Course: **Complexity of Algorithms**	**Credits: 5**
Labelling of course: **obligatory**	
Rate of theoretical or practical content: 70-30 (credit%)	
Class type: lect. + pract., number of classes/term: **42+14**, (*language***:** *English)* Any other ways of knowledge dissemination (if applied): -	
Assessment (exam/term mark/any other): **exam** Any other ways of assessment (if applied)**: two mid-semester tests**	
Frequency of course: **1st semester**	
Prerequisites: -	

Brief description of the course:

Models of Computation (Finite automata, The Turing machine, The Random Access Machine, Boolean functions and Boolean circuits) lgorithmic decidability (Recursive and recursively enumerable languages, Other undecidable problems, Computability in logic, Godel's incompleteness theorem) Computation with resource bounds (Polynomial time, Other complexity classes, General theorems on space and time complexity) Non-deterministic algorithms (Non-deterministic Turing machines, Witnesses and the complexity of non-deterministic algorithms, Examples of languages in NP, NP-completeness, Further NP-complete problems) Randomized algorithms (Verifying a polynomial identity, Primality testing, Randomized complexity classes) Information complexity (Information complexity, Self-delimiting information complexity, The notion of a random sequence, Kolmogorov complexity, entropy and coding) Pseudorandom numbers (Classical methods, The notion of a pseudorandom number generator, One-way functions, Candidates for one-way functions) Algebraic computations An application of complexity: cryptography (A classical problem, A simple complexity-theoretic model, Public-key cryptography, The Rivest-Shamir-Adleman code (RSA code))

2-5 compulsory and suggested readings (lecture notes, books), with bibliographic data (author(s), title, publication data, (pages), ISBN)

1. László Lovász: Complexity of Algorithms (Lecture Notes) http://www.cs.elte.hu/~kiraly/complexity.pdf
2. Thomas H. Cormen, Charles E. Leiserson, and Ronald L. Rivest. Algorithms. Mc Graw-Hill, New York, 1990.

List of all those professional competences and elements (knowledge, skills etc) which the course most significantly contributes to:

a) knowledge
- Having an English language proficiency sufficient to complete the programme, review English language literature, to comprehend and process texts of specific vocabulary and to perform professional tasks being qualified for as well as to continue professional self-education.
- A deeper theoretical and practical knowledge in one or more of the following fields within information technology, depending on their specialization: software design, system simulation and modelling, communication networks, mobile and resource constrained applications, computer graphics and image processing, critical and embedded systems, media information technology, IT security, parallel systems, intelligent systems, computational theory, databases.

b) skills
- Ability to reveal and understand general rules and relationships.
- Ability to analyse the performance of IT systems, to use analytical, simulation and measurement methods.

c) attitude
- Openness and commitment to self-education, self-development, to deepen and extend their own knowledge and understanding in the field of natural, engineering and information sciences.

d) autonomy and responsibility
- Ability to work in team, as a specialist in a subfield, and lead a team in a responsible way

Course coordinator (*name, position, sci. degree*)**: Dr. Attila Házy, associate professor, PhD**.

Teachers involved (*name, position, sci. degree*)**: -**

Course: **Operating Systems and Networks**	**Credits: 5**
Labelling of course: **obligatory**	
Rate of theoretical or practical content: 60-40% (credit%)	
Class type: lect. + pract., number of classes/term: **42+14**, (*language***:** *English)* Any other ways of knowledge dissemination (if applied): Cisco CCNA Routing and Switching curriculum, Introduction to Networks, online course materials	
Assessment (exam/term mark/any other): Exam Any other ways of assessment (if applied)**:** Cisco CCNA Routing and Switching curriculum, Introduction to Networks, online final exam	
Frequency of course: **1st semester**	
Prerequisites: -	

Brief description of the course:

Introduction to mainframe architectures and data center technologies (hardware redundancy, efficient data storage, clustering, data center architecture and operation, managing backups). Overview of supercomputing and high performance computing (HPC): Massive Parallel Processing, Single System Image, high-performance interconnects (InfiniBand, RDMA) supercomputers and applications. Storage Area Networks (SANs): Fibre Channel, iSCSI. Basics of real-time operating systems (RTOS). Details of virtualization technologies: emulation, kernel-based (containers), para-virtualization, hardware assisted virtualization, cloud technologies. Overview of the advanced features of modern file systems.
Analysis of the TCP/IP Computer Networks architecture. Theoretical and design aspects. Special elements of Network layer (IPv4 and IPv6) addressing schemes; Routing Concepts; Static and Dynamic Routing; Switched Networks; VLANs; DHCP; NAT for IPv4.

