Mathematics</td></tr>
<tr><td colspan="4">Way of assessment:
- mid-term tests and written or oral examination</td></tr>
<tr><td colspan="4">Competences</td></tr>
<tr><td colspan="4"></td></tr>
<tr><td colspan="4">Course descrition:</td></tr>
<tr><td colspan="4">The aim of the course is to get acquainted with concepts and methods of probability theory and statistics, and to acquire the ability to apply them. The scope of the course is: probability theory, statistics and inference. Classical and geometrical probability spaces. Conditional probability. Independent events. Random variables and their characteristics. Specific probability distributions. Functions of random variables. Laws of large numbers, central limit theorem. Concepts and elements of (mathematical) statistics. Confidence intervals. Methods of hypothesis testing. Hypothesis testing of large samples. Hypotheses of the normal distribution. Non-parametric tests. Analysis of variance. Elements of correlation and regression analysis.</td></tr>
<tr><td colspan="4">Literature</td></tr>
<tr><td colspan="4">Edited by: Zs. Lukács Dr. Sréterné: Mathematical Tasks Collections, BMF KKVFK, 2000 (in Hungarian)
Mathematical Tasks, edited by Scharnitzky V., Tankönyvkiadó, 2002 (in Hungarian)
J. Reimann, J. Tóth: Probability and Mathematical Statistics, Tankönyvkiadó, 2008 (in Hungarian)</td></tr>
</table>

<table>
<tr><td colspan="2">Name:
Basics of Information Systems</td><td>NEPTUN-code:
NIXBI1EBNE</td><td>Number of periods/week:
full-time: 2 lec + 0 sem + 1 lab</td></tr>
<tr><td colspan="2">Credit: 4
Requirement: mid-term mark</td><td colspan="2">Prerequisite:
-</td></tr>
<tr><td>Responsible:
László CSINK, Ph.D.</td><td>Position:
associate professor</td><td colspan="2">Faculty and Institute name:
John von Neumann Faculty of Informatics
Institute of Applied Mathematics</td></tr>
<tr><td colspan="4">Way of assessment:
- mid-term exams</td></tr>
<tr><td colspan="4">Competences</td></tr>
<tr><td colspan="4"></td></tr>
<tr><td colspan="4">Course descrition:</td></tr>
<tr><td colspan="4">Most important factors leading to the creation and evolution of information technology, its theoretical basics. Subject of information technology and its place among other scientific disciplines. Properties of information processing paradigms. Properties and analog and digital information processing. The von Neumann architecture, development possibilities. Core concepts of information theory. Basics of coding. Representation of information (numbers, characters, figures, music). Interpretation of minimum redundancy codes, most important coding algorithms. Dictionary-based coding, adaptive coding, its significance. Error-detection and -correcting codes, typical examples (SED-SEC, Hamming code).</td></tr>
<tr><td colspan="4">Literature</td></tr>
<tr><td colspan="4">Katalin Juhász dr. Nyakóné Dr., György Terdik, Piroska Biró, Zoltán Kátai Dr.: Introduction to Informatics, Digitális Tankönyvtár, 2011 (in Hungarian, electronic notes)
David J. C. MacKay: Information Theory, Inference and Learning Algorithms, Cambridge University Press; 1 edition, 2003</td></tr>
</table>

<table>
<tr><td colspan="2">Name:
Physics</td><td>NEPTUN-code:
KVXFI1EBNE</td><td>Number of periods/week:
full-time: 2 lec + 1 sem + 0 lab</td></tr>
<tr><td colspan="2">Credit: 5
Requirement: exam</td><td colspan="2">Prerequisite:
NMXAN1EBNE Mathematics I – Calculus I</td></tr>
<tr><td>Responsible:
Ervin RÁCZ, Ph.D.</td><td>Position:
associate professor</td><td colspan="2">Faculty and Institute name:
Kandó Kálmán Faculty of Electrical Engineering
Power System department</td></tr>
<tr><td colspan="4">Way of assessment:
- written and/or oral exam</td></tr>
<tr><td colspan="4">Competences</td></tr>
<tr><td colspan="4"></td></tr>
<tr><td colspan="4">Course descrition:</td></tr>
<tr><td colspan="4">Mechanics I.: Kinematics and dynamics of mechanical particles, dynamics of particle systems, motion of a rigid body. Relative motions: motions in inertial frames of reference, motions in non-inertial frames of reference. Elements of the theory of special relativity. Thermodynamics: Basic concepts of thermodynamics, temperature scales, equations of states, heat, heat capacities, molar heat capacities, first law of thermodynamics, thermal processes of ideal gases, cycles, Carnot-cycle, entropy, second law of thermodynamics, statistical thermodynamics. Mechanics II.: oscillations, wave motion, elements of optics (ray- and physical optics). At boundary of classical concepts: black body radiation, photo effect, Compton-effect, wave-particle duality. Classical models of an atom. Basics of quantum mechanics. Physics of condensed matter.</td></tr>
<tr><td colspan="4">Literature</td></tr>
<tr><td colspan="4">Zoltán Balázs – Dorottya Sebestyén Dr.: Physics (ÓE KVK 2065, Budapest 2011, in Hungarian, university note)
Alvin Hudson – Rex Nelson: Introdaction to Modern Physics, LSI OMAK ALAPÍTVÁNY, 1994 (in Hungarian)
Alvin Hudson – Rex Nelson: University physics, Saunders College Pub., 1990</td></tr>
</table>

<table>
<tr><td colspan="2">Name:
Electrical Engineering</td><td>NEPTUN-code:
KVEVI1EBNE</td><td>Number of periods/week:
full-time: 2 lec + 1 sem + 0 lab</td></tr>
<tr><td colspan="2">Credit: 5
Requirement: exam</td><td colspan="2">Prerequisite:
-</td></tr>
<tr><td>Responsible:
Péter KÁDÁR, Ph.D.</td><td>Position:
associate professor</td><td colspan="2">Faculty and Institute name:
Kandó Kálmán Faculty of Electrical Engineering
Power System department</td></tr>
<tr><td colspan="4">Way of assessment:
- written and/or oral exam</td></tr>
<tr><td colspan="4">Competences</td></tr>
<tr><td colspan="4"></td></tr>
<tr><td colspan="4">Course descrition:</td></tr>
<tr><td colspan="4">DC circuits analyses: linear active and passive two ports, Ohm's law, Kirchoff’s laws, voltage and current dividers, bridge circuits, superposition.
Thévenin's and Norton's theorem. Total DC network analyses techniques. Sinusoidal steady-state analyses: features of sinusoidal signals, the connection between voltage and current on R, L, C elements, the complex calculation method, complex powers, resonant circuits. Analysing networks with periodic waveforms. First-order Bode diagrams. Natural and step responses of first-order RL and RC circuits.</td></tr>
<tr><td colspan="4">Literature</td></tr>
<tr><td colspan="4">György Fodor: Electricity I. Electricity Networks, TKV. 44469/I (in Hungarian)
István Vágó: Electricity II. Electromagnetic Fields. TKV. 44469/II (in Hungarian)
K. Y. Kim (edited): Wireless Power Transfer – Principles and Engineering Explorations, InTech, 2012 (electronic notes)</td></tr>
</table>

ECONOMIC AND HUMAN STUDIES

Name: **Macroeconomics**		*NEPTUN-code:* *GGXKG1EBNE*	*Number of periods/week:* full-time: 2 lec + 0 sem + 0 lab
Credit: 2 ***Requirement:*** mid-term mark		***Prerequisite:*** -	
Responsible: András MEDVE, Ph.D.	***Position:*** associate professor	***Faculty and Institute name:*** Keleti Faculty of Business and Management Institute of Economics and Social Sciences	

Way of assessment:

- exam-semester credit: written exam, 40 minutes, 40 points, (2) satisfactory, from 50%

Competences

Course descrition:

Introduction to Macroeconomics and National Income Accounting. The MPS and the SNA-system. Gross Output, GDP, GNI, NDP, Nni, GNDI, NNDI. The Determination of National Income. The Circular Flow. The Consumption Function. The Investment Demand. Money and Modern Banking. Money and its Functions. The Monetary Base and the Money Multiplier. Commercial Banks and the Central Bank. Equlilibrium in the Financial Markets. Money and Inflation. The Cost of Inflation. The Government in the Circular Flow. The Government Budget. Monetary and Fiscal Policy. Lorenz Curve and the Gini Coefficient. Economic Growth and the Business Cycle. International trade and Commercial Policy. Absolute and Comparative Advantage in the World Trade. The Components of the Balance of Payments

Literature

István Horváth: Macroeconomics for Engineers, ÓE, 2015 (in Hungarian, electronic notes)
I. Horváth – Sz. Láhm – A. Medve: Macroeconomics, Extracts, 2004 (in Hungarian)
Mária Vörös dr. Véghné – Anita Derecskei – István Horváth: Macroeconomics Examples, 2007 (in Hungarian)
Dietmar Meyer – Katalin Solt: Macroeconomics, Aula Kiadó, 2006 (in Hungarian)
Ágnes Csiszárik-Kocsir Dr.Ph.D. – Mónika Fodor Dr.Ph.D. – András Medve Dr.Ph.D. : Crisis concepts than and now – based on the results of a two-round research, The Macrotheme Review 2 (4), summer edidition, 161. – 172. pp., 2013 (electronic notes)
Ágnes Csiszárik-Kocsir Dr. Ph.D. – András Medve Dr. Csc.: The perception of the recession due to the effects of the economic crisis in view of the questionnaire-based research results. MEB 2012 – 10th International Conference on Management, Enterprise and Benchmarking, Budapest, 2012 június 1.-2., Óbudai Egyetem, 263.-272. pp. (electronic notes)
Ágnes Csiszárik-Kocsir Dr., Ph.D., András Medve Dr. Csc.: The perception of the recession due to the effects of the economic crisis in view of the questionnaire-based research results (electronic notes)
Ágnes Csiszárik-Kocsir Dr. Ph.D. – Mónika Fodor Dr. Ph.D. – András Medve Dr. Ph.D. : The context of the macro data and the characteristics of the General Government in Central Europe, 2013 International Proceedings of Economics Development and Research, Economics, Marketing and Management (edited by: Yan Han), Vol. 59., IACSIT Press, 195.-199. pp.
Selected, peer-reviewed papers from the 2013 2nd International Conference on Economics, Marketing and Management (ICEMM 2013) 2013. January 19-20., Dubai, UAE

<table>
<tr><td colspan="2">Name:
Microeconomics</td><td>NEPTUN-code:
GGXKG2EBNE</td><td>Number of periods/week:
full-time: 1 lec + 1 sem + 0 lab</td></tr>
<tr><td colspan="2">Credit: 2
Requirement: mid-term mark</td><td colspan="2">Prerequisite:
GGXKG1EBNE Macroeconomics</td></tr>
<tr><td>Responsible:
András MEDVE, Ph.D.</td><td>Position:
associate professor</td><td colspan="2">Faculty and Institute name:
Keleti Faculty of Business and Management
Institute of Economics and Social Sciences</td></tr>
<tr><td colspan="4">Way of assessment:
- exam-semester credit: written exam, 40 minutes, 40 points, (2) satisfactory, from 50%</td></tr>
<tr><td colspan="4">Competences</td></tr>
<tr><td colspan="4"></td></tr>
<tr><td colspan="4">Course descrition:</td></tr>
<tr><td colspan="4">The Tools Of Economic Analysis. The Market. Demand, Supply and Equilibrium. Free Markets and Price Controlls: Price Ceilings and Maximum Prices. Price Elasticity Of Demand, Cross-elasticity of demand, Income-elasticity. The Theory Of Consumer Choice. Complements and Substituties. Business Organization and Behaviour. The Firms Production Decision. Production costs. Type of Business Organizations. Market Structures and Mesurement of Market Power: Herfindahl, CR and Lerner-index. Perfect Competition and Pure Monopoly. Monopolistic Competition. Oligopoly. Game-theory.and interdependent Decision. Nash- Equilibrium. Dominant Equilibrium. The Analysis of Factor Markets: Labour Market. Human Capital. Capital Markets. Rentals, Interest Rates and Assets Prices. Net Present Value.</td></tr>
<tr><td colspan="4">Literature</td></tr>
<tr><td colspan="4">Ágnes Kocsir- Csiszárik Dr: Microeconomics for Engineers. ÓE, 2015 (in Hungarian, electronic notes)
A. Medve Dr.: Economics for Engineers, Extracts, Budapesti Műszaki Főiskola, Keleti Károly Gazdasági Főiskolai Kar, 2001 (in Hungarian)
Ágnes Csiszárik-Kocsir Dr.Ph.D. – Mónika Fodor Dr.Ph.D. – András Medve Dr.Ph.D.:The effect of the economic crisis onto the consumption based on a two-round questionnaire research, International Journal of Social Sciences and Humanity Studies, Publisher: The Social Sciences Research Society, Vol.5., No. 1., 33-42. pp. 2014 (electronic notes)</td></tr>
</table>

Name: **Enterprise Economics I**		***NEPTUN-code:*** *GSXVG1EBNE*	***Number of periods/week:*** full-time: 2 lec + 0 sem + 0 lab
Credit: 2 ***Requirement:*** mid-term mark		***Prerequisite:*** -	
Responsible: Ferenc KATONA, Ph.D.	***Position:*** senior lecturer	***Faculty and Institute name:*** Keleti Faculty of Business and Management Institute of Management and Organisation	
Way of assessment: - mid-term exams			
Competences			
Course descrition:			
The aim of the course is for students to acquire knowledge which will enable them to deal with economic and financial problems from a corporate point of view. Students are introduced to the concepts of enterprise, objectives, business environment, business forms, value creation, production processes, organizational forms, strategy creation and corporate marketing. Students also gain an insight into the development of enterprises, different development strategies, problems of growing, optimal operational size and various other essential aspects of managing a corporation.			
Literature			
F. Katona: Examination of Small Business Marketing Design Timeliness, In.: Enterprise Development in the 21st Century, IV. Volume. 451 p. Edited by: Imre Nagy, Óbudai Egyetem Keleti Károly Gazdasági Kar, Budapest, pp. 233-244., 2014 (in Hungarian) Hisrich, R. D., Peters, M.P., Shepherd, D.: Entrepreneurship. McGraw-Hill/Irwin, 2016 Zs. Antal, M. Dobák: Leadership and organization, Akadémiai Kiadó, Budapest, 2016 (in Hungarian) Gy. Kadocsa: Organization of Enterprises, Óbudai Egyetem, Budapest, Moodle Keretrendszer, 2015 (in Hungarian, electronic notes)			

<table>
<tr><td colspan="2">Name:
Enterprise Economics II</td><td>NEPTUN-code:
GSXVG2EBNE</td><td>Number of periods/week:
full-time: 1 lec + 1 sem + 0 lab</td></tr>
<tr><td colspan="2">Credit: 2
Requirement: mid-term mark</td><td colspan="2">Prerequisite:
GSXVG1EBNE Enterprise Economics I</td></tr>
<tr><td>Responsible:
Ferenc KATONA, Ph.D.</td><td>Position:
senior lecturer</td><td colspan="2">Faculty and Institute name:
Keleti Faculty of Business and Management
Institute of Management and Organisation</td></tr>
<tr><td colspan="4">Way of assessment:
- mid-term exams</td></tr>
<tr><td colspan="4">Competences</td></tr>
<tr><td colspan="4"></td></tr>
<tr><td colspan="4">Course descrition:</td></tr>
<tr><td colspan="4">The aim of the course is to further develop the students' basic business and economic knowledge and thinking, keeping the practical requirements in mind, with appropriate theoretical knowledge acquisition. Students are introduced into company asset management, labor management issues, cost management, cost accounting methodology, analysis of the economics of investments and the basics of corporate finance. Students also gain an insight into basic marketing concepts and methods.</td></tr>
<tr><td colspan="4">Literature</td></tr>
<tr><td colspan="4">F. Katona: Examination of Small Business Marketing Design Timeliness, In.: Enterprise Development in the 21st Century, IV. Volume. 451 p. Edited by: Imre Nagy, Óbudai Egyetem Keleti Károly Gazdasági Kar, Budapest, pp. 233-244., 2014 (in Hungarian)
Hisrich, R. D., Peters, M.P., Shepherd, D.: Entrepreneurship. McGraw-Hill/Irwin, 2016
Zs. Antal, M. Dobák: Leadership and organization, Akadémiai Kiadó, Budapest, 2016 (in Hungarian)
Gy. Kadocsa: Organization of Enterprises, Óbudai Egyetem, Budapest, Moodle Keretrendszer, 2015 (in Hungarian, electronic notes)</td></tr>
</table>