2-5 compulsory and suggested readings (lecture notes, books), with bibliographic data (author(s), title, publication data, (pages), ISBN)

1. Tannenbaum, Woodhull: Operating Systems, Design and Implementation, Prentice-Hall, 1997, 978-0-1360-0663-3
2. Hubbert Smith: Data Center Storage: Cost-Effective Strategies, Implementation, and Management, 2011, 978-1439834879.
3. Chris Takemura and Luke S. Crawford: Book of Xen, 2009, 978-1-59327-186-2
4. Cisco CCNA Routing and Switching curriculum, Introduction to Networks course materials.
5. Andrew S. Tanenbaum, David J. Wetherall: Computer Networks, Prentice Hall 2010, 978-0132126953
6. Mellanox White Paper: Introduction to Infiniband (http://www.mellanox.com/pdf/whitepapers/IB_Intro_WP_190.pdf)

List of all those professional competences and elements (knowledge, skills etc) which the course most significantly contributes to:

a) knowledge
- Having an English language proficiency sufficient to complete the programme, review English language literature, to comprehend and process texts of specific vocabulary and to perform professional tasks being qualified for as well as to continue professional self-education
- Knowledge of widely applicable problem-solving techniques required to develop technical IT systems
- An understanding of the principle of the scientific and engineering methods required for the development of IT applications.

b) skills
- Ability to apply and use the acquired knowledge in practice
- Ability to cooperate with the experts in the application environment in a professional way.
- Understanding of the application requirements.

c) attitude
- Ability to perform development tasks at a professionally high level taking quality into consideration, as well as to ascertain the faultlessness of the developed systems.

- Openness and commitment to self-education, self-development, to deepen and extend their own knowledge and understanding in the field of natural, engineering and information sciences.
- Promoting information sciences and sharing their own knowledge.

d) autonomy and responsibility

- Responsibility for complying with and enforcing deadlines.
- Holding an IT position independently, maintaining the whole workflow in a professionally responsible way.

Course coordinator (*name, position, sci. degree*)**: Dr. Szilveszter Kovács, associate professor, Ph.D.**
Teachers involved (*name, position, sci. degree*)**: Dr. Dávid Vincze, associate professor, Ph.D.**

Course: **Operation Research and Optimization**	**Credits: 5**
Labelling of course: **obligatory**	
Rate of practical or theoretical content: 50-50 (credit%)	
Class type: lect. + pract., number of classes/term: **28+28**, (*language***:** *English)* Any other ways of knowledge dissemination (if applied): **case-studies**	
Assessment (exam/term mark/any other): **term mark** Any other ways of assessment (if applied)**: two mid-semester tests**	
Frequency of course: **1st semester**	
Prerequisites: -	

Brief description of the course:

Classification of optimization models. Constrained and unconstrained optimization methods. Linear programming. Graphical solution of two-dimensional problems. Simplex method. Primal and dual problem. Duality theorem. Shadow price. Transportation problem, assignment problem, Hungarian method. Integer programming and its applications. Classical optimization methods. Nonlinear problems, Karush-Kuhn_tucker conditions. Solving optimization problems by MS Excel.

2-5 compulsory and suggested readings (lecture notes, books), with bibliographic data (author(s), title, publication data, (pages), ISBN)

1. Foulds, L.R.: Optimization Techniques. Springer Verlag, ISBN 978-1-4613-9458-7, 1981
2. Operation research by Tommi Sottinen: http://lipas.uwasa.fi/~tsottine/lecture_notes/or.pdf

List of all those professional competences and elements (knowledge, skills etc) which the course most significantly contributes to:

a) knowledge
- Having an English language proficiency sufficient to complete the programme, review English language literature, to comprehend and process texts of specific vocabulary and to perform professional tasks being qualified for as well as to continue professional self-education
- Knowledge of widely applicable problem-solving techniques required to develop technical IT systems

b) skills
- Ability to reveal and understand general rules and relationships
- Ability to apply and use the acquired knowledge in practice

c) attitude
- Openness and commitment to self-education, self-development, to deepen and extend their own knowledge and understanding in the field of natural, engineering and information sciences

d) autonomy and responsibility
- Ability to work in team, as a specialist in a subfield, and lead a team in a responsible way

Course coordinator (*name, position, sci. degree*)**: Dr. Attila Körei, associate professor, PhD**.

Teachers involved (*name, position, sci. degree*)**: -**

Course: **Software Engineering**	**Credits: 5**

Labelling of course: **obligatory**

Rate of practical or theoretical content: 50-50% (credit%)

Class type: lect. + pract., number of classes/term: **42+14**, (*language***:** *English)*
Any other ways of knowledge dissemination (if applied):

- Assessment, Project work
- Team work

Assessment (exam/term mark/any other): term mark
Any other ways of assessment (if applied)**:**

- Participation in the development
- Evaluation of the developed components
- Criteria:
  - Code quality
  - Design and implementation
  - Testing
  - Deadlines
  - Communication

Frequency of course: **1st semester**

Prerequisites: -

Brief description of the course:

Software Engineering course gives a detailed insight into the modern software development methodologies and processes. Students gets understanding of cooperation of wide range of team work technologies. The strudent learn how to use the GIT, JIRA and Jenkins tool. The core technologies that are presented are source code management, project management, issue tracking, static code analysis and continuous integration. In addition to their bachelor studies, students acquire some team leading abilities that are indispensable for project managers or scrum masters.