<table>
<tr><td colspan="2">Name:
Basics of Management</td><td>NEPTUN-code:
GVXME1EBNE</td><td>Number of periods/week:
full-time: 1 lec + 1 sem + 0 lab</td></tr>
<tr><td colspan="2">Credit: 3
Requirement: mid-term mark</td><td colspan="2">Prerequisite:
-</td></tr>
<tr><td>Responsible:
Bianka PARRAGH, Ph.D.</td><td>Position:
senior lecturer</td><td colspan="2">Faculty and Institute name:
Keleti Faculty of Business and Management
Institute of Enterprise Management</td></tr>
<tr><td colspan="4">Way of assessment:
- mid-term exam</td></tr>
<tr><td colspan="4">Competences</td></tr>
<tr><td colspan="4"></td></tr>
<tr><td colspan="4">Course descrition:</td></tr>
<tr><td colspan="4">Managament as a scientifical discipline (theories and waves). Content of the managerial activity, skills and tasks. Decision like the centre of the managerial activity. Decision theories. Relationship of the leader and employees. Leadership styles and typology of the leadership. The organizations, structures (organogram) and characteristics. The successfull and effective managers. Fields of management: strategical-, project-, innovation-, and marketing management, TQM. Envorinmentally friendly management. Deal and handle the problems, conflicts, crisis management. Goals for the Human Resource Management (recruitment and selection). Corporate culture and identity. Self management, communication skills, personality tests. Creation, creativity techniques. Case studies from the fields of decision, responsibilty, emotions, moral. Recruitment and selection, demontsration of a job interview.</td></tr>
<tr><td colspan="4">Literature</td></tr>
<tr><td colspan="4">József Roóz Dr.: Basic of Management, PERFEKT ZRT, 2006 (in Hungarian)
M. Dobák and mk.: Leadership and Organization I-II., Aula Kiadó, 1991 (in Hungarian)</td></tr>
</table>

Name: **Public Administration and Law**		***NEPTUN-code:*** *GGXJA1EBNE*	***Number of periods/week:*** full-time: 2 lec + 0 sem + 0 lab
Credit: 3 ***Requirement:*** mid-term mark		***Prerequisite:*** *GGXME1EBNE* Basics of Management	
Responsible: Csilla KOHLHOFFER-MIZSER, Ph.D.	***Position:*** senior lecturer	***Faculty and Institute name:*** Keleti Faculty of Business and Management Institute of Economics and Social Sciences	

Way of assessment:

- condition of the signature: participation on lectures
- exam-semester credit: written exam, 60 minutes, 45 points, (2) satisfactory, from 60%

Competences

Course descrition:

System of politics and jurisprudence, articulation of rule of law. Enforcement of law. Legal regulation, legal facts, law. Emergence of law. Thesis of law, legal rule, publication. Types of legal norms. Availability of legal norm, mandatory power. Legal norm (complete behavior rule). Speciality of source of law. Formation of law. Constitution of law-source of law. Definition of law. Structure of state, state-organization, specialities of state. Relationship between state and social-econmical environment. System of the state organisations. Function of state. Development of modern state. The Fundamental Law of Hungary. Constitution of law. Civil law, law of economic companies, basics of business law. Basics of hungarian criminal law. Basics of labour law. Administration procedure. Local municipalty system of Hungary. Family law, alternative dispute resolutions, mediation.

Literature

András Patyi, András Zs. Varga: General Administrative Law (in the Basic Law System), Dialóg Campus Kiadó, 2012 (in Hungarian)

Hungary's Basic Law (in Hungarian)

CXXX of 2010. Act on Legislation. (in Hungarian)

Péter Szilágyi: Basic Legal, Budapest, ELTE Eötvös Kiadó, 2011 or Osiris Kiadó, 2006 (in Hungarian)

Mihály Tóth: From the Old Testament to the Pink Floyd (legal cases), Dialóg Campus Kiadó, 2005 (in Hungarian)

Csilla Mizser Dr.: Consideration of ministerial responsibility in the cross-section of constitutional law, civil law, administrative law, labor law, criminal law and EU law, Themis AZ ELTE ÁLLAM- ÉS JOGTUDOMÁNYI DOKTORI ISKOLA ELEKTRONIKUS FOLYÓIRATA 3:(2) pp. 30-38., 2005 (in Hungarian)

Csilla Mizser Dr.: Areas and / or regions. Will there be changes? KÖZJOGI SZEMLE 2:(4) pp. 51-56., 2009 (in Hungarian)

The region is in some eastern European countries and some Western European countries, The Constitution of the Republic for 20 years ago. Pécs: Pécsi Alkotmányjogi Műhely Alapítvány, pp. 513-526., 2009 (PAMA Könyvek) (in Hungarian)

Gábor Kurunczi, Ádám Varga, Lóránt Csink, Balázs Schanda, Gusztáv Nagy, Zsolt Balogh, Ildikó Marosi Hörcherné, Barnabás Hajas, Lilla Berkes, Ádám Varga, András Zs. Varga, Nóra Balogh-Békés: Presentation of the Fundamental Law, Nemzeti Közszolgálati Egyetem Vezető -és Továbbképzési Intézet, Budapest, 2014 (in Hungarian)

<table>
<tr><td colspan="2">Name:
Infocommunication Techniques</td><td>NEPTUN-code:
NNXIK1EBNE</td><td>Number of periods/week:
full-time: 2 lec + 0 sem + 0 lab</td></tr>
<tr><td colspan="2">Credit: 4
Requirement: mid-term mark</td><td colspan="2">Prerequisite:
-</td></tr>
<tr><td>Responsible:
László NÁDAI, Ph.D.</td><td>Position:
associate professor, habil.</td><td colspan="2">Faculty and Institute name
John von Neumann Faculty of Informatics
Institute of Biomatics</td></tr>
<tr><td colspan="4">Way of assessment:
- conducting literature review, and writing an essay in a selected topic</td></tr>
<tr><td colspan="4">Competences</td></tr>
<tr><td colspan="4"></td></tr>
<tr><td colspan="4">Course descrition:</td></tr>
<tr><td colspan="4">Literature survey. The available scientific websites, overview of public scientific databases. Phases of the project work plan, the details of each phase. The content and format of the work plan. Presentation techniques, structure, form and content of the presentation material. Publication and presentation of results.</td></tr>
<tr><td colspan="4">Literature</td></tr>
<tr><td colspan="4">John Sonmez, Soft Skills: The Software Developer's Life Manual, Manning Publications, 2015 (electronic notes)
Stephen C. Lundin, J. Christensen, Harry Paul: Fish! A Proven Way to Boost Morale and Improve Results, Interpress Külker. Kft., 2008 (in Hungarian)</td></tr>
</table>

CORE STUDIES

<table>
<tr><td colspan="2">Name:
Software Design and Development I</td><td>NEPTUN-code:
NIXSF1EBNE</td><td>Number of periods/week:
full-time: 3 lec + 0 sem + 3 lab</td></tr>
<tr><td colspan="2">Credit: 6
Requirement: exam</td><td colspan="2">Prerequisite:
-</td></tr>
<tr><td>Responsible:
Szabolcs SERGYÁN, Ph.D.</td><td>Position:
associate professor</td><td colspan="2">Faculty and Institute name
John von Neumann Faculty of Informatics
Institute of Applied Informatics</td></tr>
<tr><td colspan="4">Way of assessment:
- precondition of signature: achievement of tests and project work
- oral exam</td></tr>
<tr><td colspan="4">Competences</td></tr>
<tr><td colspan="4"></td></tr>
<tr><td colspan="4">Course descrition:</td></tr>
<tr><td colspan="4">Introduction to the principles and methods of structured and object oriented programming. Introduction to an object oriented programming language.
Main competencies: Concepts of algorithms, flow controls. Methods and tools of algorithm description. Data structures. Basic programming procedures: sequence calculation, decision, selection, linear search, counting, maximum selection. Complex programming procedures: copy, assorting, intersection, union. Elementary sorting algorithms: selection sort, bubble sort, insertion sort, Shell sort. Binary search. Set methods. Recursive algorithms, quicksort and merge sort. Heaps, heapsort.
Elements of the object oriented paradigm: object, class, connections between classes. Features of the object oriented methodology: encapsulation, data hiding, inheritance, polymorphism, code regeneration.</td></tr>
<tr><td colspan="4">Literature</td></tr>
<tr><td colspan="4">Szabolcs Sergyán: Algorithms, Data Structures I., Óbudai Egyetem, 2014 (in Hungarian, electronic notes)
T. H. Cormen, C. E. Leiserson, R. L. Rivest and C. Stein: Introduction to Algorithms (3rd ed.), MIT Press, 2009</td></tr>
</table>

<table>
<tr><td colspan="2">Name:
Software Design and Development II</td><td>NEPTUN-code:
NIXSF2EBNE</td><td>Number of periods/week:
full-time: 3 lec + 0 sem + 3 lab</td></tr>
<tr><td colspan="2">Credit: 6
Requirement: exam</td><td colspan="2">Prerequisite:
NIXSF1EBNE Software Design and Development I</td></tr>
<tr><td>Responsible:
Sándor SZÉNÁSI, Ph.D.</td><td>Position:
associate professor</td><td colspan="2">Faculty and Institute name:
John von Neumann Faculty of Informatics
Institute of Applied Informatics</td></tr>
<tr><td colspan="4">Way of assessment:
- precondition of signature: achievement of tests and project work
- oral exam</td></tr>
<tr><td colspan="4">Competences</td></tr>
<tr><td colspan="4"></td></tr>
<tr><td colspan="4">Course descrition:</td></tr>
<tr><td colspan="4">Introduction to the advanced principles of object oriented programming and commonly used basic data structures. Main competences: Class hierarchy. Inheritance. Constructors and inheritance. Method overriding and hiding. Polymorphism. Abstract classes. Interfaces. Event handling. Delegates. Traditional error handling methods. Exception handling. Generics. Iterators. Simple and sorted linked lists. Linked list variants. Binary search tree. B-tree. Directed and undirected graphs. Spanning tree. Kruskal and Prim algorithm. Graph search algorithms. Depth-first and breadth-first search. Finding the shortest path. Dijkstra algorithm. Finding components. Topological sorting. Hash maps. Backtracking. Dynamic programming. Greedy algorithms. Branch and bound method. Programming paradigms.</td></tr>
<tr><td colspan="4">Literature</td></tr>
<tr><td colspan="4">Sándor Szénási: Algorithms, Data Structures II, Óbudai egyetem, 2014 (in Hungarian, electronic notes)
T. H. Cormen, C. E. Leiserson, R. L. Rivest and C. Stein: Introduction to Algorithms (3rd ed.), MIT Press, 2009</td></tr>
</table>

Name: **Web Programming and Advanced Development Techniques**		*NEPTUN-code:* *NIXWH1EBNE*	*Number of periods/week:* full-time: 0 lec + 0 sem + 5 lab
Credit: 5 ***Requirement:*** mid-term mark		***Prerequisite:*** *NIXSF2EBNE* Software design and development II	
Responsible: Zoltán VÁMOSSY, Ph.D.	***Position:*** associate professor	***Faculty and Institute name:*** John von Neumann Faculty of Informatics Institute of Applied Informatics	

Way of assessment:

- mid-semester grade based on mid-semester tests and a project work

Competences

Course descrition:

One aim of the subject acquisition for the development of Web applications. Generating HTML documents, creating HTML forms. Session and cookie management. Hidden form fields.
Another part of the subject of half Lambda expressions and LINQ, LINQ to Entities and XLINQ. ADO.NET Entity Framework, architecture, data model (EDM). Using Database Engine Query. Application development, entities and associations. Update and insert data. Manage processes, starting the process from static methods and objects, stopping the process. EnableRaisingEvents, HasExited properties. Threads and synchronization introduction, priority, state transition diagram. Foreground and background threads, ThreadPool class, collecting threads into group. Synchronization: lock, Monitor class and synchronization operation, signaling. Parallel.For. Parallel programming algorithms.

Literature

Andrew Troelsen: The C# 2008 and NET 3.5 – Volume 2 – The discovery of the .NET universe braces, Szak Kiadó, 2009 (in Hungarian)
Joseph Albahari - Ben Albahari: C# 4.0 in a Nutshell, O'Reilly, 2010

<table>
<tr><td colspan="2">Name:
Databases</td><td>NEPTUN-code:
NIXAB0EBNE</td><td>Number of periods/week:
full-time: 2 lec + 0 sem + 2 lab</td></tr>
<tr><td colspan="2">Credit: 5
Requirement: mid-term mark</td><td colspan="2">Prerequisite:
NIXSF1EBNE Software design and development I</td></tr>
<tr><td>Responsible:
Rita Dominika FLEINER, Ph.D.</td><td>Position:
senior lecturer</td><td colspan="2">Faculty and Institute name:
John von Neumann Faculty of Informatics
Institute of Applied Informatics</td></tr>
<tr><td colspan="4">Way of assessment:
- signature requirement: passing the mid-term exams, and successful submission of a homework assignment
- written exam</td></tr>
<tr><td colspan="4">Competences</td></tr>
<tr><td colspan="4"></td></tr>
<tr><td colspan="4">Course descrition:</td></tr>
<tr><td colspan="4">During this course students learn about the principles and implementation of database management systems, about database design process and advanced data management techniques. The aim of the course is also the practical application of relational database management system theory, and the understanding of SQL.
Topics of the course: theory and practice of the relational model. Database anomalies and normalization. Database design. Database modeling. Entity relationship diagram. Relational algebra. SQL: DDL, DML, DQL, DCL. Indexed structures. Use and structure of indexes. Database administrator roles. Main database system models. Database architectures. Database management system architectures. Data security. Data warehouses. Database optimization. Query processing. Transaction management and logging. Exercises on the above mentioned topics using the SQL language.</td></tr>
<tr><td colspan="4">Literature</td></tr>
<tr><td colspan="4">Ullman J.D., Widom J.: Database Systems; Foundations, 2nd edition, PANEM Kiadó, Budapest, 2008 (in Hungarian)
M. Kende, I. Nagy: Oracle Examples (SQL, PL/SQL). Panem, Budapest, 2005 (in Hungarian)
Ramakrishnan, Raghu, Johannes Gehrke, and Johannes Gehrke: Database Management Systems, 3rd Edition. McGraw-Hill Education, 2003</td></tr>
</table>

Name: **Software Technology and GUI Design**		***NEPTUN-code:*** *NIXSG1EBNE*	***Number of periods/week:*** full-time: 2 ea + 0 gy + 3 lab
Credit: 5 ***Requirement:*** exam	***Prerequisite:*** *NIXWH1EBNE* Web programming and advanced development techniques		
Responsible: József TICK, Ph.D.	***Position:*** associate professor, habil.	***Faculty and Institute name:*** John von Neumann Faculty of Informatics Institute of Applied Informatics	

Way of assessment:

- precondition of signature: to achieve min. 50% in the tests written during the semester
- written exam

Competences

Course descrition:

The lectures aim to present the paradigms of software engineering, methodology of software design and development, in particular to the modern methodologies based on object-oriented modelling.
The lectures' major subject areas are: trends and tendencies of software engineering, paradigms and methodologies of software development, notations of IT plans and documentations. The agile development models. The ways of software development, object-oriented analysis and design methods, modelling, model-driven software development, Unified Modelling Language, the UML models and their application in the development process, the UML-profiles, Model-driven Architecture (MDA), the use of design patterns, application-development with UML and RUP. Development of mainframe systems, cloud-based application development. Case studies, best-practice examples.
Under the current lab sessions students are introduced to the use of the acquired theoretical knowledge in practice. During the semester, students are required to solve a complex task in teamwork with CASE tool. During the execution of the task practice-oriented problem solving is on focus, students are training to reach a skill-level in development, teamwork and presentation of the development are highlighted. A central element of the elaborated and developed system is the planning and development of a modern graphical user interface of the system.

Literature

Ian Sommerville: Software Engineering, Panem Kft., 2007 (in Hungarian)
Ian Sommerville: Software Engineering, Pearson, 9 edition, 2010

Name: **System Theory**		***NEPTUN-code:*** *NIXRE1EBNE*	***Number of periods/week:*** full-time: 2 lec + 1 sem + 0 lab
Credit: 5 ***Requirement:*** exam		***Prerequisite:*** *NMXAN2EBNE* Calculus II	
Responsible: Levente Adalbert KOVÁCS, Ph.D.	***Position:*** professor, habil.	***Faculty and Institute name:*** John von Neumann Faculty of Informatics Institute of Biomatics	

Way of assessment:

- submission of homework assignment

Competences

Course description:

The students will get acquainted with the basics of system theory. The main topic of the course is the description and analysis of systems with linear dynamics. The course gives an overview of the description of linear systems in time domain, frequency domain and complex frequency domain along with the connection among these descriptions and paying special attention to their applications. The fundamental tools of system theory are discussed that can be used to analyze the equilibrium and stability of systems, the quality of the transients of the system, and the result of the connection of different systems. In the second half of the semester, the description of discrete-time systems is discussed in time and frequency domains. Students will become familiar with the fundamentals and applications of sampling. After finishing the course, the students will have sufficient knowledge for analyzing dynamical systems, and they will have the fundamentals for control engineering studies. The theory learned in the lectures is illustrated with the practical examples in the seminars.