2-5 compulsory and suggested readings (lecture notes, books), with bibliographic data (author(s), title, publication data, (pages), ISBN)

1. Fred Brooks: The Mythical Man-Month ISBN: 0-201-00650-2
2. Tom DeMarco, Tim Lister: Peopleware: Productive Projects and Teams ISBN 0-932633-43-9
3. Mauro Pezze, Michal Young: Software Testing and Analysis: Process, Principles and Techniques ISBN: 0471455938
4. GIT: http://rogerdudler.github.io/git-guide/
5. JIRA: https://www.tutorialspoint.com/jira/
6. Jenkins: https://www.tutorialspoint.com/jenkins/

List of all those professional competences and elements (knowledge, skills etc) which the course most significantly contributes to:

a) knowledge
- Knowledge of widely applicable problem-solving techniques required to develop technical IT systems

b) skills
- Ability to use problem-solving techniques for software and application development
- Ability to develop complex IT systems
- Ability to cooperate with the experts in the application environment in a professional way.

c) attitude
- Initiative to solve problems, ability to make informed decisions, not avoiding personal responsibility
- Working in a creative and flexible way, recognising and solving problems based on intuition and methodology

d) autonomy and responsibility
- Holding an IT position independently, maintaining the whole workflow in a professionally responsible way

Course coordinator (*name, position, sci. degree*)**: Dr. Zsolt Tóth, Lecturer, PhD**

Teachers involved (*name, position, sci. degree*)**: -**	
Course: **Architectures and Embedded Systems**	**Credits: 4**
Labelling of course: **obligatory**	
Rate of practical or theoretical content: 60-40% (credit%)	
Class type: lect. + pract., number of classes/term: **28+28**, (*language***:** *English)* Any other ways of knowledge dissemination (if applied): -	
Assessment (exam/term mark/any other): exam Any other ways of assessment (if applied): -	
Frequency of course: **1st semester**	
Prerequisites: -	

Brief description of the course:

Embedded system components and structure. Input output elements of and embedded system. Signal conditioning, signal processing; Micro-controllers, microprocessors FPGA architecture, Digital signal processors; processing elements and optimal solution for system integration. Embedded system communication (wired and wireless); Hardware – software co-design, hardware in the loop simulation/testing. Embedded system design process from hardware to software development; Operating systems for embedded system applications; Model based development. Debugging embedded systems. Re-configurable and adaptable architectures. Open standard processor architecture: ARM

2-5 compulsory and suggested readings (lecture notes, books), with bibliographic data (author(s), title, publication data, (pages), ISBN)

1. Labrosse J.J et all: Embedded Software know it all. Newness, 2008, pp. 770, ISBN: 978-07506-8582-5.
2. Labrosse J.J: MicroC/OS-II The real-time kernel. CMP Books, 2002, pp. 606, ISBN: 1-57820-103-9.
3. Scott H., Andree D. ed.: Re-configurable Computing The Theory and Practice of FPGA-Based Computation. Elsvier, 2008, pp. 945, ISBN: 978-0-12-370522-8.
4. Zainalabedin Navabi: Embedded Core Design with FPGAs, McGraw-Hill, 2007, ISBN-978-0-07-147481-8, pp.433
5. Andrew N. Sloss, Dominic Symess, Chris Wright: ARM System Developer's Guide, Elsevier, ISBN: 1-55860-874-5, 2004, pp. 703. On Internet: https://doc.lagout.org/electronics/Game boy advance/ARM_BOOKS/ARM_System_Developers_Guide-Designing_and_Optimizing_System_Software.pdf
6. Xilinx: Embedded Design Flow on Zynq, http://www.xilinx.com/support/university/vivado/vivado-workshops/Vivado-embedded-design-flow-zynq.html

List of all those professional competences and elements (knowledge, skills etc) which the course most significantly contributes to:

a) **knowledge**
- A deeper theoretical and practical knowledge in one or more of the following fields within information technology, depending on their specialization: software design, system simulation and modelling, communication networks, mobile and resource constrained applications, computer graphics and image processing, critical and embedded systems, media information technology, IT security, parallel systems, intelligent systems, computational theory, databases

b) **skills:**
- Expertise, analysis, design and implementation skills of their specialization

c) **attitude:**
- Openness and commitment to self-education, self-development, to deepen and extend their own knowledge and understanding in the field of natural, engineering and information sciences

d) **autonomy and responsibility:**
- Holding an IT position independently, maintaining the whole workflow in a professionally responsible way

Course coordinator (*name, position, sci. degree*)**: Dr. József Vásárhelyi associate professor, Ph.D.**

Teachers involved (*name, position, sci. degree*)**: -**

Course: Discrete Mathematics	**Credits: 5**
Labelling of course: **obligatory**	
Rate of practical or theoretical content: 50-50% (credit%)	
Class type: lect. + pract., number of classes/term: **28+28**, (*language***:** *English)* Any other ways of knowledge dissemination (if applied): -	
Assessment (exam/term mark/any other): exam. Any other ways of assessment (if applied): -	
Frequency of course: **1st semester**	
Prerequisites: -	

Brief description of the course:

Pascal's triangle, Fibonacci numbers, semigroups and groups, Lagrange and Cauchy theorems for finite groups, rings and fields, number fields, the algebra of polynomials, Euclidean algorithm, irreducible factorizations of polynomials, introduction to graph-theory, trees, the greedy algorithm, planar graphs, the chromatic number, bipartite graphs, matchings, graphs and matrices, partial and linear orders, the order dimension of a poset, lattices and complete lattices, distributive and Boolean lattices, Boolean functions, polynomial form, disjunctive and conjunctive normal forms, clones of Boolean functions, maximal clones, completeness, Post lattice, De Morgan and Heyting algebras.

2-5 compulsory and suggested readings (lecture notes, books), with bibliographic data (author(s), title, publication data, (pages), ISBN)

Compulsory reading:

1. L. Lovász, J. Pelikán, K. Vesztergombi: Discrete Mathematics: Elementary and Beyond, Springer, 2003
2. S. N. Burris: Logic for mathematics and Computer Science, Prentice Hall,1998.
3. Stephan Foldes: Fundamental Structures of Algebra and Discrete Mathematics, Wiley, 1994
4. Wallis, W.D: A Beginner's Guide to Discrete Mathematics, Birkhauser. (2002)

Suggested reading:

1. Rosen, Kennth H. : Discrete Mathematics and its Applications, McGraw-Hill, 5th edition, 2003
2. Goodaire, E. and Parmenter, M : Discrete Mathematics with Graph Theory, 2nd Edition; Prentice Hall, 2002

List of all those professional competences and elements (knowledge, skills etc) which the course most significantly contributes to:

a) **knowledge**:

- Having an English language proficiency sufficient to complete the programme, review English language literature, to comprehend and process texts of specific vocabulary and to perform professional tasks being qualified for as well as to continue professional self-education

b) skills:

- Ability to reveal and understand general rules and relationships
- Ability to apply and use the acquired knowledge in practice
- Ability to recognise and solve routine problems, as well as to come up with original ideas.

c) attitude

- Openness and commitment to self-education, self-development, to deepen and extend their own knowledge and understanding in the field of natural, engineering and information sciences.
- Initiative to solve problems, ability to make informed decisions, not avoiding personal responsibility.
- Working in a creative and flexible way, recognising and solving problems based on intuition and methodology.

d) autonomy and responsibility

- Responsibility for complying with and enforcing deadlines.
- Ability to develop and operate systems containing operational critical and sensitive information based on their professional competencies.

Course coordinator (*name, position, sci. degree*)**: Dr. Sándor Radeleczki**, professor CSc

Teachers involved (*name, position, sci. degree*)**: -**

Course: **Protection of Information Systems**	**Credits: 4**
Labelling of course: **obligatory**	
Rate of practical or theoretical content: 50-50% (credit%)	
Class type: lect. + pract., number of classes/term: **28+28**, (*language***:** *English)* Any other ways of knowledge dissemination (if applied): -	
Assessment (exam/term mark/any other): **term mark** Any other ways of assessment (if applied)**:** course project and poster presentation	
Frequency of course: **3rd semester**	
Prerequisites: -	

Brief description of the course:

Protection from physical damage and unauthorized access. Basic concepts: intruders; attack against security systems; source of risks, threats, costs; Confidentiality, integrity, availability, functionality. concept of protection, expand concept of protection, Implementation of Access Matrix: Formal methods: Bell LaPadula, Biba; MAC, DAC; Firewalls; Application level gateway; stateless and stateful packet filtering firewall; High Availability firewalls; VPN; Deep Packet Inspection Firewall; TCSEC, ITSEC, Common Criteria; Attack methods: steganography, cryptography; Kerckhoff; symmetric and asymmetric cryptography; problems of key share; solutions: Diffie-Hellman-Merkle, public key infrastructure; PGP, NTFS-EFS, digital signature and the Hash; the certificates; virus search methods.
Theoretical background and interdisciplinary aspects: Basic concepts and purposes of the relevant mathematical theories. Concepts of data and information. Processing and communication systems. Economic and social interests in information. Ownership and privacy. Legal protection of information systems.

2-5 compulsory and suggested readings (lecture notes, books), with bibliographic data (author(s), title, publication data, (pages), ISBN)

- Bruce Schneier: Applied Cryptography (John Wiley & Sons, 1996, ISBN 0 471 11709 9)
- Cheswick, Bellowin, Rubin: Firewalls and Internet Security (Addison-Wesley, 2003, ISBN 0 201 63466 X)
- Harold F. Tipton, Micki Krause: Information Security Management Handbook, (Auerbach, 2000, ISBN 0 8439 9829 0)
- D.T. Lindsay, W.L. Price: Information Security (Elsevier, ISBN 0 444 89219 2
- Michael Sikorski (Author), Andrew Honig : Practical Malware Analysis: A Hands-On Guide to Dissecting Malicious Software (No Starch Press;), 2012
- on-line course: http://memooc.hu/courses/course-v1:UNI-MISKOLC+IT.S1.SECURITY.0.ex+2015_T1/about

List of all those professional competences and elements (knowledge, skills etc) which the course most significantly contributes to:

a) **knowledge**
- Having an English language proficiency sufficient to complete the programme, review English language literature, to comprehend and process texts of specific vocabulary and to perform professional tasks being qualified for as well as to continue professional self-education
- An understanding of the principle of the scientific and engineering methods required for the development of IT applications

b) **skills**
- Ability to reveal and understand general rules and relationships
- Ability to apply and use the acquired knowledge in practice
- Ability to cooperate with the experts in the application environment in a professional way

c) **attitude**
- Initiative to solve problems, ability to make informed decisions, not avoiding personal responsibility
- Working in a creative and flexible way, recognising and solving problems based on intuition and methodology

d) **autonomy and responsibility**
- Responsibility for complying with and enforcing deadlines
- Holding an IT position independently, maintaining the whole workflow in a professionally responsible way