Literature

Béla Lantos: System Theory and Planning I., Single Variable Regulations. Akadémia Kiadó, 2nd edition, 2005 (in Hungarian)
William S. Levine: William S. Levine: The Control Handbook, CRC Press, 2010 (electronic notes)

<table>
<tr><td colspan="2">Name:
Electronics</td><td>NEPTUN-code:
NIEEL0EBNE</td><td>Number of periods/week:
full-time: 2 lec + 0 sem + 2 lab</td></tr>
<tr><td colspan="2">Credit: 4
Requirement: mid-term mark</td><td colspan="2">Prerequisite:
-</td></tr>
<tr><td>Responsible:
Dániel Zoltán STOJCSICS, Ph.D.</td><td>Position:
senior lecturer</td><td colspan="2">Faculty and Institute name:
John von Neumann Faculty of Informatics
Institute of Applied Informatics</td></tr>
<tr><td colspan="4">Way of assessment:
- 2 midterm tests during the semester
- homework</td></tr>
<tr><td colspan="4">Competences</td></tr>
<tr><td colspan="4"></td></tr>
<tr><td colspan="4">Course description:</td></tr>
<tr><td colspan="4">Students will learn the basic tools and fields of analog signal processing, the properties, typical applications and operation of fundament electronic devices. They will obtain knowledge in computer aided design and measurement theory.
Topics of the subject: Basic concepts of analogue signals; The operational amplifier; Theory of feedback; Typical linear and non-linear applications of operational amplifiers; Characteristics and operation of the basic components of electronic circuits; Using simulation to investigate electronic circuits; Basics of measurement theory; Measurement devices.</td></tr>
<tr><td colspan="4">Literature</td></tr>
<tr><td colspan="4">Henriette Steiner – Komoróczki Dr., Zsolt Kertész: Electronics, 2015-2017 (in Hungarian)
Erzsébet Csepesz Iváncsyné Dr.: ELECTRONICS, Kandó Kálmán Főiskola, 2002 (in Hungarian)
Henriette Steiner – Komoróczki Dr., Zsolt Kertész: Electronics, 2015-2017</td></tr>
</table>

<table>
<tr><td colspan="2">Name:
Digital Systems</td><td>NEPTUN-code:
NIXDR0EBNE</td><td>Number of periods/week:
full-time: 2 lec + 0 sem + 2 lab</td></tr>
<tr><td colspan="2">Credit: 4
Requirement: mid-term mark</td><td colspan="2">Prerequisite:
NIEEL0EBNE Electronics</td></tr>
<tr><td>Responsible:
András MOLNÁR, Ph.D.</td><td>Position:
associate professor, habil.</td><td colspan="2">Faculty and Institute name:
John von Neumann Faculty of Informatics
Institute of Applied Informatics</td></tr>
<tr><td colspan="4">Way of assessment:
- written exam</td></tr>
<tr><td colspan="4">Competences</td></tr>
<tr><td colspan="4"></td></tr>
<tr><td colspan="4">Course descrition:</td></tr>
<tr><td colspan="4">Student will learn the basic principles of digital electronics required for computer engineers. They will get familiar with the most important construction elements of digital systems, the advancement of logic families, and the application aspects of use of construction elements in the realization of complex tasks. The course provides information how to write effective code in VHDL. The syntax, language components, basic structures and hardware development approach are all covered during the lectures. Finite state machines and synchronous system design are in focus due to their importance Furthermore, the student learn about the basics of semiconductors. The physical phenomena of operation of diodes and transistors are presented. The possibly realization of basic digital components are discussed in chronological order. DDL, RTL, DTL and TTL systems are explained. The most important transistor families (bipolar, FET, CMOS, etc.) are presented and compared through their advantages and disadvantages.</td></tr>
<tr><td colspan="4">Literature</td></tr>
<tr><td colspan="4">Henriette Steiner – Komoróczki Dr., Zsolt Kertész: Electronics, 2015-2017 (in Hungarian)
István Matijevics: INTERACTIVE DIGITAL TECHNOLOGY COLLECTIONS, Digitális Tankönyvtár, 2011 (in Hungarian, electronic notes)
Henriette Steiner – Komoróczki Dr., Zsolt Kertész: Digital Systems, 2015-2017</td></tr>
</table>

Name: **Introduction to Computer Architectures**	***NEPTUN-code:*** *NIESA1EBNE*	***Number of periods/week (lec/sem/lab):*** full-time: 2 lec + 0 sem + 2 lab
Credits: 4 ***Requirement:*** exam		***Prerequisite:*** -
Responsible: Dezső SIMA, DSc	***Position:*** professor emeritus	***Faculty and Institute name:*** John von Neumann Faculty of Informatics Institute of Applied Informatics
Way of assessment: - written mid-term, written exam		
Competences		
Course description		
The lectures present relevant knowledge about instruction level architectures and the microarchitecture of traditional Neumann computers. The material presented is based on the design space approach. Case examples and major trends will be given to illustrate the evolution. Course description: Computational models and architectures. Data based computational models, the von Neumann computational model, data flow computational model. The concept of computer architecture and different levels of abstraction. ISA. Memory space and register space. Data types, operations, operand-types, instruction formats, addressing methods. User visible status. RISC and CISC architectures, and main dimensions of the most popular ISAs. Execution units. Operation, principles of parallel addition and multiplication. Basics of bus-systems, alternatives of organizing bus operations, signal systems, classes of bus systems, parallel and serial buses, speed limit of parallel buses, basic characteristics of parallel and serial buses (FSB, PCI, PCIe, HT, QPI). Programmed I/O, memory mapped I/O, DMA, I/O channel. The interrupt system. Operation of DRAMs, types of DRAMs (SDRAM, DDR, DDR2, DDR3, 3D RAM). Characteristics of DIMMs (UDIMM, RDIMM, ECC).		
Literature		
Sima, Fountain, Kacsuk: Modern Computer Architectures, Szak Kiadó, 1998 (in Hungarian) Computer Architecture by J.L. Henessy and D. A. Patterson, 5th ed, Elsevier, 2011 Computer Organization and architecture by W. Stallings, 10th ed, Pearson, 2016 Digital Design and Computer Architercture by S.L. Harris, D.M. Harris, ARM Edition, Elsevier, 2016 Conputer Organization and Design by J.L. Henessy and D. A. Patterson, ARM ed, Elsevier, 2016		

Name: **Advanced Computer Architectures I**		***NEPTUN-code:*** *NIXKA1EBNE*	***Number of periods/week:*** full-time: 2 lec + 0 sem + 2 lab
Credit: 4 ***Requirement:*** exam		***Prerequisite:*** *NIESA1EBNE* Introduction to Computer Architectures	
Responsible: Dezső SIMA, DSc.	***Position:*** professor emeritus	***Faculty and Institute name:*** John von Neumann Faculty of Informatics Institute of Applied Informatics	
Way of assessment: - written mid-term, written exam			
Competences			
Course description:			
The lectures provide an overview about main classes of parallel architectures such as: pipeline, superscalar and VLIW processors, and its system architectures. The material presented is based on the design space approach. Case studies and the identification of major trends concerning the evolution enhance the lectures. Major topics include: Levels of the utilized parallelism. Flynn's and an updated classification of architectures. Data, control and resource dependencies and basic methods of their handling. Preserving sequential consistency. Pipelined processors. Superscalar processors of 1st, 2nd and 3rd generation. ISA enhancements (MMX, SSE, etc.). Layout alternatives of caches, 2-3 level cache-hierarchies, optimum size of caches, cache coherency, trends, examples. Evolution of transistor technology development. VLIW and EPIC architectures. Performance issues of processors. Basics of power management. Thread-level parallel, fine, coarse-grained, and SMT architectures. Process-level parallel architectures. Processor-level virtualization support. Motherboards.			
Literature			
Sima, Fountain, Kacsuk: Modern Computer Architectures, Szak Kiadó, 1998 (in Hungarian) Computer Architecture by J.L. Henessy and D. A. Patterson, 5th ed, Elsevier, 2011 Computer Organization and architecture by W. Stallings, 10th ed, Pearson, 2016 Digital Design and Computer Architercture by S.L. Harris, D.M. Harris, ARM Edition, Elsevier, 2016 Conputer Organization and Design by J.L. Henessy and D. A. Patterson, ARM ed, Elsevier, 2016			

Name: **Advanced Computer Architectures II**		***NEPTUN-code:*** *NIXKA2EBNE*	***Number of periods/week:*** full-time: 2 lec + 0 sem + 0 lab
Credit: 2 ***Requirement:*** exam		***Prerequisite:*** *NIXKA1EBNE* Advanced Computer Architectures I	
Responsible: Dezső SIMA, DSc.	***Position:*** professor emeritus	***Faculty and Institute name:*** John von Neumann Faculty of Informatics Institute of Applied Informatics	
Way of assessment: - written mid-term, written exam			
Competences			
Course description:			
Main objective of the lecture is to identify decisive aspects and main steps of the evolution of advanced processor and system architectures. The subject discussed is based on the design space approach, emphasizing main aspects and options for each step of the evolution as well as major trends identified. Many case examples illustrate the material presented. Main topics: Overview of multicore processors. The evolution of Intel's basic architectures. Evolution of Intel's server architectures. Manycore processors. Emerging of the mobile boom, its implications. Evolution of the ARM's ISA, main processor implementations. bigLITTLE mobile processors. Case examples for mobile processors. Discussion of significant implementation issues, such as providing appropriate memory bandwidth for multicore server processors, providing cache coherency in multicores and multiprocessors, overview of power management and the turbo boost technology, processor level support of virtualization.			
Literature			
Sima, Fountain, Kacsuk: Modern Computer Architectures, Szak Kiadó, 1998 (in Hungarian) Computer Architecture by J.L. Henessy and D. A. Patterson, 5th ed, Elsevier, 2011 Computer Organization and architecture by W. Stallings, 10th ed, Pearson, 2016 Digital Design and Computer Architercture by S.L. Harris, D.M. Harris, ARM Edition, Elsevier, 2016 Conputer Organization and Design by J.L. Henessy and D. A. Patterson, ARM ed, Elsevier, 2016 Sima Dezső: Evolution of Intel's transistor technology, 2017 (electronic notes) Sima Dezső: Introduction to multicores, 2017 (eBook, electronic notes) Sima Dezső: Intel's Core family TOCK lines Core 2 to Skylake, 2017 (eBook, electronic notes) Sima Dezső: Intel's high-end Multicore Server Platforms, 2017 (eBook, electronic notes) Sima Dezső: The mobile boom. 2017 (eBook, electronic notes) Sima Dezső: ARM's processor lines, 2017 (eBook, electronic notes) Sima Dezső: big.LITTLE technology, 2017 (eBook, electronic notes) Sima Dezső: Power management, 2017 (eBook, electronic notes)			

Name: **Operating Systems**		***NEPTUN-code:*** *NIEOR1EBNE*	***Number of periods/week:*** full-time: 2 lec + 0 sem +3 lab
Credit: 5 ***Requirement:*** exam		***Prerequisite:*** *NIXSH0EBNE* Computer Networks	
Responsible: András RÖVID, Ph.D.	***Position:*** associate professor	***Faculty and Institute name:*** John von Neumann Faculty of Informatics Institute of Applied Mathematics	

Way of assessment:

- requirements for signature: passing the two mid-terms (written during the labs)
- written midterm

Competences

Course description:

During the semester the students get to know the main tasks of the operating systems, the parts of the operating systems, and the different implementation possibilities of each part. During the semester the curse uses real world examples from today's most widespread operating systems.
In the lab practices the students learn the means of administering operating systems on an advanced level. The focus is on the command line based operation of Linux, however at certain points solutions from other operating systems (e.g. Microsoft Windows) are also presented.
Main competences: architectures of operating systems, major functions and modules of operating systems (process and thread handling, scheduling, memory management, I/O and file management, communication between processes), evolution of operating systems, interface standardisation, solutions in todays' most widespread operating systems.

Literature

Operating Systems: Internals and Design Principles by William Stallings, 8th ed, Pearson, 2014
Operating System Concepts by Abraham Silberschatz, Peter B. Galvin and Greg Gagne, 9th ed, Wiley, 2012
Modern Operating Systems by Andrew S. Tanenbaum and Herbert Bos, 4th ed, Pearson, 2014
Windows Internals by Mark Russinovich, David Solomon and Alex Ionescu, 6th ed, Ms Press, 2012
Systems Performance: Enterprise and the Cloud by Brendan Gregg, Prentice Hall, 2013

Name: **Computer Networks**		***NEPTUN-code:*** *NIXSH0EBNE*	***Number of periods/week:*** full-time: 2 lec + 0 sem + 2 lab
Credit: 4 ***Requirement:*** exam		***Prerequisite:*** *NIXBI1EBNE* Basics of information systems	
Responsible: András RÖVID, Ph.D.	***Position:*** associate professor	***Faculty and Institute name:*** John von Neumann Faculty of Informatics Institute of Applied Mathematics	

Way of assessment:

- requirements for signature: passing the mid-terms
- written exam

Competences

Course description:

The course covers the basics of computer networks with emphasis on the Internet. Students are introduced to networks' architectural and functional principles, essential terminology, working methods and layered approach of the reference models. They get to know the operating model of the TCP/IP protocol stack, the architecture of the Internet, its hierarchical addressing system, the functioning of protocols ensuring basic Internet services. Other areas of coverage include the main functioning methods of computer networks, their opportunities for use, performance characteristics and specifics of application. Students also familiarize themselves with the physical data transfer environment of computer networks, the methods and characteristics of their use and some details of operation.

Main competencies: network reference models, Internet basics, Internet's hierarchical addressing method, domain name system (DNS), IP protocol, basic ideas of packet switching and routing, concepts of connectionless and connection full data transfer, transport protocols and their performance, wired and wireless local area networks, basics of Ethernet.

Literature

A. S. Tanenbaum és D. J. Wetherall: Computer Networks, 3rd edition, Panem, Budapest, 2013 (in Hungarian)

A. S. Tanenbaum and D. J. Wetherall: Computer Networks, 5th edition, Prentice Hall, 2011 (electronic notes)

<table>
<tr><td colspan="2">Name:
Intelligent Systems</td><td>NEPTUN-code:
NIXIR0EBNE</td><td>Number of periods/week:
full-time: 1 lec + 0 sem + 2 lab</td></tr>
<tr><td colspan="2">Credit: 3
Requirement: mid-term mark</td><td colspan="2">Prerequisite:
-</td></tr>
<tr><td>Responsible:
András MOLNÁR, Ph.D.</td><td>Position:
associate professor, habil.</td><td colspan="2">Faculty and Institute name:
John von Neumann Faculty of Informatics
Institute of Applied Informatics</td></tr>
<tr><td colspan="4">Way of assessment:
- mid-term exam</td></tr>
<tr><td colspan="4">Competences</td></tr>
<tr><td colspan="4"></td></tr>
<tr><td colspan="4">Course description:</td></tr>
<tr><td colspan="4">The course aim is to teach the general concepts related to mobile robots: sensors, path planning, orientation. The applications of mobile robots will be demonstrated: military, disaster management, space exploration, civil applications. The students will learn the ground aerial path planning and guidance: terrestrial path planning algorithms, known and unknown terrain, rule-based, neural network based and self-learning algorithms, wavefront propagation. Basic concepts of genetic algorithms: gene, population, selection, mutation. Programming of a simple genetic algorithm to solve problems. The optimization of genetic algorithms. Neural networks basic concepts: Perceptron, feedforward networks, learning and error correction. A simple neural networks can be solved. General description of the satellite positioning systems: GPS, Glonass.</td></tr>
<tr><td colspan="4">Literature</td></tr>
<tr><td colspan="4">Attila Álmos, Sándor Győri: Genetic Algorithms, Typotex Kft. Elektronikus Kiadó, 2002 (in Hungarian)
Cawsey, Alison: The Essence of Artificial Intelligence, Panem Kft., 2002 (in Hungarian)</td></tr>
</table>

Name: **Enterprise Information Systems**		***NEPTUN-code:*** *NIXVI0EBNE*	***Number of periods/week:*** full-time: 2 lec + 0 sem + 2 lab
Credit: 4 ***Requirement:*** exam	***Prerequisite:*** *NIXAB0EBNE* Databases *NMXVS1EBNE* Probability theory and mathematical statistics		
Responsible: László ERDŐDI, Ph.D.	***Position:*** senior lecturer	***Faculty and Institute name:*** John von Neumann Faculty of Informatics Institute of Applied Informatics	
Way of assessment: - requirements for signature: passing the mid-terms and successful submission of a homework assignment - oral exam			
Competences			
Course description:			
The objective of the course is to discuss the fundamental aspects of business functionality, determine the requirements of business IT systems and to present the data model and IT processes that guarantee integrated operation. The main concepts: business system, IT system, IT tools and their categorization, requirements of IT systems. Customer relationship model. Functional subsystems of the business system: customer service, procurement, finance, inventory. Relationships among the subsystems, business processes and the supporting data model. IT processes. System service functions. The concept and importance of control, categories and examples. Historical survey. The objective of the lab is to support the lectures by providing practical examples. Students will learn to use a business process modeling tool, as well as the supporting data models. Students will form small teams that analyze certain areas of a model company. The results of the teamwork will provide the basis to design and develop an integrated system or select an adequate standard system.			
Literarure			
Csaba Komló: Information Systems Planning Methodology, Eszterházy Károly Főiskola, 2014 (in Hungarian) Holyinka Péter: Enterprise Information Systems. (electronic notes) U. Wahli, V. Avula, H. Macleod, M. Saeed, A. Vinther: Business Process Management: Modeling through Monitoring Using WebSphere V6.0.2 Products, IBM Press, 2007 Dumas, M., La Rosa, M., Mendling, J., Reijers, H.: Fundamentals of Business Process Management, Springer, 2013			

Name: **IT Security**		***NEPTUN-code:*** *NIEIB0EBNE*	***Number of periods/week:*** full-time: 2 lec + 0 sem + 2 lab
Credit: 4 ***Requirement:*** exam		***Prerequisite:*** *NIEOR1EBNE* Operating Systems	
Responsible: Valéria PÓSER, Ph.D.	***Position:*** associate professor	***Faculty and Institute name:*** John von Neumann Faculty of Informatics Institute of Biomatics	

Way of assessment:

- Two mid-terms which are prerequisites of the signature. One retake possibility
- Oral exam. Final mark is calculated as the average of mid-terms and exam

Competences

Course description:

The goal of the subject is to raise security awareness, to provide an overview on certain areas of IT security, and to prepare the prospective computer engineer for IT security problems, which arise in their later work.