Course coordinator (*name, position, sci. degree*)**: Prof. Dr. István Földes professor DSc**
Teachers involved (*name, position, sci. degree*)**: -**

Course: **Enterprise Application Integration**	**Credits: 4**
Labelling of course: **obligatory**	
Rate of practical or theoretical content: 40-60 (credit%)**.**	
Class type: lect. + pract., number of classes/term: **28+28**, (*language***:** *English)* Any other ways of knowledge dissemination (if applied): **Case Report**, **Video-projection / Youtube**.	
Assessment (exam/term mark/any other): **term mark** Any other ways of assessment (if applied)**: Thematic presentation**, **Theme developement**	
Frequency of course: **2nd semester**	
Prerequisites: -	

Brief description of the course:

Course description: Enterprise Application Integration, or EAI, has existed as a technical term since the early 2000s, but the central problem that it attempts to solve is much older. In a nutshell, EAI is an approach, or more accurately, a general category of approaches, to providing interoperability between the multiple disparate systems that make up a typical enterprise infrastructure. Enterprise architectures, by their nature, tend to consist of many systems and applications, which provide the various services the company relies upon to conduct their day to day business. A single organization might use separate systems, either developed in-house or licensed from a third party vendor, to manage their supply chain, customer relationships, employee information, and business logic. This modularization is often desirable. In theory, breaking the task of running a business into multiple smaller functionalities allows for easy implementation of the best and newest technological advancements in each area, and quick adaptation to changing business needs. However, to gain the benefits of this kind of distributed, modular system, an organization must implement technologies that deal with the problems presented by this architecture.

2-5 compulsory and suggested readings (lecture notes, books), with bibliographic data (author(s), title, publication data, (pages), ISBN)

Required readings:

1.Alexi Leon.: Enterprise Resource Planning – Publishing by Mc Graw Hill Publishing Company Limited, Copyright 2008, Alexi Leon. ISBN(13) 978-0-07-065680-2.
2. William A. Ruh, Francis X. Maginnis, William J. Brown- Enterprise Application Integration, 224 pages February 2002- ISBN: 978-0-471-43786-4
3. D. Chappel: Enterprise Service Bus: Theory in Practice. O'Reilly Media, 2004. ISBN-10: 0596006756 p. 792
4. T. Erl: Service-Oriented Architecture (SOA): Concepts, Technology, and Design, Prentice Hall Ptr, 2005.

Recommended readings:

1. Claus Ibsen: Camel in action, Manning Publications, ISBN-10: 1935182366, p. 552, 2011.
2. G. Hohpe, B. Woolf: Enterprise Integration Patterns: Designing, Building, and Deploying Messaging Solutions. Addison-Wesley Professional, ISBN: 0321200683, 2003.
3. D. S. Linthicum: Enterprise Application Integration. Addison Wesley, ISBN: 0201615835, 1999.

List of all those professional competences and elements (knowledge, skills etc) which the course most significantly contributes to:

a) knowledge

- Having an English language proficiency sufficient to complete the programme, review English language literature, to comprehend and process texts of specific vocabulary and to perform professional tasks being qualified for as well as to continue professional self-education
- Knowledge of widely applicable problem-solving techniques required to develop technical IT systems
- An understanding of the principle of the scientific and engineering methods required for the development of IT applications.

b) skills

- Ability to reveal and understand general rules and relationships
- Ability to apply and use the acquired knowledge in practice
- Ability to view IT management of technical, economic and human resources as a system

- Ability to use the tools and formal methods of information technology on a skill level.

c) attitude

- Ability to perform development tasks at a professionally high level taking quality into consideration, as well as to ascertain the faultlessness of the developed systems
- Examining the opportunities of setting research, development and innovation objectives and striving to achieve them during their work
- Working in a creative and flexible way, recognising and solving problems based on intuition and methodology

d) autonomy and responsibility

- Responsibility for complying with and enforcing deadlines
- Holding an IT position independently, maintaining the whole workflow in a professionally responsible way
- Ability to work in team, as a specialist in a subfield, and lead a team in a responsible way
- Ability to develop and operate systems containing operational critical and sensitive information based on their professional competencies

Course coordinator (*name, position, sci. degree*)**: Dr. Samad Dadvandipour**, associate professor PhD

Teachers involved (*name, position, sci. degree*)**: -**

Course: **Database Systems**	**credits: 5**
Labelling of course: **obligatory**	
Rate of theoretical or practical content: 60-40% (credit%)	
Class type: lect. + pract., number of classes/term: **42+14**, (*language***:** *English)* Any other ways of knowledge dissemination (if applied): practice in document and graph database management	
Assessment (exam/term mark/any other): Exam Any other ways of assessment (if applied)**:** development of document and graph database management	
Frequency of course: **2nd semester**	
Prerequisites: -	

Brief description of the course:

Overview of data modelling, relational data structure, relational algebra; overview of the SQL standard; SQL API middleware architecture, JDBC API, Lambda calculus, LINQ API programming; LDAP architecture, LDAP model; LDAP data management (schema and security), LDAP API; Overview of XML, Basics of XML schema, Overview of jQuery language, ; Data persistency API, JPA, mapping XML; JPA API elements; NOSQL database systems, MongoDB architecture, document model, ,JSON, database operations, Mongo API programming, Document database model, Neo4J architecture, Neo4J database operations, Neo4J API in Java, Big Data architecture

2-5 compulsory and suggested readings (lecture notes, books), with bibliographic data (author(s), title, publication data, (pages), ISBN)

1. Brad Dayley: NoSQL with MongoDB in 24 Hours, Sams Teach Yourself, Computers & Internet, 2014
2. Guy Harrison: Next Generation Databases: NoSQLand Big Data, 2015
3. Ian Robinson, Jim Webber, Emil Eifrem: Graph Databases, O'Reilly, 2015
4. Moodle homepage of the course, course materials, moodle.iit.uni-miskolc.hu
5. https://university.mongodb.com/ (MongoDB management)
6. https://neo4j.com/graphacademy/online-training/getting-started-graph-databases-using-neo4j/ (Neo4J management)

List of all those professional competences and elements (knowledge, skills etc) which the course most significantly contributes to:

a) knowledge
- Having an English language proficiency sufficient to complete the programme, review English language literature, to comprehend and process texts of specific vocabulary and to perform professional tasks being qualified for as well as to continue professional self-education.
- Knowledge of widely applicable problem-solving techniques required to develop technical IT systems.
- An understanding of the principle of the scientific and engineering methods required for the development of IT applications.

b) skills
- Ability to apply and use the acquired knowledge in practice.
- Ability to use problem-solving techniques for software and application development
- Expertise, analysis, design and implementation skills of their specialization.
- Understanding of the application requirements.

c) attitude
- Ability to perform development tasks at a professionally high level taking quality into consideration, as well as to ascertain the faultlessness of the developed systems.
- Openness and commitment to self-education, self-development, to deepen and extend their own knowledge and understanding in the field of natural, engineering and information sciences.
- Working in a creative and flexible way, recognising and solving problems based on intuition and methodology.

d) autonomy and responsibility
- Responsibility for complying with and enforcing deadlines.
- Holding an IT position independently, maintaining the whole workflow in a professionally responsible way.

Course coordinator (*name, position, sci. degree*)**: Dr. László Kovács, associate professor, Ph.D.**
Teachers involved (*name, position, sci. degree*)**: -**

Course: **Communication Theory**	**Credits: 5**
Labelling of course:: **obligatory**	
Rate of theoretical or practical content: 75-25% (credit%)	
Class type: lect. + pract., number of classes/term: **42+14**, (*language***:** *English)* Any other ways of knowledge dissemination (if applied): -	
Assessment (exam/term mark/any other): Exam Any other ways of assessment (if applied): -	
Frequency of course: **2nd semester**	
Prerequisites: -	

Brief description of the course:

Representation, description and types of signals. Continuous and discrete time signals. Describing signals in time domain. Statistical average, time average, autocorrelation. Fourier transformation, describing signals in frequency domain. Analog signal transmission. Sampling, quantization and coding. DFT. FFT algorithm. Coding, code types, error-detecting and error-correcting codes. Base concepts of digital signal transmission. Simplex, half-duplex and full-duplex connection. Analog and digital modulation techniques. Orthogonal Frequency Division Multiplex. Basics of digital signal processing. Inter-symbol interference. Viterbi algorithm.

2-5 compulsory and suggested readings (lecture notes, books), with bibliographic data (author(s), title, publication data, (pages), ISBN)

Compulsory reading:

1. Proakis, Salehi: Communication Systems Engineering, Prentice Hall, 2002, ISBN 0-13-095007-6

Recommended reading:

2. 1. Uli sorger: Communication Theory, Books on Demand GmbH, 2009. pp. 237. ISBN:978-3-8370-8521-1
3. Sudakshina Kundu: Analog and Digital Communications, 2010. pp. 367. ISBN 978-81-317-3187-1.
4. P Ramakrishna Rao: Signals and Systems, Tata McGraw Hill Co., 2008. pp. 559. ISBN 978-0-07-0669277.
5. 4. Bhagawandas P. Lathi: Linear Systems and Signals, Oxford University Press Incorporated, 2009. pp. 975. ISBN 0195392566.

List of all those professional competences and elements (knowledge, skills etc) which the course most significantly contributes to:

a) knowledge

- A deeper theoretical and practical knowledge in one or more of the following fields within information technology, depending on their specialization: software design, system simulation and modelling, communication networks, mobile and resource constrained applications, computer graphics and image processing, critical and embedded systems, media information technology, IT security, parallel systems, intelligent systems, computational theory, databases.

b) skills

- Ability to apply and use the acquired knowledge in practice.

c) attitude

- Openness and commitment to self-education, self-development, to deepen and extend their own knowledge and understanding in the field of natural, engineering and information sciences.

d) autonomy and responsibility

- Responsibility for complying with and enforcing deadlines.