Major topics of the subject: Short overview on the history of information security. Ethical issues, motivations, targets, security awareness, regulations. Cryptology, cryptographic algorithms and basic protocols. Vulnerability of workstations, servers, networks and infrastructures. Physical protection. Malicious software (malware). User authentication, authorisation and access management. Password management in operating systems. Problems of password choice, password breaking techniques. Network attack methods. Border protection of network (firewalls, IDS/IPS). Public Key Infrastructure. Secure communication, internet security protocols. Secure mail and data storage. Security of mobile and cloud-based systems. Vulnerability of applications. Risk management.

Literature

Levente Buttyán, László Győrfi, Sándor Győri, István Vajda: Codingtechnique, 2006 (electronic notes)
Mark S. Merkow Jim Breithaupt: Information Security: Principles and Practices, Second Edition, Pearson Education, 2014 (electronic notes)
Howard M. "A tutorial on linear and differential cryptanalysis." Cryptologia 26.3, 189-221., 2002 (electronic notes)

<table>
<tr><td colspan="2">Name:
Comprehensive Exam</td><td>NEPTUN-code:
NIXSS1EBNE</td><td>Number of periods/week:
full-time: 0 lec + 0 sem + 0 lab</td></tr>
<tr><td colspan="2">Credit: 0
Requirement: comprehensive exam</td><td colspan="2">Prerequisite:
NIXSF2EBNE Software design and development II
NIXDR0EBNE Digital Systems</td></tr>
<tr><td>Responsible:
Levente KOVÁCS, Ph.D.</td><td>Position:
professor, habil.</td><td colspan="2">Faculty and Institute name:
John von Neumann Faculty of Informatics
Institute of Biomatics</td></tr>
<tr><td colspan="4">Way of assessment:
- written exam covering the topics of the prerequisite lectures</td></tr>
<tr><td colspan="4">Competences</td></tr>
<tr><td colspan="4"></td></tr>
<tr><td colspan="4">Course description:</td></tr>
<tr><td colspan="4">General verification of software design and development, and digital systems knowledge.</td></tr>
<tr><td colspan="4">Literature</td></tr>
<tr><td colspan="4">-</td></tr>
</table>

<table>
<tr><td colspan="2">Name:
Project Work</td><td>NEPTUN-code:
NNPPR1EBNE</td><td>Number of periods/week:
full-time: 0 lec + 0 sem + 4 lab</td></tr>
<tr><td colspan="2">Credit: 2
Requirement: mid-term mark</td><td colspan="2">Prerequisite:
-</td></tr>
<tr><td>Responsible:
László CSINK, Ph.D.</td><td>Position:
associate professor</td><td colspan="2">Faculty and Institute name:
John von Neumann Faculty of Informatics
Institute of Applied Informatics</td></tr>
<tr><td colspan="4">Way of assessment:
- successful submission and presentation of the assignment</td></tr>
<tr><td colspan="4">Competences</td></tr>
<tr><td colspan="4"></td></tr>
<tr><td colspan="4">Course description:</td></tr>
<tr><td colspan="4">The students must choose a project task in the first two weeks, and form 2-person teams. If it is justifiable, the group size can be 1 or 3. During solving their task, the students must present the part results and the problems arise at labs. The aim of this course is getting experience in teamwork and solving complex problems. At the last two weeks of the semester, the teams must preset their results under a miniconference, and answer the upcoming questions. The aim of these presentations is to improve the presentation and debate skills of the students. These project works can initiate a student research project or a thesis.</td></tr>
<tr><td colspan="4">Literature</td></tr>
<tr><td colspan="4">-</td></tr>
</table>

IOT, EMBEDDED SYSTEMS AND ROBOTICS SPECIALIZATION (I)

<table>
<tr><td colspan="2">Name:
Control Engineering</td><td>NEPTUN-code:
NAXIT3JBNE</td><td>Number of periods/week:
full-time: 1 lec + 0 sem + 2 lab</td></tr>
<tr><td colspan="2">Credit: 4
Requirement: mid-term mark</td><td colspan="2">Prerequisite:
NIXRE1EBNE Systems Theory</td></tr>
<tr><td>Responsible:
Levente KOVÁCS, Ph.D.</td><td>Position:
professor, habil.</td><td colspan="2">Faculty and Institute name:
John von Neumann Faculty of Informatics
Institute of Biomatics</td></tr>
<tr><td colspan="4">Way of assessment:
- practical exam</td></tr>
<tr><td colspan="4">Competences</td></tr>
<tr><td colspan="4"></td></tr>
<tr><td colspan="4">Course description:</td></tr>
<tr><td colspan="4">Based on the knowledge gained from system theory, the students will become familiar with the applications of classical control theory. After a short summary of the analysis of linear dynamic systems, the fundamentals of control engineering is discussed, such as analysis of closed-loop systems, root locus, phase margin, gain margin, and stability. This is followed by the fundamentals of the design of serial compensators that are the controllers widely applied in industry up till now. The connection between the Type Number and the steady-state error and the role of integral and derivative terms and their effect on the closed-loop are discussed in details. During the laboratory practices, the students will learn several serial compensator (PID controller) design methodologies. During the end of the semester, the effect of the sampling is introduced, and discrete-time controller design methodologies are discussed. After the semester, the students will be able to design classical industrial controllers and implement them in sampled (digital, processor-based) systems.</td></tr>
<tr><td colspan="4">Literature</td></tr>
<tr><td colspan="4">Béla Lantos: System Theory and Planning I., Single Variable Regulations. Akadémia Kiadó, 2nd edition, 2005 (in Hungarian)
William S. Levine: The Control Handbook, CRC Press, 2010 (electronic notes)</td></tr>
</table>

<table>
<tr><td colspan="2">Name:
Embedded and Sensor Based Systems</td><td>NEPTUN-code:
NIXBE1JBNE</td><td>Number of periods/wee:
full-time: 1 lec + 0 sem + 2 lab</td></tr>
<tr><td colspan="2">Credit: 4
Requirement: exam</td><td colspan="2">Prerequisite:
NIXDR0EBNE Digital Systems</td></tr>
<tr><td>Responsible:
András MOLNÁR, Ph.D.</td><td>Position:
associate professor, habil.</td><td colspan="2">Faculty and Institute name:
John von Neumann Faculty of Informatics
Institute of Applied Informatics</td></tr>
<tr><td colspan="4">Way of assessment:
- mid-term exam
- oral exam</td></tr>
<tr><td colspan="4">Competences</td></tr>
<tr><td colspan="4"></td></tr>
<tr><td colspan="4">Course description:</td></tr>
<tr><td colspan="4">Students will learn the fundamentals of embedded systems (microcontrollers), their architecture and peripherals. The course will discuss the various methods of measurement of physical properties and processing procedures of the measured data in detail. The main areas covered in the lectures: the concept of measurement, general measurement equipment, remote sensor systems, basic structure, grouping of sensors and measurement principles with practical examples, recording techniques, especially imaging (tube based, semiconductor based, and gamma camera). Data digitization, processing of measurement results, measurement errors, deviations, filtering data. Basic image processing algorithms (filters, adjustments, edge enhancement). Wired and wireless data transmission. The central units in respect of the main structures of the general knowledge of materials, hardware and software features for embedded systems, processors, microcontrollers. communication possibilities between processors and peripherals. Parallel processing effectiveness, limitations, synchronization issues, topologies. The laboratory sessions demonstrate theoretical knowledge made possible through the implementation of sample tasks.</td></tr>
<tr><td colspan="4">Literature</td></tr>
<tr><td colspan="4">Attila Halmai Dr.: Sensor and Aktuatortechnique, Digitális Tankönyvtár, 2012 (in Hungarian, electronic notes)
Jon S. Wilson: Sensor Technology Handbook, Newnes, 2004</td></tr>
</table>

Name: **Introduction to Robotics**		***NEPTUN-code:*** *NBXRT1JBNE*	***Number of periods/week:*** full-time: 3 lec + 0 sem + 0 lab
Credit: 4 ***Requirement:*** exam		***Prerequisite:*** *NAXIT3JBNE* Control Engineering	
Responsible: Péter GALAMBOS, Ph.D.	***Position:*** associate professor	***Faculty and Institute name:*** John von Neumann Faculty of Informatics Institute of Biomatics	
Way of assessment: - oral exam			
Competences			
Course description:			
Goals of the course are two fold: On the one hand, it reviews the development of robotics, uncover the relevant interplays between different scientific disciplines and introduces the terminology of the field. The other aim is to revisit the relevant aspects of mathematics and physics that are prerequisits of further studies in robotics. Topics: General historical survey; Major robot types; Robot applications; Basic concepts in Physics; Mechanical background; Linear algebra; Rotational transformations; Homogeneous transformations; Differential equations in robotics.			
Literature			
Béla Kulcsár: Robotics, Typotex, 2013 (in Hungarian) Assorted chapters of: Handbook of Robotics (Editors: Siciliano, Bruno, Khatib, Oussama), Springer, 2016			

<table>
<tr><td colspan="2">Name:
Embedded Programming I</td><td>NEPTUN-code:
NIXBP1JBNE</td><td>Number of periods/week:
full-time: 0 lec + 0 sem + 3 lab</td></tr>
<tr><td colspan="2">Credit: 4
Requirement: mid-term mark</td><td colspan="2">Prerequisite:
NIXBE1JBNE Embedded and sensor based systems</td></tr>
<tr><td>Responsible:
Dániel Zoltán STOJCSICS, Ph.D.</td><td>Position:
senior lecturer</td><td colspan="2">Faculty and Institute name:
John von Neumann Faculty of Informatics
Institute of Applied Informatics</td></tr>
<tr><td colspan="4">Way of assessment:
- successful completition of the assignement</td></tr>
<tr><td colspan="4">Competences</td></tr>
<tr><td colspan="4"></td></tr>
<tr><td colspan="4">Course description:</td></tr>
<tr><td colspan="4">Students will gain hands-on experience in embedded systems development through a complex task. The students in the first two weeks of the semester choose individual tasks, based on a two-wheeled ground vehicle. The tasks are organized in teams of two people. In some cases the team can consist of three people. The teams acquire knowledge about the development of embedded systems during the semester and get acquainted with the autonomous vehicle control guidance. On the lab they will design the ciruit and PDB design of the onboard electronics (central MCU, sensors, external modules, power supply, I / O peripherals).</td></tr>
<tr><td colspan="4">Literature</td></tr>
<tr><td colspan="4">Brian W. Evans: Arduino programming notebook, TavIR, 2011 (in Hungarian)
Michael McRoberts: Beginning Arduino, Apress, 2013</td></tr>
</table>

Name: **Introduction to Robot Programing**		***NEPTUN-code:*** *NBXRP1JBNE*	***Number of periods/week:*** full-time: 2 lec + 0 sem + 0 lab
Credit: 3 ***Requirement:*** exam		***Prerequisite:*** *NBXRT1JBNE* Introduction to Robotics	
Responsible: Péter GALAMBOS, Ph.D.	***Position:*** associate professor	***Faculty and Institute name:*** John von Neumann Faculty of Informatics Institute of Biomatics	
Way of assessment: - oral exam			
Competences			
Course description:			
The course is aimed at giving an insight to the operation and fundamental programming paradigms of industrial robots and various service robot in a practice orientad fashion. Students shall learn the elemntary skills related to a wider set of robots that will serve a good practical basis for the deeper theoretical disscussions of robot programming and control. Within the course, the following topics are touched: Relation of robot and the robot program; Remote controlled, semi-autonomous and autonomous operation; Relationship of on-board and outsourced functions; Programming of LEGO NXT or similar toy robot; Programming of NAO humanoid robot; Shopfloor programming of industral robots (FANUC); Proramming of modern Co-working robots (KUKA LBR IIWA); Surgical robots (Da Vinci); Medical manipulators; Force-feedback manipulators and haptic intefaces.			
Literature			
Béla Kulcsár: Robotics, Typotex, 2013 (in Hungarian) Assorted chapters of: Handbook of Robotics (Editors: Siciliano, Bruno, Khatib, Oussama), Springer, 2016			

<table>
<tr><td colspan="2">Name:
Embedded Programming II</td><td>NEPTUN-code:
NIEBP2JBNE</td><td>Number of periods/week:
full-time: 0 lec + 0 sem + 4lab</td></tr>
<tr><td colspan="2">Credit: 4
Requirement: mid-term mark</td><td colspan="2">Prerequisite:
NIXBP1JBNE Embedded Programming I</td></tr>
<tr><td>Responsible:
Dániel Zoltán STOJCSICS, Ph.D.</td><td>Position:
senior lecturer</td><td colspan="2">Faculty and Institute name:
John von Neumann Faculty of Informatics
Institute of Applied Informatics</td></tr>
<tr><td colspan="4">Way of assessment:
- successful completition of the assignement</td></tr>
<tr><td colspan="4">Competences</td></tr>
<tr><td colspan="4"></td></tr>
<tr><td colspan="4">Course description:</td></tr>
<tr><td colspan="4">Students continue the previous lab robot. For the design of the shell of the robot they learn about CAD/CAM systems, the basics of technical drawing and design components as well as technology FDM 3D printing options. By the end of the semester everyone has to build and complete a unique, individually designed and manufactured an autonomous ground vehicle and presented in a race, held for the occasion.</td></tr>
<tr><td colspan="4">Literature</td></tr>
<tr><td colspan="4">Gábor Ruzsinszki: Microcontroller System Development in C / C ++ language II.: Arduino Platform, 2013 (in Hungarian)
James A. Langbridge: Arduino Sketches Tools and Techniques for Programming Wizardry Wiley;1 edition, 2015</td></tr>
</table>

<table>
<tr><td colspan="2">Name:
Robot Control</td><td>NEPTUN-code:
NBERI1JBNE</td><td>Number of periods/week:
full-time: 1 lec + 0 sem + 2 lab</td></tr>
<tr><td colspan="2">Credit: 3
Requirement: mid-term mark</td><td colspan="2">Prerequisite:
NAXIT3JBNE Control Engineering</td></tr>
<tr><td>Responsible:
Tamás HAIDEGGER, Ph.D.</td><td>Position:
associate professor</td><td colspan="2">Faculty and Institute name:
John von Neumann Faculty of Informatics
Institute of Biomatics</td></tr>
<tr><td colspan="4">Way of assessment:
- requirement of signature: successful submission of homework assignment
- written exam</td></tr>
<tr><td colspan="4">Competences</td></tr>
<tr><td colspan="4"></td></tr>
<tr><td colspan="4">Course description:</td></tr>
<tr><td colspan="4">Basics of control engineering (linear, continuous/discrete time invariant systems, stability analysis in time/frequency domain, observability, controllability, Kalman-decomposition). Empirical controller design. PPID controllers and simple variants. Stability through state feedback and pole placement. Ackermann formula. LQ control.
Lab work: practical exercises under MATLAB.</td></tr>
<tr><td colspan="4">Literature</td></tr>
<tr><td colspan="4">Béla Kulcsár: Robotics, Typotex, 2013 (in Hungarian)
Assorted chapters of: Handbook of Robotics (Editors: Siciliano, Bruno, Khatib, Oussama), Springer, 2016</td></tr>
</table>

<table>
<tr><td colspan="2">Name:
Sensor Networks, IoT Systems</td><td>NEPTUN-code:
NIXSI1JBNE</td><td>Number of periods/week:
full-time: 1 lec + 0 sem + 2 lab</td></tr>
<tr><td colspan="2">Credit: 4
Requirement: exam</td><td colspan="2">Prerequisite:
NIXBP1JBNE Embedded programming I</td></tr>
<tr><td>Responsible:
András MOLNÁR, Ph.D.</td><td>Position:
associate professor, habil.</td><td colspan="2">Faculty and Institute name:
John von Neumann Faculty of Informatics
Institute of Applied Informatics</td></tr>
<tr><td colspan="4">Way of assessment:
- requirement of signature: successful mid-term exam
- oral exam</td></tr>
<tr><td colspan="4">Competences</td></tr>
<tr><td colspan="4"></td></tr>
<tr><td colspan="4">Course description:</td></tr>
<tr><td colspan="4">The course is definitely practice-oriented. The IoT architecture, technologies, operational processes and planning issues will be presented. The course is focused on providing solutions based on business strategies, "open", efficient, flexible and sufficiently robust services that are vendor-independent, including design principles, implementation methods, processing, storage, data security, network technologies. Based on the presentations and case studies, analyzes, expectations and technological considerations, the implementation process and management practice is in line with business requirements. Lab sessions are mostly based on Cisco and Intel technology and equipment, that are presented in detail.</td></tr>
<tr><td colspan="4">Literature</td></tr>
<tr><td colspan="4">Attila Halmai Dr.: Sensor and Aktuatortechnique, Digitális Tankönyvtár, 2012 (in Hungarian, electronic notes)
Amiya Nayak, Ivan Stojmenovic: Wireless Sensor and Actuator Networks, Wiley, 2010
R Budampati, S. Kolavennu: Industrial Wireless Sensor Networks: Monitoring, Control and Automation, Woodhead Publishing, 2015</td></tr>
</table>

BIG DATA AND BUSINESS INTELLIGENCE SPECIALIZATION (G)

Name: **Introduction to Finance and Accounting of Enterprises**		***NEPTUN-code:*** *GGXVP1BBNE*	***Number of periods/week:*** full-time: 3 lec + 0 sem + 0 lab
Credit: 3 ***Requirement:*** practice mark		***Prerequisite:*** -	
Responsible: Bianka PARRAGH, Ph.D.	***Position:*** senior lecturer	***Faculty and Institute name:*** Keleti Faculty of Business and Management	
Way of assessment: - mid-term exam			
Competences			
Course description:			
Competencies: accounting aspects of business operations, financial - management skills. Domestic and international accounting, accounting policies, accounting information system. The accounting services. Reporting and accounting obligations, types, features, reports portions types, bookkeeping features, balance sheet. The economic events. Assessment methods and procedures. Balance Sheet and Profit and Loss Statement compilation and understanding of the relationships between them. The creation of modern money. Banking system, central bank regulation, financial sector, commercial banks, and passive business lines. Active lines of business - lending. Special forms of financing. Payment transactions, electronic banking services. Calculating the time value of money, banking operations, teaching basic calculations. Securities, calculating transmission. Bonds, shares, and related calculations. Securities markets - stock trading, stock market transactions variety of trading systems, stock exchange orders, stock market indices. Public Finance System - fiscal policy. Central government revenue and expenditure sides of the budget - the tax system. And public debt management. Basic concepts of international finance, international capital flows, international financial institutions and integration efforts.			
Literature			
Ágnes Kocsir-Csiszárik Dr.: Business Finances, Electronic notes, Óbudai Egyetem (in Hungarian) Ágnes Kocsir-Csiszárik Dr. – Pál Tibor Szilágyi (2016): The prevalence of investment economics calculations among domestic small and medium-sized enterprises, Enterprise Development in the 21st century, VI – Volume (edited by: Ágnes Kocsir-Csiszárik) Óbudai Egyetem, Keleti Károly Kar, 39-52.pp. (in Hungarian) Kocsir-Csiszárik Ágnes Ph.D. Dr. –Mónika Fodor Dr. Ph.D – András Medve Ph.D. Dr. – János Varga Ph.D. Dr. (2015): Do we know everything about the financial strategies? - results based on a Hungarian questionnaire research, The Macrotheme Review, 4 (5) summer edition, 117-136. pp. Ágnes Kocsir-Csiszárik Dr. – János Varga Dr. (2015): Conscious corporate financing strategies in the light of funding, "Outlook - 25 years of economics training in Győr", Gyula Kautz Memorial Conference, 11. 06. 2015. Volume in electronic format (edited by: Anikó Tompos, Lívia Mihályka Ablonczyné) (in Hungarian) Valéria Nagy Dr. Pappné – Ágnes Kocsir-Csiszárik Dr.: Accounting of Enterprises notes, Electronic notes, Óbudai Egyetem (in Hungarian) Ágnes Kocsir-Csiszárik Dr. (2015): Financing strategies applied by domestic enterprises in the light of the results of a questionnaire survey, Enterprise Development in 21st century V. – Volume (edited by: Ágnes Kocsir-Csiszárik Dr.) Óbudai Egyetem, Keleti Károly Kar, 33-55. pp. (in Hungarian) Ágnes Csiszárik-Kocsir Dr.Ph.D. (2016): Transformation of the international and European project finance market as a result of the crisis, Financial and Economic Review, Vol. 15 Issue 1., March2016, 51-69. pp. dr. Ivánné Illés: Companies Finances, Saldo, 2003 (in Hungarian) dr. Ivánné Illés: Tasks of the Company's Finances, Saldo, 2003 (in Hungarian) László Balogh: Corporate Finance Examples. - [Bp.]: Aula, 2003. (in Hungarian)			

Brealey - Meyers: Modern Business Finances 1-2., McGraw Hill - Panem, 1992 (in Hungarian)
Gábor Magyar: Financial Navigator, INVENT Kiadó, Budapest, 2003 (in Hungarian)
Éva Új Sándorné: Finance for everyone, Variant-Media Kiadó, Budapest, 2001 (in Hungarian)
Act C of 2000 on Accounting/ Imre Sztanó Dr.: The basic of accounting, Perfekt kiadó, 2015 (in Hungarian)
Ildikó Gombaszögi: Introduction to Accounting, Óbudai Egyetem, 2016 (in Hungarian, electronic notes)
Erzsébet Bukucs Kovácsné: An Example for Accounting Bases, Óbudai Egyetem, 2016 (in Hungarian, electronic notes)
Dr. Larry M. Walther: NEW Managerial Accounting Solutions Manual, 2015
Alex Byrne: Practical Accounts & Bookkeeping in easy steps, 2016

Name: **Advanced Databases**		***NEPTUN-code:*** *NIXKD1BBNE*	***Number of periods/week:*** full-time: 2 lec + 0 sem + 2 lab
Credit: 5 ***Requirement:*** exam		***Prerequisite:*** *NIXAB0EBNE* Databases	
Responsible: Rita Dominika FLEINER, Ph.D.	***Position:*** senior lecturer	***Faculty and Institute name:*** John von Neumann Faculty of Informatics Institute of Applied Informatics	

Way of assessment:

- signature requirement: passing the mid-term exams, and successful submission of a homework assignment
- written exam

Competences

Course description:

During the course students learn about concepts, procedures and tools related to advanced topics of database management systems.
Topics: refreshing and deepening SQL knowledge, Oracle database architecture, Oracle instance, memory structures. SQL processing. Database tuning, access paths, execution plan, index structures, join methods, CBO statistics, selectivity, costs, materialization, pipelining, query optimization. Transactions, concurrency control and recovery. Semi structured data model. Management of XML data type: XML, DTD, XSD, XSLT, XQuery, XPath. NoSQL databases and types. Document stores, key-value stores, graph databases, column stores: basics, architecture, queries. CAP theorem. Semantic web, RDF, SPARQL, OWL.

Literature

Garcia E., Ullman J.D., Widom J.: Database Systems (Execution), Panem, Budapest, 2000 (in Hungarian)
Gaurav, V.: Getting Started with NoSQL. Packt Publishing, 2013
McCreary, D., Kelly, A.: Making Sense of NoSQL. Manning Publications Co., 2013

Name: **Data Warehousing and Business Intelligence**		***NEPTUN-code:*** *NIXAT1BBNE*	***Number of periods/week:*** full-time: 3 ea + 0 gy + 3 lab
Credit: 8 ***Requirement:*** exam		***Prerequisite:*** *NIXKD1BBNE* Advanced Databases	
Responsible: Imre FELDE, Ph.D.	***Position:*** associate professor	***Faculty and Institute name:*** John von Neumann Faculty of Informatics Institute of Biomatics	

Way of assessment:

- signature requirement: passing the mid-term exams, and successful submission of a homework assignment
- written exam

Competences

Course description:

During the course students learn about concepts, procedures and tools related to data warehousing, datamining and business intelligence.
Topics: Data warehouse concepts, architecture, components, data model, design. OLTP and OLAP systems. Implementation of data warehouse projects. Data mining algorithms. Data analysis types: creating business and statistical analyzes. Planning, forecasting and business modeling, implementing "what if" analyzes types. Metrics, key performance indicators. Making Executive Dashboards. Consolidation, aggregation preparation. Making Time-series analysis. Migration, churn analysis. Customer Segmentation, fraud detection, credit rating, cross-selling analysis. Weblog analysis. Geographical analysis of the data. Data visualization, graphs, creating charts. Data, voice and text mining.

Literature

B. Fajszi, L. Cser, T. Fehér: Business profit deep in the data - the data mining every days, Alinea, IQSYS, Budapest, 2010 (in Hungarian)
G. Varga Bánné: The data warehouse-production technology of architecture through the dimensional modeling of business intelligence applications description of Oracle tools, Typotex Kiadó, 2012 (in Hungarian)
Han, J., M. Kamber: Data Mining. Concepts and Techniques, Panem Kft., 2004 (in Hungarian)
Ralph Kimball et al.: The Data warehouse Lifecycle Toolkit. Wiley, 2013

Name: **Big Data Algorithms and Programming**		***NEPTUN-code:*** *NIEBD1BBNE*	***Number of periods/week:*** full-time: 2 lec + 0 sem + 2 lab
Credit: 5 ***Requirement:*** exam		***Prerequisite:*** *NIXKD1BBNE* Advanced Databases	
Responsible: Imre FELDE, Ph.D.	***Position:*** associate professor	***Faculty and Institute name:*** John von Neumann Faculty of Informatics Institute of Biomatics	
Way of assessment: - signature requirement: passing the mid-term exams, and successful submission of a homework assignment - written exam			
Competences			
Course description:			
During the course students learn about concepts related to Big Data circuit technologies, paradigms, components, application areas, hardware and software tools used in this field and industry characteristics. Topics: Apache Hadoop framework, file systems, resource management, MapReduce paradigm. Infrastructure planning, configuration, access. Big Data clusters installation and maintenance. Distributed data processing framework, streaming and batch processing tools. Data analysis concepts, forecasting basics, data science. Exploratory and confirmatory data analysis tools. A review of open source packages and query tools. Data mining fundamentals. The basic functions of the R statistical environment.			
Literature			
Gy. Bőgel: The Big Data ecosystem, Typotex kiadó, 2015 (in Hungarian) Han, J., M. Kamber: Data Mining. Concepts and Techniques, Panem Kft., 2004 (in Hungarian) Harrison, G.: Next Generation Databases: NoSQL, NewSQL, and Big Data. Apress, 2015 Manyika J., Chui M., Brown B., Bughin J., Dobbs R., Roxburgh C., Byers A.H.: Big Data, the Next Frontier for Innovation, Competition and Productivity. McKinsey Global Institute, 2011			

Name: **Enterprise Resource Planning I**		***NEPTUN-code:*** *NIXER1BBNE*	***Number of periods/week:*** full-time: 2 lec + 0 sem + 0 lab
Credit: 2 ***Requirement:*** mid-term mark		***Prerequisite:*** *NIXVI0EBNE* Enterprise Information Systems	
Responsible: László ERDŐDI, Ph.D.	***Position:*** senior lecturer	***Faculty and Institute name:*** John von Neumann Faculty of Informatics Institute of Applied Informatics	

Way of assessment:

- signature requirements: participation on the lectures
- oral exam (roundtable discussion)

Competences

Course description:

Competences: manufacturing, classification of manufacturing processes, inventory management, project planning and control. The manufacturing, and the point of viewpoints of the manufacturing processes. The classification of the manufacturing processes. Product planning, planning the manufacturing process of the product.

Type: components production and assembly. Manufacturing orders, and the master production schedule. Data model. The components and the structure of the product. The bill of material. Material requirements planning. Data model. Capacity planning: long time and short time programming. The priority, scheduling on priorities. Scheduling rules. Operations – operations for items – manufacturing resources – human resources – tools: data model. The manufacturing execution system.

Type: project planning and control. The network: logical planning, time frame planning, resources planning, cost frame planning. The tasks of the phases. Time frame optimization – cost frame optimization. CPM, PERT, MPM.

The basics of inventory management. Classification of models, some deterministic static and – dynamic models. ABC analysis, JIT, Kanban.

Literature

Péter Holyinka: Production Control.(in Hungarian)
Péter Holyinka: MRP I. (in Hungarian, electronic notes)
Péter Holyinka: CRP. (in Hungarian, electronic notes)
Péter Holyinka: Operative Programming. (in Hungarian, electronic notes)
Imre Kovács Dr.: Integrated Enterprise Management Systems, Szent István Egyetem, 2011 (in Hungarian)
Tarek Samara, ERP and Information Systems: Integration or Disintegration, Wiley, 2015
Langenwalter, G. A.: Enterprise Resource Planning and Beyond, CRC Press, 2000
Cassidy, A.: Planning for E-Business Success, CRC Press, 2002

<table>
<tr><td colspan="2">Name:
Enterprise Resource Planning II</td><td>NEPTUN-code:
NIEER2BBNE</td><td>Number of periods/week:
full-time: 2 ea + 0 tgy + 3 lab</td></tr>
<tr><td colspan="2">Credit: 7
Requirement: exam</td><td colspan="2">Prerequisite:
NIXER1BBNE Enterprise Resource Planning I</td></tr>
<tr><td>Responsible:
Lásló ERDŐDI, Ph.D.</td><td>Position:
senior lecturer</td><td colspan="2">Faculty and Institute name:
John von Neumann Faculty of Informatics
Institute of Applied Informatics</td></tr>
<tr><td colspan="4">Way of assessment:
- signature requirements: participation on the lectures and successful submission of a homework assignment
- oral exam (roundtable discussion)</td></tr>
<tr><td colspan="4">Competences</td></tr>
<tr><td colspan="4"></td></tr>
<tr><td colspan="4">Course description:</td></tr>
<tr><td colspan="4">Competences: structure of ERP systems, its usual subsystems. Creation of systems. E-business fundamentals, business processes.
History of IT systems: isolated systems, MRP I, MRP II, ERP, ERP II systems. Structure and functionality of systems. Subsystems and their relationships. The role of strategy and vision of future. IT strategy, decision alternatives. Management support, marketing, integration of finance, sales and operations planning, supply chain control. Measuring operation. System development, standard system and its purchase, standard system as service. The process of purchase of a system, vision of future, determining functionalities, setup of product options, enquiry, reference visits, demonstrations, contract. Steps of system implementation. Success-failure ratio and its causes. Technical issues. The workflow. Paradigm change in business management and its consequences to systems. Electronic customer relationships, categories, planning. System integration. At the labs the business and IT processes of the model company will be designed, as well as its data and process models.</td></tr>
<tr><td colspan="4">Literature</td></tr>
<tr><td colspan="4">Péter Holyinka: Production Control.(in Hungarian)
Péter Holyinka: MRP I. (in Hungarian, electronic notes)
Péter Holyinka: CRP. (in Hungarian, electronic notes)
Péter Holyinka: Operative Programming. (in Hungarian, electronic notes)
Imre Kovács Dr.: Integrated Enterprise Management Systems, Szent István Egyetem, 2011 (in Hungarian)
Tarek Samara, ERP and Information Systems: Integration or Disintegration, Wiley, 2015
Langenwalter, G. A.: Enterprise Resource Planning and Beyond, CRC Press, 2000
Cassidy, A.: Planning for E-Business Success, CRC Press, 2002</td></tr>
</table>