Course coordinator (*name, position, sci. degree*)**: Dr. László Czap, associate professor PhD**

Teachers involved (*name, position, sci. degree*)**: Attila Károly Varga PhD, associate professor**

Course: **Information Theory**	**credits: 5**
Labelling of course: **obligatory**	
Rate of theoretical or practical content: 80-20% (credit%)	
Class type: lect. + pract., number of classes/term: **28+28**, (*language***:** *English)* Any other ways of knowledge dissemination (if applied): -	
Assessment (exam/term mark/any other): **exam.** Any other ways of assessment (if applied): **in busy period two tests (4-4 practical problems, minimum: 2 solved**).	
Frequency of course: **2nd semester**	
Prerequisites: -	

Brief description of the course:

Main purpose: To master basic concepts in information theory, including source coding, and algorithms of channel capacity.To investigate important specific codes and channels. To continue to develop problem-solving skills and to apply these skills to the solving of application problems in communication theory.Be able to apply the gained knowledge to the solution of practical problems in engineering areas through evaluation and selection of appropriate statistical techniques.
Specification: Source coding : entropy, I-divergence, classification of codes, Kraft-McMillan inequality, source coding theorem, Shannon-Fano coding, Gilbert-Moore coding, Huffman coding, Extended Huffman coding. McMillan's theorem
Channel capacity: joint and conditional entropies, mutual information. types of discrete memoryless channels, BSC, BEC, channel capacity, Arimoto-Blahut algorithms.
Channel coding: Hamming weight, Hamming distance, minimum distance decoding, single parity codes, Hamming codes, repetition codes, linear block codes, cyclic codes, syndrome calculation, encoder and decoder
Continuous source, entropy, channels, minimum entropy method.

2-5 compulsory and suggested readings (lecture notes, books), with bibliographic data (author(s), title, publication data, (pages), ISBN)

R. B. Ash. *Information Theory*. Interscience, New York. 2000.
T. M. Cover, J.A. Thomas. *Elements of information theory*. Wiley, New York. 1991.
D. Salomon. *Data Compression*, Springer, 2004
Xue-Bin Liang. *An Algebraic, Analytic and Algorithmic Investigation on the Capacity and Capacity-Achieving Input Probability Distributions of Finite-Input Finite-Output Discrete Memoryless Channels*. Department of Electrical and Computer Engineering Louisiana State University, Baton Rouge, LA 70803. 2004.
Claude E. Shannon, Warren Weaver: *The Mathematical Theory of Communication***,** *Bell System Technical Journal, 1947.*

List of all those professional competences and elements (knowledge, skills etc) which the course most significantly contributes to:

a) knowledge
- An understanding of the principle of the scientific and engineering methods required for the development of IT applications

b) skills
- Ability to process new problems and phenomena arising on the boundaries of knowledge of sciences related to information technology,
- Ability to analyse the performance of IT systems, to use analytical, simulation and measurement methods.

c) attitude
- Openness and commitment to self-education, self-development, to deepen and extend their own knowledge and understanding in the field of natural, engineering and information sciences.

d) autonomy and responsibility
- Responsibility for complying with and enforcing deadlines.

Course coordinator (*name, position, sci. degree*)**: Dr. Sándor Fegyverneki,** associate professor, PhD

Teachers involved (*name, position, sci. degree*)**: -**

Course: **Artificial Neural Network**	**credits: 4**
Labelling of course:: **obligatory**	
Rate of theoretical or practical content: 60-40% (credit%**).**	
Class type: lect. + pract., number of classes/term: **28+28**, (*language***:** *English)* Any other ways of knowledge dissemination (if applied): **Case Report**, **Video-projection / Youtube**.	
Assessment (exam/term mark/any other): **Exam** Any other ways of assessment (if applied)**: Thematic presentation**, **Theme developement**	
Frequency of course: **4th semester**	
Prerequisites: -	

Brief description of the course:

Course objective: The course aims at simulating the human brain's functionality using artificial neural networks. We usually use the simulation models for the solution of different problems in many fields in engineering, business, machine learning and medical issues. In general, the procedure of an ANN is performed through two steps. First, a learning phase which is a charge of creating values for every one of the network connections, then a phase of real use, where the network presents the input and tells us the calculated output value in response.

Course description: The Work on artificial neural networks, usually stated to as „neural networks," has been motivated right from its foundation by the recognition that the brain computes in the entirely different way from the conventional digital computer. The fundamentals of Artificial Network (ANN) covers mainly the structural levels of organisation in the brain, models of a neuron, neural networks viewed as directed graphs, feedback, network architectures, knowledge representation, visualising process in neural networks, artificial intelligence & neural networks and historical problems. Furthermore learning the process and perceptron structure are the essential parts of the study of the neural network.
The essential points of this study are as follows:

- Structural levels of organisation in the brain,
- Network architecture,
- Visualisation processes in neuronal networks,
- Learning processes (error-correction learning, Hebbian learning, etc.),
- Supervised learning,
- Unsupervised learning,
- Correlation matrix memory,
- The perceptron structure,
- Least-Mean-Square Algorithm.

The course discusses the biological meaning of neurons processes in the human's brain as pre-studying to the artificial neural network.

2-5 compulsory and suggested readings (lecture notes, books), with bibliographic data (author(s), title, publication data, (pages), ISBN)

Required readings:

1. Simon Haykin 1999. Neural Networks: *A comprehensive foundation*, Ed. Prentice Hall.
ISBN: 0139083855
2.Kung, S. Y., 2007. *Digital Neural Networks*, Ed. Prentice Hall. ISBN: 0136123260
3.Simon Haykin 1999. *Neural Networks. A Comprehensive Foundation.* New York: Mc Millan. ISBN: 0-02-352781-7.
4. Presented Lectures

Recommended readings:

1.Brian J. Taylor 2010. Methods and Procedures for the Verification and Validation of Artificial Neural Networks. Springer Publishing Company. ISBN: 1441939350.
2.Daniel S. Levine 2013. Neural Network for Knowledge Representation and Interference. Psychology Press. ISBN: 1134771614.
3. S.M. Sapuan, Iqbal Mohammed Mujtaba (szerk.) 2010. Applications *of Neural Networks.* Taylor and Francis Group. ISBN: 978-1-4200-9332-2.