CLOUD SERVICE TECHNOLOGIES AND IT SECURITY SPECIALIZATION (F)

Name: **Network Technologies I**		***NEPTUN-code:*** *NIXHT1CBNE*	***Number of periods/week:*** full-time: 2 ea + 0 tgy + 1 lab
Credit: 4 ***Requirement:*** exam		***Prerequisite:*** *NIXSH0EBNE* Computer Networks	
Responsible: Miklós KOZLOVSZKY, Ph.D.	***Position:*** associate professor	***Faculty and Institute name:*** John von Neumann Faculty of Informatics Institute of Biomatics	
Way of assessment: - oral exam			
Competences			
Course description:			
The course introduces the modern local area network (LAN) and wide area network (WAN) technologies, the different transmission media (copper cable, optical and wireless), signalling systems and decoding solutions, signal-to-noise ratio of analogue and digital transmissions, as well as the physical and logical topology of networks. The course materials also contain the internal structure and services of communication systems according to the OSI model, the aims and operation of the participating protocols and interfaces, their theoretical and typical practical implementations. The student can become familiar with the principles and practice of the basic switching and routing concepts together with standards based on laboratory exercises (configuration of the different routing mechanisms, VLANs, VTP, DTP) and the GNS3 emulation software.			
Literature			
A. S. Tanenbaum és D. J. Wetherall: Computer Networks, 3rd edition, Panem, Budapest, 2013 (in Hungarian) A. S. Tanenbaum and D. J. Wetherall: Computer Networks, 5th edition, Prentice Hall, 2011 (electronic notes) The Cisco Networking Academy online curriculum (in English)			

Name: **Virtualised Storage Systems**		***NEPTUN-code:*** *NIXVT1FBNE*	***Number of periods/week:*** full-time: 2 lec + 0 sem + 1 lab
Credit: 4 ***Requirement:*** mid-term mark		***Prerequisite:*** *NIEOR1EBNE* Operating Systems	
Responsible: Miklós KOZLOVSZKY, Ph.D.	***Position:*** associate professor	***Faculty and Institute name:*** John von Neumann Faculty of Informatics Institute of Biomatics	
Way of assessment: - passing on the mid-terms			
Competences			
Course description:			
The main goal of the course is to provide comprehensive knowledge about the features and architectures of storage systems designed for data centers; beginning from the properties of storage elements (SATA, SAS, SSD, tape) through their physical and logical data security levels (RAID, Logical Volume Managers), and ending with the basics of distributed network filesystems (such as GlusterFS). The architecture of storage systems (DAS, NAS, SAN) and then the applied protocols (iSCSI, FC, FCoIP) as well as various storage virtualization techniques are presented. Further major topics: Information Lifecycle Management, backup policies, high availability systems and disaster tolerant solutions, public cloud storages (Amazon, Google, Microsoft), self-hosted solutions (e.g. OwnCloud and Pydio), and storages for server environments (such as Ceph, FreeNAS, OpenFiler) based on clouds.			
Literature			
Dezső Sima Dr. Tamás Schubert Dr.: Data Centers, Typotex kiadó, 2011 (in Hungarian) EMC Education Services: Information Storage and Management, Wiley Publishing, 2009 (electronic notes) Jason Venner: Pro Hadoop, Apress, 2009 (electronic notes) Tom White: Hadoop The Definitive Guide, O'Reilly, 2015 (electronic notes) Jason Buffington: Data Protection for Virtual Data Centers, Wiley Publishing, 2010			

<table>
<tr><td colspan="2">Name:
Cloud Computing Services I</td><td>NEPTUN-code:
NIXFS1FBNE</td><td>Number of periods/week:
full-time: 2 lec + 0 sem + 0 lab</td></tr>
<tr><td colspan="2">Credit: 3
Requirement: mid-term mark</td><td colspan="2">Prerequisite:
NIXVT1FBNE Virtualised storage systems</td></tr>
<tr><td>Responsible:
Róbert LOVAS, Ph.D.</td><td>Position:
associate professor</td><td colspan="2">Faculty and Institute name:
John von Neumann Faculty of Informatics
Institute of Applied Informatics</td></tr>
<tr><td colspan="4">Way of assessment:
- oral exam</td></tr>
<tr><td colspan="4">Competences</td></tr>
<tr><td colspan="4"></td></tr>
<tr><td colspan="4">Course description:</td></tr>
<tr><td colspan="4">The main aim of the subject is to get familiarised with cloud computing systems, and to provide theoretical grounding for widespread public, private, and hybrid cloud platforms both from the user’s and from the cloud operator’s point of view. The students will acquire knowledge on service types offered by clouds (IaaS/PaaS/SaaS), and their related deployment characteristics, typical solutions, as well as their management and automation possibilities. The course serves as the basis for the practical knowledge to be used for the deployment of an open-source cloud computing system during the practice labs later.</td></tr>
<tr><td colspan="4">Literature</td></tr>
<tr><td colspan="4">Bálint Farkas, Gábor Kovács, István Király, Attila Turóczy, Tibor Kőnig, Attila Érsek, Mátyás Safranka, Dávid Fülöp. Krisztián Pellek, Balázs Kiss: Windows Azure step by step, 2013 (in Hungarian, electronic notes)
Tamás Schubert, Gergely Windisch: INFORMATION TECHNOLOGY SERVICES CLOUD COMPUTING (CLOUD COMPUTING), Digitális Tankönyvtár, 2011 (in Hungarian, electronic notes)
Barrie Sosinsky: Cloud Computing Bible, Kiadó: Wiley, 2011 (electronic notes)
Anne Gentle, Diane Fleming, Everett Toews, Joe Topjian, Jonathan Proulx, Lorin Hochstein, Tom Fifield: OpenStack Operations Guide, O`Reilly, 2014 (electronic notes)</td></tr>
</table>

<table>
<tr><td colspan="2">Name:
Cloud Computing Services II</td><td>NEPTUN-code:
NIEFS2FBNE</td><td>Number of periods/week:
full-time: 0 lec + 0 sem + 2 lab</td></tr>
<tr><td colspan="2">Credit: 2
Requirement: mid-term mark</td><td colspan="2">Prerequisite:
NIXFS1FBNE Cloud computing services I</td></tr>
<tr><td>Responsible:
Róbert LOVAS, Ph.D.</td><td>Position:
associate professor</td><td colspan="2">Faculty and Institute name:
John von Neumann Faculty of Informatics
Institute of Applied Informatics</td></tr>
<tr><td colspan="4">Way of assessment:
- practical mid-term and submission of homework assignment</td></tr>
<tr><td colspan="4">Competences</td></tr>
<tr><td colspan="4"></td></tr>
<tr><td colspan="4">Course description:</td></tr>
<tr><td colspan="4">The main aim of the subject is to get practical skills on cloud computing systems. Besides the public cloud computing services (e.g. Amazon Web Services), there is a special focus on setting up of platform services (e.g. Microsoft Azure) and their access through various interfaces. The students get familiar with the step-by-step deployment and operation of private Infrastructure-as-a-Service clouds particularly based on open-source solutions (e.g. OpenNebula and OpenStack). For demonstration purposes Big Data and IoT (Internet of Things) applications will be presented during the practices.</td></tr>
<tr><td colspan="4">Literature</td></tr>
<tr><td colspan="4">Bálint Farkas, Gábor Kovács, István Király, Attila Turóczy, Tibor Kőnig, Attila Érsek, Mátyás Safranka, Dávid Fülöp. Krisztián Pellek, Balázs Kiss: Windows Azure step by step, 2013 (in Hungarian, electronic notes)
Tamás Schubert, Gergely Windisch: INFORMATION TECHNOLOGY SERVICES CLOUD COMPUTING (CLOUD COMPUTING), Digitális Tankönyvtár, 2011 (in Hungarian, electronic notes)
Barrie Sosinsky: Cloud Computing Bible, Kiadó: Wiley, 2011 (electronic notes)
Anne Gentle, Diane Fleming, Everett Toews, Joe Topjian, Jonathan Proulx, Lorin Hochstein, Tom Fifield: OpenStack Operations Guide, O`Reilly, 2014 (electronic notes)</td></tr>
</table>

Name: **Security of Computer Networks and Clouds**	***NEPTUN-code:*** *NIXSH1CBNE*	***Number of periods/week:*** full-time: 2 lec + 0 sem + 2 lab
Credit: 5 ***Requirement:*** exam	***Prerequisite:*** *NIEIB0EBNE* IT Security *NIXHT1CBNE* Network Technologies I	
Responsible: Miklós KOZLOVSZKY, Ph.D.	***Position:*** associate professor	***Faculty and Institute name:*** John von Neumann Faculty of Informatics Institute of Biomatics

Way of assessment:

- theoretical part: mid-term and oral exam
- practical part: evaluation of lab performance, practical exam

Competences

Course description:

as Layer 7 NextGen firewalls, VPN servers, and IPS/IDS devices. In addition, they can be familiar with centralized management of network devices, their security issues, centralized authentication, authorization and accounting (AAA). The obtained theoretical knowledge can be practiced based on lab exercises such as configuration of the switch/router/firewall policies and filters, setting and testing of IPS/IDS systems with the assistance of vulnerability analyser. The course materials contain also the security issues of wireless networks (WLAN) and storage systems, the security and Site-To-Site VPN solutions of Cisco, as well as open source technologies (such as PfSense).

Literature

A. S. Tanenbaum és D. J. Wetherall: Computer Networks, 3rd edition, Panem, Budapest, 2013 (in Hungarian)
Levente Buttyán, István Vajda: Cryptography and its Applications, Typotex, 2005 (in Hungarian)
Fabio Alessandro Locati: OpenStack Cloud Security, PACKT, 2015 (electronic notes)
Imad M. Abbadi: Cloud Management and Security, WILEY, 2014 (electronic notes)
The Cisco Networking Academy online curriculum (in English)
A. S. Tanenbaum and D. J. Wetherall: Computer Networks, 5th edition, Prentice Hall, 2011 (electronic notes)
William Stallings: Network Security Essentials: Applications and Standards, 4th edition, Prentice Hall, 2011 (electronic notes)

CLOUD SERVICE TECHNOLOGIES AND IT SECURITY SPECIALIZATION (F)

INFORMATION SECURITY SUBSPECIALIZATION

Name: **Security of Information Systems and Services**		***NEPTUN-code:*** *NIXIS1CBNE*	***Number of periods/week:*** full-time: 2 lec + 0 sem + 2 lab
Credit: 5 ***Requirement:*** exam	***Prerequisite:*** *NIEIB0EBNE* IT Security		
Responsible: Valéria PÓSER, Ph.D.	***Position:*** associate professor	***Faculty and Institute name:*** John von Neumann Faculty of Informatics Institute of Biomatics	

Way of assessment:

- requirement for signature: practical mid-term and successful submission of a research assignment
- Oral exam. Final mark is calculated as the average of mid-term and the exam.

Competences

Course description:

Information system and related fundamental concepts. Corporate security supervision and its typical problems. Basic expectations concerning operating systems. Forms, components, tools, and motivations of attacks. Plan for the supervision infrastructure. Risk analysis. Protection of Active Directory. Defence and central management of servers and client computers against viruses and penetration. User authentication. Real-time synchronisation of user register data sources. Identity and access management. Secure connection on the services. Planning and implementing public key infrastructure. The most widespread corporate IT services provided on internet/intranet/cloud. Reduction of risks originating from software vulnerability. Elimination of common development mistakes of web applications. Data protection, data rescue and recovery.

Literature

Valéria Oláh Póserné: Security of Information Services, Digitális Tankönyvtár, 2011 (in Hungarian, electronic notes)
Tibor Szentgyörgyi – Csaba Filkor – Balázs Borbély: Construction of a Modern Working Environment, Windows Server 2012, Windows 8 and Office 365 bases, Jedlik Oktatási Stúdió Budapest, 2012 (in Hungarian, electronic notes)
Gregg Kreizman: An Introduction to Information Security Architecture, Gartner The Future of IT Conference, 2011 (electronic notes)
IBM Knowledge Center (electronic notes)

Name: **Institution Information Security**		***NEPTUN-code:*** *NIEIB1CBNE*	***Number of periods/week:*** full-time: 2 lec + 0 sem + 4 lab
Credit: 7 ***Requirement:*** exam	***Prerequisite:*** *NIXIS1CBNE* Security of Information Systems and Services		
Responsible: Valéria PÓSER, Ph.D.	***Position:*** associate professor	***Faculty and Institute name:*** John von Neumann Faculty of Informatics Institute of Biomatics	

Way of assessment:

- Requirements of signature: participation on lectures, midterm, submissionof homework assignment. Oral and written exam.
- Final mark is calculated form the mid-term, assignment performance and exam result.

Competences

Course description:

Basics of information security. Pillars of IT security: organisation, regulation, technology. IT security laws in Hungary and in the EU, industrial regulations and other standards, best practices. Relations among corporate strategy, IT strategy, and business goals, as well as their consequences on the general and information securities. Connection between strategy and risk management. Hierarchy of the company IT security regulations. IT security requirements of application systems in the stages of their life cycle. Decreasing the probability of vulnerabilities during the development. Business continuity, IT business continuity and aspects of the strategy and risk management. Significance and insurance of data quality. Basics of IT security audit requirements and tasks. Deduction of the control objectives from the business plan, fulfilment of the control objectives with preventive, objective and corrective control measures. Security and audit perspectives of the information management systems. Security and audit aspects of the corporate assets (information and information system).
Presentation and analysis of security case studies. Security planning, device configuration and testing of corporate information systems. Creating network topology, select and configure of active devices. Configuration of network intrusion prevention systems, vulnerability protection devices and firewalls, and joining them to the network topology. Server and client operation system's security systems installation and configuration. Antivirus system setup and central monitoring. Security of services: Web, FTP and mail server security system configuration. Documentation and maintenance planning.

Literature

Katalin Szenes: Extend IT Security Methods Support of Corporate Governance, Operations, and Risk Management, Minőség és Megbízhatóság; nemzeti minőségpolitikai szakfolyóirat, kiadja: az European Organization for Quality (EOQ) Magyar Nemzeti Bizottsága, XLVI. évf. 2012. / 5. sz. (in Hungarian)
Andy Taylor (Editor), David Alexander, Amanda Finch, David Sutton: Information Security Management Principles An ISEB Certificate, The British Computer Society, 2008 (elektronic notes)

CLOUD SERVICE TECHNOLOGIES AND IT SECURITY (F)

COMPUTER NETWORKS SUBSPECIALIZATION

<table>
<tr><td colspan="2">Name:
Network Technologies II</td><td>NEPTUN-code:
NIXHT2CBNE</td><td>Number of periods/week:
full-time: 2 lec + 0 sem + 2 lab</td></tr>
<tr><td colspan="2">Credit: 5
Requirement: exam</td><td colspan="2">Prerequisite:
NIXHT1CBNE Network Technologies I</td></tr>
<tr><td>Responsible:
Miklós KOZLOVSZKY, Ph.D.</td><td>Position:
associate professor</td><td colspan="2">Faculty and Institute name:
John von Neumann Faculty of Informatics
Institute of Biomatics</td></tr>
<tr><td colspan="4">Way of assessment:
- theoretical part: mid-term and oral exam
- practical part: design task, evaluation of lab performances, practical exam. Oral and written exam.</td></tr>
<tr><td colspan="4">Competences</td></tr>
<tr><td colspan="4"></td></tr>
<tr><td colspan="4">Course description:</td></tr>
<tr><td colspan="4">The subject introduces the design goals of LAN and WAN networks; the typical methods of design; the best practices of design and operating methods including the systematic design methods (such as Cisco hierarchical network design, the PPDIOO and ITIL methodologies) together with the possibility and benefits of simulations; the hardware and software tools/devices for designing, implementing, configuring, fine-tuning, troubleshooting; design and implementation in practice; the possible solutions of documenting network infrastructures; the implementation, operation, and network management issues of a designed network including the performance metrics of the operational security and data security. The course familiarises the students with advanced, redundant switching (STP, HSRP, EtherChannel) and routing concepts (multi-area OSPF, BGP, MPLS VPN). The course materials contain also the quality requirements of the transmission and Quality of Service (QoS) basics.</td></tr>
<tr><td colspan="4">Literature</td></tr>
<tr><td colspan="4">A. S. Tanenbaum és D. J. Wetherall:Computer Networks, 3rd edition, Panem, Budapest, 2013 (in Hungarian)
A. S. Tanenbaum and D. J. Wetherall: Computer Networks, 5th edition, Prentice Hall, 2011 (electronic notes)
The Cisco Networking Academy online curriculum (in English)</td></tr>
</table>

Name: **Technologies of Virtualised Networks and Data Centers**		***NEPTUN-code:*** *NIEVA1CBNE*	***Number of periods/week:*** full-time: 2 lec + 0 sem + 4 lab
Credit: 7 ***Requirement:*** exam		***Prerequisite:*** *NIXHT2CBNE* Network Technologies II *NIXFS1FBNE* Cloud Computing Services I	
Responsible: András RÖVID, Ph.D.	***Position:*** associate professor	***Faculty and Institute name:*** John von Neumann Faculty of Informatics Institute of Biomatics	

Way of assessment:

- theoretical part: mid-term and oral exam
- practical part: design task, evaluation of lab performances, practical exam
- oral and written exam

Competences

Course description:

The goal of the subject is to familiarise the students with the technologies of data centers and virtualised networks which support Infrastructure-as-a-Service (IaaS). The course materials include the different requirements of the data centers, the limitations of the legacy solutions, and the virtual multi-tenant data centers (VMDC). Furthermore, the reference model of VMDC, the layers and their functions, I/O consolidation, Point of Delivery (PoD) and Integrated Compute Stack (ICS) are presented. The student can become familiar with the implementation of the secure logical separation between the simultaneous subscribers, as well as the requirements of high availability of the infrastructure. Configuration and implementation of Cisco Data Centers solutions are discussed.

Literature

Gyula Fehér: Cisco based Infrastructure Services (IAAS) for Data Center support, Óbudai Egyetem, 2013-14 (in Hungarian)
Scott D. Lowe, James Green and David Davis: Building a Modern Data Center, Atlantis Computing, 2016 (electronic notes)

SOFTWARE DESIGN AND DEVELOPMENT SPECIALIZATION (S)

Name: **Parallel Programing**		***NEPTUN-code:*** *NIXPP1TBNE*	***Number of periods/week:*** full-time: 2 lec + 0 sem + 2 lab
Credit: 5 ***Requirement:*** exam	***Prerequisite:*** *NIXWH1EBNE* Web programming and advanced development techniques		
Responsible: Zoltán VÁMOSSY, Ph.D.	***Position:*** associate professor	***Faculty and Institute name:*** John von Neumann Faculty of Informatics Institute of Applied Informatics	

Way of assessment:

- precondition of signature: successful home project
- written exam

Competences

Course description:

Introduction to parallel computing and parallel computer architectures. When cannot be parallelize? PRAM model. Performance characteristics, Amdahl's Law and Gustafson' law. Shared and distributed software architectures. Design patterns for parallel programming (efficiency, simplicity, portability and scalability aspects). Decomposition methods by data and function, agglomeration, mappings. Parallel programming algorithms. Parallel sum and parallel prefix scan. Dense matrix algorithm. MapReduce as algorithmic framework. Sorting and search algorithms. Numerical methods. Discrete Optimization and Dynamic Programming with parallelization. Parallel image processing techniques. Parallel programming fundamentals in practice, processes, thread management. Threading libraries: implicit (OpenMP) and explicit thread management (Windows and .NET framework threads), synchronization methods (lock, mutex, semaphore) and signaling (barriers). Dekker's algorithm. Debugging, tracing in parallel environment.
Lab: solving practical tasks.

Literature

A. Iványi: Parallel Algorithms, ELTE Eötvös Kiadó, Budapest, 2005 (in Hungarian, electronic notes)
Zoltán Hernyák: Communication Foundation – Distributed Programming in Microsoft.NET Environment, Kempelen Farkas Hallgatói Információs Központ, 2011 (in Hungarian, electronic notes)
A. Grama, A. Gupta, G. Karypis, V. Kumar: Introduction to Parallel Computing, 2nd edition Addison-Wesley, 2003
Joseph Albahari - Ben Albahari: C# 4.0 in a Nutshell, O'Reilly, 2010
J. Albahari: Threading in C# (electronic notes)

<table>
<tr><td colspan="2">Name:
Developing Large Software Systems</td><td>NEPTUN-code:
NIXNR1TBNE</td><td>Number of periods/week:
full-time: 2 lec + 0 sem + 0 lab</td></tr>
<tr><td colspan="2">Credit: 3
Requirement: mid-term mark</td><td colspan="2">Prerequisite:
NIXWH1EBNE Web programming and advanced development techniques</td></tr>
<tr><td>Responsible:
József TICK, Ph.D.</td><td>Position:
associate professor, habil.</td><td colspan="2">Faculty and Institute name:
John von Neumann Faculty of Informatics
Institute of Applied Informatics</td></tr>
<tr><td colspan="4">Way of assessment:
- mid-semester grade based on mid-semester tests and a project work</td></tr>
<tr><td colspan="4">Competences</td></tr>
<tr><td colspan="4"></td></tr>
<tr><td colspan="4">Course description:</td></tr>
<tr><td colspan="4">Introduction to the special attributes of large software system development, related issues and alternative solutions. Main competences: version control systems (svn, git): comparison, recommendations. Team work: specialties, organization, coordination. Decomposition of large problems. Handling large source code base, recommendations. Clean code, refactoring methods. Lifecycle of software systems: handling different editions, patching. Software maintenance: methods, tools. Bug report systems: tickets, services, comparison of some widely used systems. Licencing policies: issues and solutions. Ensuring software quality. Software authentication, built-in security functions, digital signing. Multi-platform development: specialties, tools.</td></tr>
<tr><td colspan="4">Literature</td></tr>
<tr><td colspan="4">Lajos Ficsor, Zoltán Krizsán, Péter Mileff: Software Development, Miskolci Egyetem (in Hungarian, electronic notes)
Ian Sommerville: Software Engineering, Pearson; 9 edition, 2010</td></tr>
</table>

<table>
<tr><td colspan="2">Name:
Data-Parallel Programming</td><td>NEPTUN-code:
NIXAP1TBNE</td><td>Number of periods/week:
full-time: 0 lec + 0 sem + 2 lab</td></tr>
<tr><td colspan="2">Credit: 2
Requirement: mid-term mark</td><td colspan="2">Prerequisite:
NIXPP1TBNE Parallel Programing</td></tr>
<tr><td>Responsible:
Sándor SZÉNÁSI, Ph.D.</td><td>Position:
associate professor</td><td colspan="2">Faculty and Institute name:
John von Neumann Faculty of Informatics
Institute of Applied Informatics</td></tr>
<tr><td colspan="4">Way of assessment:
- mid-semester grade based on mid-semester tests and a project work</td></tr>
<tr><td colspan="4">Competences</td></tr>
<tr><td colspan="4"></td></tr>
<tr><td colspan="4">Course description:</td></tr>
<tr><td colspan="4">Introduction to GPU programming using the NVIDIA CUDA C and OpenCL languages. Main concepts: GPU hardware specialties. CUDA C environment basics. CUDA models (memory, kernel, memory). Writing and compiling kernels (command line tools and Visual Studio built-in features). Synchronization methods (kernel level and block level synchronization methods). Using shared memory to reduce access latency. Using atomic operations. Optimisation techniques. GPU benchmarking (GPU occupancy examinations). Avoiding warp divergence. Using the appropriate memory access patterns. Using streams and events. Multi-GPU development. Using the additional built-in libraries (CUBLAS, cuFFT, cuRandom). OpenCL basics (source code, variables, compiling, etc.), examples.</td></tr>
<tr><td colspan="4">Literature</td></tr>
<tr><td colspan="4">D. Sima, S. Szénási, Á. Tóth: Massively Parallel Programming with GPGPU. (in Hungarian, electronic notes)
CUDA C Programming Guide (electronic notes)</td></tr>
</table>

<table>
<tr><td colspan="2">Name:
Modern Software Technology</td><td>NEPTUN-code:
NIXST3TBNE</td><td>Number of periods/week:
full-time: 2 lec + 0 sem + 0 lab</td></tr>
<tr><td colspan="2">Credit: 2
Requirement: exam</td><td colspan="2">Prerequisite:
NIXNR1TBNE Developing Large Software Systems</td></tr>
<tr><td>Responsible:
József TICK, Ph.D.</td><td>Position:
associate professor, habil.</td><td colspan="2">Faculty and Institute name:
John von Neumann Faculty of Informatics
Institute of Applied Informatics</td></tr>
<tr><td colspan="4">Way of assessment:
- precondition of signature: to achieve min. 50% jointly in the two tests written during the semester
- written exam</td></tr>
<tr><td colspan="4">Competences</td></tr>
<tr><td colspan="4"></td></tr>
<tr><td colspan="4">Course description:</td></tr>
<tr><td colspan="4">The lectures aim to present the principles and methodology of modern software engineering. The students will learn about the formal description of IT and software systems, modelling, design and development of complex IT systems, planning and design based on formal methods, decomposition and integration strategies. Such as the use of information technology-based development tools (CASE) in the development process, in special regard to Reverse and Round-trip engineering, Test-driven Development (TDD), Aspect-oriented Development (AOD), cloud-based application development, and model transformation in practice. The quality-based approach of software development, the improvement of quality, data security and secure code. Verification, validation, testing software systems.</td></tr>
<tr><td colspan="4">Literature</td></tr>
<tr><td colspan="4">R. Pressman: Software Engineering, McGraw-Hill Education, 8 edition, 2014
Sándor Sike, László Varga: Software Technology and UML, ELTE Eötvös Kiadó, 2003 (in Hungarian)</td></tr>
</table>

<table>
<tr><td colspan="2">Name:
Advanced Algorithms</td><td>NEPTUN-code:
NIEHA1TBNE</td><td>Number of periods/week:
full-time: 2 lec + 0 sem + 2 lab</td></tr>
<tr><td colspan="2">Credit: 4
Requirement: exam</td><td colspan="2">Prerequisite:
NIXAP1TBNE Data-parallel Programming</td></tr>
<tr><td>Responsible:
Sándor SZÉNÁSI, Ph.D.</td><td>Position:
associate professor</td><td colspan="2">Faculty and Institute name:
John von Neumann Faculty of Informatics
Institute of Applied Informatics</td></tr>
<tr><td colspan="4">Way of assessment:
- precondition of signature: achievement of tests and project work
- oral exam</td></tr>
<tr><td colspan="4">Competences</td></tr>
<tr><td colspan="4"></td></tr>
<tr><td colspan="4">Course description:</td></tr>
<tr><td colspan="4">The lectures aim to present the principles and methodology of widely used modern problem-solving methods. Beyond the introduction of theories, students will learn the implementation of these algorithms using modern parallel and data-parallel (GPU) programming techniques. Main concepts: parallel design patterns. Parallel adaptations of standard optimisation methods (divide and conqueror, backtracking, branch and bound). Using gradient based methods. Biologically inspired methods (Genetic Algorithm, Particle Swarm Optimisation, Fireworks, Ant/Honey Bee Colony Optimization) using modern architectures. Neural networks. Deep learning. Real-time computing. Algorithm analysis in parallel environments. General optimisation techniques (time and memory intensive tasks).</td></tr>
<tr><td colspan="4">Literature</td></tr>
<tr><td colspan="4">A. Iványi (edited): Informatics Algorithms 1-2, ELTE Eötvös Kiadó, 2004, 2005 (in Hungarian)
Jason Brownlee: Clever Algorithms / Nature-Inspired Programming Recipes, lulu.com, 2012</td></tr>
</table>

<table>
<tr><td colspan="2">Name:
Software Testing</td><td>NEPTUN-code:
NIETE1TBNE</td><td>Number of periods/week:
full-time: 1 lec + 0 sem + 2 lab</td></tr>
<tr><td colspan="2">Credit: 3
Requirement: mid-term mark</td><td colspan="2">Prerequisite:
NIXNR1TBNE Developing Large Software Systems</td></tr>
<tr><td>Responsible:
József TICK, Ph.D.</td><td>Position:
associate professor, habil.</td><td colspan="2">Faculty and Institute name:
John von Neumann Faculty of Informatics
Institute of Applied Informatics</td></tr>
<tr><td colspan="4">Way of assessment:
- a semester mark based on the results of the tests written during the semester and of the home assignment</td></tr>
<tr><td colspan="4">Competences</td></tr>
<tr><td colspan="4"></td></tr>
<tr><td colspan="4">Course description:</td></tr>
<tr><td colspan="4">The glossary and syllabi of testing established by the International Software Testing Qualifications Board (ISTQB) organization are world-wide accepted as de facto standards of testing in the software testing profession. The course aims to make students familiar with the concepts used in basic software testing, test types and techniques, so that they can place software testing into the software development life cycle, and so that they can use these techniques in practice in their future works so as to develop higher quality software products.</td></tr>
<tr><td colspan="4">Literature</td></tr>
<tr><td colspan="4">Lajos Ficsor, László Kovács, Gábor Kusper, Zoltán Krizsán: Software Testing, Miskolci Egyetem, Digitális Tankönyvtár, 2011 (in Hungarian, electronic notes)
Ron Patton: Software Testing, Sams Publishing; 2 edition, 2005 (electronic notes)</td></tr>
</table>

SOFTWARE DESIGN AND DEVELOPMENT (S)

ALGORITHMS THEORY SUBSPECIALIZATION

Name: **Programming Paradigms**		***NEPTUN-code:*** *NIXPA1TBNE*	***Number of periods/week:*** full-time: 1 lec + 0 sem + 2 lab
Credit: 4 ***Requirement:*** mid-term mark		***Prerequisite:*** *NIXPP1TBNE* Parallel Programing	
Responsible: László CSINK, Ph.D.	***Position:*** associate professor	***Faculty and Institute name:*** John von Neumann Faculty of Informatics Institute of Applied Informatics	
Way of assessment: - mid-semester grade based on mid-semester tests and a project work			
Competences			
Course description:			
The main objective of the course is to give an introduction to the two main areas of declarative programming, namely functional programming and logic programming. The introduction will be supported by demonstrative examples and will include main F# concepts (literal, function, lambda expression, variable, binding, operator, pattern matching, recursion, terminal recursion, accumulator, control, lists) and Prolog concepts (predicate, clause, inference engine, negation, logic variable, unification, pattern matching). Once the fundamentals have been covered, the applications of constraint logic programming will be discussed. Students will be assigned home projects in F# and/or Prolog and they will be supervised during the term.			
Literature			
Thomas H. Cormen, Charles E. Leiserson Ronald L. Rivest, Clifford Stein: New Algorithms, Scolar Kiadó, 2003 (in Hungarian) J. Sharp: Microsoft Visual C# 2005 step by step, SZAK Kiadó, 2005 (in Hungarian)			

<table>
<tr><td colspan="2">Name:
Advanced Data Structures</td><td>NEPTUN-code:
NIXHD1TBNE</td><td>Number of periods/week:
full-time: 1 ea + 0 tgy + 1 lab</td></tr>
<tr><td colspan="2">Credit: 3
Requirement: exam</td><td colspan="2">Prerequisite:
NIXSF2EBNE Software Design and Development II</td></tr>
<tr><td>Responsible:
Szabolcs SERGYÁN, Ph.D.</td><td>Position:
associate professor</td><td colspan="2">Faculty and Institute name:
John von Neumann Faculty of Informatics
Institute of Applied Informatics</td></tr>
<tr><td colspan="4">Way of assessment:
- a mid-semester grade based on mid-semester tests and a project work</td></tr>
<tr><td colspan="4">Competences</td></tr>
<tr><td colspan="4"></td></tr>
<tr><td colspan="4">Course description:</td></tr>
<tr><td colspan="4">At the end of the subject students will know the frequently-used data structures, and will be able to construct and implement data structures to solve occurring problems.
Data structures of sets and intervals. Heaps: Fibonacci-heap, pairing heaps, r-heaps, Thorup’s heap. Implementation of dictionaries using binary search tree. Optimal binary search tree. 2-3 trees, B-trees, Red-black trees, AVL-trees, self-balanced trees. Binomial heaps and binomial trees. Strings, suffix trees and arrays. Geometrical data structures. Dynamic paths and trees. Dynamic graphs.</td></tr>
<tr><td colspan="4">Literature</td></tr>
<tr><td colspan="4">Zoltán Király: Data Structures, ELTE jegyzet, 2017 (in Hungarian)
P. Brass: Advanced Data Structures, Cambridge University Press, 2008</td></tr>
</table>

Name: **Interpreter and Script Languages**	***NEPTUN-code:*** *NIXIP1TBNE*	***Number of periods/week:*** full-time: 1 lec + 0 sem + 2 lab
Credit: 4 ***Requirement:*** exam	***Prerequisite:*** *NIXWH1EBNE* Web programming and advanced development techniques	
Responsible: Szabolcs SERGYÁN, Ph.D.	***Position:*** associate professor	***Faculty and Institute name:*** John von Neumann Faculty of Informatics Institute of Applied Informatics

Way of assessment:

- precondition of signature: achievement of tests and project work
- oral exam

Competences

Course description:

Features of interpreter and script languages, comparison with compiled languages.
Python language elements: Data, variables, operators, expressions, controls, functions, parameter assingments. Data structures of Python: lists, stacks, queues, tuples, sets, dictionaries. Python as an object oriented language. Frequently-used Python modules: numpy, matplotlib, etc. Parallel programming in Python. Django framework.

Literature

Gérard Swinnen: Learn to program using Python, GNU Szabad Dokumentációs Licence, 2005 (in Hungarian)
M. Pilgrim: Dive Into Python 3, Springer-Verlag, 2009

SOFTWARE DESIGN AND DEVELOPMENT (S)

IMAGE PROCESSING SUBSPECIALIZATION

Name: **Fundamentals of Image Processing**		***NEPTUN-code:*** *NIXKA1TBNE*	***Number of periods/week:*** full-time: 2 lec + 0 sem + 1 lab
Credit: 4 ***Requirement:*** mid-term mark		***Prerequisite:*** *NIXPP1TBNE* Parallel Programing	
Responsible: Zoltán VÁMOSSY, Ph.D.	***Position:*** associate professor	***Faculty and Institute name:*** John von Neumann Faculty of Informatics Institute of Applied Informatics	
Way of assessment: - successful home project + min. 50% in the tests written during the semester			
Competences			
Course description:			
The image processing mathematical foundations. Homogeneous coordinates and transformations (elementary and complex transformations, active and passive aspects of the model). Solid Modelling. Pre-processing methods. Basics of computer vision, sampling, quantization, digital representations of images. Point operations, histogram-based techniques. Basic methods for noise reduction, morphology, histogram and histogram transformations, sharpening, balancing. Normalization, the use of image pyramid. Convolution and correlation. Edge enhancement methods, Canny algorithm, SUSAN method. Border finding along the edges, edge detection by subpixel accuracy. Fitting curves, Hough transform. Split and Merge method for optimized fit. Adaptive methods for binarization. Interest point detectors. Segmentation algorithms, connected component analysis. Watershed method. Split and merge method for regions. Texture characteristics. Skeleton. Lab: solving practical tasks.			
Literature			
Dimitrij Csetverikov: Digital Image Analysis Essential Algorithms, ELTE IK, 2014 (in Hungarian, electronic notes) Gonzales, Woods: Digital Image Processing, 3rd edition. Prentice Hall, 2008			

<table>
<tr><td colspan="2">Subject name:
Advanced Algorithms of Image Processing</td><td>NEPTUN-code:
NIXKH1TBNE</td><td>Number of periods/week:
full-time: 2 lec + 0 sem + 0 lab</td></tr>
<tr><td colspan="2">Credit: 3
Requirement: mid-term mark</td><td colspan="2">Prerequisite:
NIXKA1TBNE Fundamentals of Image Processing</td></tr>
<tr><td>Responsible:
Zoltán VÁMOSSY, Ph.D.</td><td>Position:
associate professor</td><td colspan="2">Faculty and Institute name:
John von Neumann Faculty of Informatics
Institute of Applied Informatics</td></tr>
<tr><td colspan="4">Way of assessment:
- successful home project + min. 50% in the tests written during the semester</td></tr>
<tr><td colspan="4">Competences</td></tr>
<tr><td colspan="4"></td></tr>
<tr><td colspan="4">Course description:</td></tr>
<tr><td colspan="4">Morphological methods. Colour models, transformations between the models. Pattern matching, correlation based algorithms (SSD, SAD, NCC). Shape parameters, invariant features, Fourier descriptors. Identifying objects. Contour and regional descriptors, parameters calculated from the moment invariants. Processing images in frequency domain. FFT, DFT, filtering in frequency domain, homomorphic transformation. Active contours. Energy minimization curve. Use of Snake-s segmentation and tracking. Optical flows and motion detection. Motion tracking. Camera models (perspective, weak perspective and orthographic) and calibration. Stereo systems and 3D vision. Stereo model, epipolar geometry, finding coherent pixels, disparity maps. Application areas of visual navigation and 3D mapping. Sensor fusion. Image mosaicking (panoramic transformation).</td></tr>
<tr><td colspan="4">Literature</td></tr>
<tr><td colspan="4">Kálmán Palágyi: Image Processing for Advanced, Typotex, 2011 (in Hungarian, electronic notes)
R. Szeliski: Computer Vision Algorithms and Applications, Springer, 2011 (electronic notes)
Gonzales, Woods: Digital Image Processing, 3rd edition. Prentice Hall, 2008</td></tr>
</table>

<table>
<tr><td colspan="2">Name:
Image Analyses and Computer Vision</td><td>NEPTUN-code:
NIXKG1TBNE</td><td>Number of periods/week:
full-time: 2 ea + 0 tgy + 1 lab</td></tr>
<tr><td colspan="2">Credit: 4
Requirement: exam</td><td colspan="2">Prerequisite:
NIXKH1TBNE Advanced Algorithms of Image Processing</td></tr>
<tr><td>Responsible:
Zoltán VÁMOSSY, Ph.D.</td><td>Position:
associate professor</td><td colspan="2">Faculty and Institute name:
John von Neumann Faculty of Informatics
Institute of Applied Informatics</td></tr>
<tr><td colspan="4">Way of assessment:
- precondition of signature: successful home project
- written exam</td></tr>
<tr><td colspan="4">Competences</td></tr>
<tr><td colspan="4"></td></tr>
<tr><td colspan="4">Course description:</td></tr>
<tr><td colspan="4">3D and RGB-D sensors, multi-camera systems. Panoramic lens for 3D mapping. Multicam methods. Object detection. Principal component-based methods. Least squares method and its variants (RANSAC). Meanshift technology. Knowledge representation. Statistical pattern recognition (SVM). BOW method. Application of neural networks. Feedforward networks, Hopfield nets. Graph-based detection. The detection optimization (genetic algorithms, simulated annealing). Fuzzy-based techniques. Boosting methods, using AdaBoost object detection. Semantic image segmentation and understanding. Hidden Markov models.
Point Clouds, filtering, feature points. Registration kd-tree, octal tree. Clouds segmentation, visualization. Kinect and the use of other sensors. Content-based image retrieval methods.
Lab: solving practical tasks.</td></tr>
<tr><td colspan="4">Literature</td></tr>
<tr><td colspan="4">Zoltán Kató and László Czúni: Computer Vision, Typotex, 2011 (in Hungarian, electronic notes)
R. Szeliski: Computer Vision Algorithms and Applications, Springer, 2011 (electronic notes)
Gonzales, Woods: Digital Image Processing, 3rd edition. Prentice Hall, 2008</td></tr>
</table>

SOFTWARE DESIGN AND DEVELOPMENT (S)

MOBILE SYSTEM DEVELOPMENT SUBSPECIALIZATION

Name: **Android Development I**		***NEPTUN-code:*** *NIXAF1TBNE*	***Number of periods/week:*** full-time: 1 lec + 0 sem + 2 lab
Credit: 4 ***Requirement:*** mid-term mark		***Prerequisite:*** *NIXSG1EBNE* Software Technology and GUI Design	
Responsible: Szabolcs SERGYÁN, Ph.D.	***Position:*** associate professor	***Faculty and Institute name:*** John von Neumann Faculty of Informatics Institute of Applied Informatics	
Way of assessment: - mid-semester grade based on mid-semester tests and a project work			
Competences			
Course description:			
The main objective of the course is to give an introduction to the Android development on basic level. Student will learn to use Android Studio that based on JetBrains IDE. Some demonstrative examples show how to use phone sensors and build interactive applications. Students learn about the GPS and Network positioning systems. Explore the new intuitive user interface and discover the Material Design rules. Introduce the Google Maps and other aspect of map based functions. Experience difficulties due to differences between the individual devices and how to handle it. Gain an insight into the Android application optimization as well. The course is practice-oriented and end of the curse will be able to independently develop Android applications.			
Literature			
Péter Ekler – Marcell Fehér – Bertalan Forstner – Imre Kelényi: Android Software Development, SZAK KIADÓ KFT., 2012 (in Hungarian) Ed Burnette: Hello, Android: Introducing Google's Mobile Development Platform, Pragmatic Bookshelf; Third Edition edition, 2010			

<table>
<tr><td colspan="2">Name:
Android Development II</td><td>NEPTUN-code:
NIXAF2TBNE</td><td>Number of periods/week:
full-time: 0 lec + 0 sem + 2 lab</td></tr>
<tr><td colspan="2">Credit: 3
Requirement: mid-term mark</td><td colspan="2">Prerequisite:
NIXAF1TBNE Android Development I</td></tr>
<tr><td>Responsible:
Szabolcs SERGYÁN, Ph.D.</td><td>Position:
associate professor</td><td colspan="2">Faculty and Institute name:
John von Neumann Faculty of Informatics
Institute of Applied Informatics</td></tr>
<tr><td colspan="4">Way of assessment:
- mid-semester grade based on mid-semester tests and a project work</td></tr>
<tr><td colspan="4">Competences</td></tr>
<tr><td colspan="4"></td></tr>
<tr><td colspan="4">Course description:</td></tr>
<tr><td colspan="4">The main objective of the course is to show what you still need to publish an Android application successfully. Introduction to the modern mobile application development tools and processes. Experience the benefits of teamwork based on market expectations. It presents opportunities for testing Android applications and deploy quality mobile software (like automata-test, ux-test, a/b test and more). What external tools are available for build prototype. How to configure an automated deployment system. What methods are creating alternative versions of applications, such as free, paid, trial versions. How to publish a completed Android application in a production environment. What analytical tools are available to tracking and monitoring? How to follow-up of the software user reactions. Explore new area with Android Wear as wearable technology development. Presentation of additional areas of Android application development follow-up actual trends.</td></tr>
<tr><td colspan="4">Literature</td></tr>
<tr><td colspan="4">Péter Ekler – Marcell Fehér – Bertalan Forstner – Imre Kelényi: Android Software Development, SZAK KIADÓ KFT., 2012 (in Hungarian)
Reto Meier: Professional Android Application Development, Wrox; 3rd edition, 2012</td></tr>
</table>

<table>
<tr><td colspan="2">Name:
iOS-Based Development</td><td>NEPTUN-code:
NIXIO1TBNE</td><td>Number of periods/week:
full-time: 1 lec + 0 sem + 2 lab</td></tr>
<tr><td colspan="2">Credit: 4
Requirement: exam</td><td colspan="2">Prerequisite:
NIXAF1TBNE Android Development I</td></tr>
<tr><td>Responsible:
Szabolcs SERGYÁN, Ph.D.</td><td>Position:
associate professor</td><td colspan="2">Faculty and Institute name:
John von Neumann Faculty of Informatics
Institute of Applied Informatics</td></tr>
<tr><td colspan="4">Way of assessment:
- precondition of signature: achievement of tests and project work
- written exam</td></tr>
<tr><td colspan="4">Competences</td></tr>
<tr><td colspan="4"></td></tr>
<tr><td colspan="4">Course description:</td></tr>
<tr><td colspan="4">The purpose of the subject is to introduce students into iOS-based development. The development steps of a whole application will be implemented.
Main topics: XCode, CocoaPods, Git, Swift, UIKit, design and building of layouts, usage of images, MVC, ViewController lifecycles, implementation of backend infrastructure, threads and GCD, network-handling, data-handling, error-handling, multimedia devices, optimization to more devices, best practices, Apple Member Center, App Store, iTunes Connect.</td></tr>
<tr><td colspan="4">Literature</td></tr>
<tr><td colspan="4">Wei-Meng Lee: Beginning iPhone SDK Programming with Objective-C, Szak Kiadó, 2011 (in Hungarian)
M. Mathias and J. Gallagher: Swift Programming, The Big Nerd Ranch Guide (2nd ed.), Pearson Technology Group, 2016</td></tr>
</table>

SOFTWARE DESIGN AND DEVELOPMENT (S)

ENTERPRISE DEVELOPMENT SUBSPECIALIZATION

Name: **J2EE Development**		***NEPTUN-code:*** *NIXJA1TBNE*	***Number of periods/week:*** full-time: 1 lec + 0 sem + 2 lab
Credit: 4 ***Requirement:*** mid-term mark		***Prerequisite:*** *NIXWH1EBNE* Web Programming and Advanced Development Techniques	
Responsible: Krisztina ERDÉLYI, Ph.D.	***Position:*** senior lecturer	***Faculty and Institute name:*** John von Neumann Faculty of Informatics Institute of Applied Informatics	

Way of assessment:

- mid-semester grade based on mid-semester tests and a project work

Competences

Course description:

Introduce the technologies, methods and environment of the Java Enterprise Edition. The knowledge of the Java programming language is a must. The students will learn how to use the standard JEE libraries and how to build an enterprise application with Gradle. The project will be deployed into a JBoss and/or WebLogic JEE complient application server, the scope of the subject is learning the basic administration tasks of these servers. The data model will be implemented in a RDBMS (e.g.: postgresql) but the entire persistent layer will be used via ORM.
The responsibility of the server side business components will be presented. The students will learn how to write efficient and well-tested enterprise applications which have several interfaces for example to standard message-driven communication or management opportunities. The subject will cover the standard authentication and authorization techniques and libraries.

Literature

Steve Graham - Simeon Simeonov: Java-based Web Services, Kiskapu, 2002 (in Hungarian)
O'Reilly Media: Java EE 6 Pocket, Wiley, 2006 (electronic notes)

<table>
<tr><td colspan="2">Name:
Web Development</td><td>NEPTUN-code:
NIXWF1TBNE</td><td>Number of periods/week:
full-time: 0 lec + 0 sem + 2 lab</td></tr>
<tr><td colspan="2">Credit: 3
Requirement: mid-term mark</td><td colspan="2">Prerequisite:
NIXWH1EBNE Web Programming and Advanced Development Techniques</td></tr>
<tr><td>Responsible:
Krisztina ERDÉLYI, Ph.D.</td><td>Position:
senior lecturer</td><td colspan="2">Faculty and Institute name:
John von Neumann Faculty of Informatics
Institute of Applied Informatics</td></tr>
<tr><td colspan="4">Way of assessment:
- mid-semester grade based on mid-semester tests and a project work</td></tr>
<tr><td colspan="4">Competences</td></tr>
<tr><td colspan="4"></td></tr>
<tr><td colspan="4">Course description:</td></tr>
<tr><td colspan="4">The objective of the lesson is to introduce the ASP.NET MVC web application development, mainly focusing on the common tasks that are shared between the client-side and the server-side code (validation, push messages). The students of the subject will gain proficiency in creating simple webpages in C# language that follow the MVC design pattern; and also in the efficient separation of business layers in web applications.
Topics: Description of the ASP.NET MVC framework, basic building blocks. Bundle-management and CSS basics, usage of script bundles. Processing forms using simple GET/POST methods, Javascript basics, jQuery basics, usage of AJAX forms. Automatic client-side and server-side validation. Usage of SignalR to implement web-based push notifications.</td></tr>
<tr><td colspan="4">Literature</td></tr>
<tr><td colspan="4">István Reiter: ASP.NET MVC Web API, 2015 (in Hungarian, electronic notes)
Andrew Troelsen - Philip Japikse: C# 6.0 and the .NET 4.6 Framework 7th ed. Edition, Springer, 2015</td></tr>
</table>

Name: **Advanced Data Processing**		***NEPTUN-code:*** *NIXHAS1TBNE*	***Number of periods/week:*** full-time: 2 lec + 0 sem + 1 lab
Credit: 4 ***Requirement:*** exam		***Prerequisite:*** *NIXAB0EBNE* Databases	
Responsible: Krisztina ERDÉLYI, Ph.D.	***Position:*** senior lecturer	***Faculty and Institute name:*** John von Neumann Faculty of Informatics Institute of Applied Informatics	
Way of assessment: - exam grade based on mid-semester tests and a project work			
Competences			
Course description:			
The objective of the course is to demonstrate the usage of the various database management systems and data processing methods; while focusing on the service layer of the multi-layer web development architecture. The students of the subject gain proficiency in the dialect-independent usage of multiple database servers, and in the usage of the Service-Oriented Architectures (SOA) with web applications Topics: comparison of SQL dialects (Oracle, TSQL, MySQL, PostgreSQL), NoSql (MongoDB/CouchDB), Azure SQL. Repository pattern in the practice: usage of a repository layer on top of the ORM layer in a multi-layer application. Description of WCF technologies, HTTP/TCP binding, implementation alternatives of WCF callbacks. Implementing the service layer using WCF or SignalR, OOP AutoMapper. Data Access using REST API: WCF REST, WebApi, ADO.NET Data Services.			
Literature			
István Reiter: ASP.NET MVC Web API, 2015 (in Hungarian, electronic notes) Andrew Troelsen - Philip Japikse: C# 6.0 and the .NET 4.6 Framework 7th ed. Edition, Springer, 2015			