List of all those professional competences and elements (knowledge, skills etc) which the course most significantly contributes to:

a) knowledge

- Having an English language proficiency sufficient to complete the programme, review English language literature, to comprehend and process texts of specific vocabulary and to perform professional tasks being qualified for as well as to continue professional self-education
- Knowledge of widely applicable problem-solving techniques required to develop technical IT systems
- An understanding of the principle of the scientific and engineering methods required for the development of IT applications.
- A deeper theoretical and practical knowledge in one or more of the following fields within information technology, depending on their specialization: software design, system simulation and modelling, communication networks, mobile and resource constrained applications, computer graphics and image processing, critical and embedded systems, media information technology, IT security, parallel systems, intelligent systems, computational theory, databases.

b) skills

- Ability to reveal and understand general rules and relationships
- Ability to apply and use the acquired knowledge in practice,
- Ability to process new problems and phenomena arising on the boundaries of knowledge of sciences related to information technology,
- Ability to use the tools and formal methods of information technology on a skill level,

c) attitude

- Initiative to solve problems, ability to make informed decisions, not avoiding personal responsibility,
- Promoting information sciences and sharing their own knowledge.,
- Examining the opportunities of setting research, development and innovation objectives and striving to achieve them during their work.

d) autonomy and responsibility

- Ability to develop and operate systems containing operational critical and sensitive information based on their professional competencies.

Course coordinator (*name, position, sci. degree*)**: Dr Samad Dadvandipour**, associate professor, PhD

Teachers involved (*name, position, sci. degree*)**: -**

Course: **Geometric Modeling**	**credits: 5**
Labelling of course: **obligatory**	
Rate of theoretical or practical content: 60-40% (credit%)	
Class type: lect. + pract., number of classes/term: **28+28**, (*language***:** *English)* Any other ways of knowledge dissemination (if applied): -	
Assessment (exam/term mark/any other): exam Any other ways of assessment (if applied): -	
Frequency of course: **2nd semester**	
Prerequisites: -	

Brief description of the course:

Description of curves, interpolating and approximating curves, spline curves. Osculating plane, arc length, curvature, torsion, Frenet frame. Definition and properties of Hermite arc, Ferguson and Overhauser splines. Parametric description and properties of Bézier curves, de Calteljau algorithm. Parametric form and properties of B-spline curves. Description of surfaces, tangent plane, normal, surfaces swept by a moving curve. Interpolating and approximating surfaces: Coons patch, Bézier and B-spline surfaces. Generation of rational Bézier and B-spline surfaces and their properties. Surface and solid modeling in CAD systems.

2-5 compulsory and suggested readings (lecture notes, books), with bibliographic data (author(s), title, publication data, (pages), ISBN)

1. Farin, G.:Curves and Surface for Computer-Aided Geometric Design, 5th edition Morgan-Kaufmann, 2002
2. Hoschek, J., Lasser, D.: Fundamentals of Computer Aided Geometric Design, AK Peters, Wellesley, 1993.
3. Prautzsch, H., Boehm, W., M. Paluszny, M., Bézier and B-spline Techniques, Springer, 2002.

List of all those professional competences and elements (knowledge, skills etc) which the course most significantly contributes to:

a) knowledge

- A deeper theoretical and practical knowledge in one or more of the following fields within information technology, depending on their specialization: software design, system simulation and modelling, communication networks, mobile and resource constrained applications, computer graphics and image processing, critical and embedded systems, media information technology, IT security, parallel systems, intelligent systems, computational theory, databases,

b) skills

- Ability to use problem-solving techniques for software and application development
- Ability to cooperate with the experts in the application environment in a professional way

c) attitude

- Working in a creative and flexible way, recognising and solving problems based on intuition and methodology

d) autonomy and responsibility

- Responsibility for complying with and enforcing deadlines

Course coordinator (*name, position, sci. degree*)**: Dr. Imre Juhász, professor, DSc**

Teachers involved (*name, position, sci. degree*)**: Sándor Lajos, master instructor**

Course: **Quality Assurance for Information Technology**	**credits: 4**
Labelling of course: **obligatory**	
Rate of theoretical or practical content: 60-40% (credit%)	
Class type: lect. + pract., number of classes/term: **28+14**, (*language***:** *English)* Any other ways of knowledge dissemination (if applied): pair programming, video lectures	
Assessment (exam/term mark/any other): term mark Any other ways of assessment (if applied): test, essay, programming assignment	
Frequency of course: **2nd semester**	
Prerequisites: -	

Brief description of the course:

The definition of Quality, Quality Management. Factors contributing to quality. The definition of Information Science. The role of quality in the global competitive market. Computer Aided Quality Assurance and its integration.
The quality aspects of software products and software development process. Software process models. Modelling methods of computer application development. Refactoring. Quality standards of software products. Software specifications. Quality improvements of software development process. Software metrics. Human resources in the software development. Coding standards.

2-5 compulsory and suggested readings (lecture notes, books), with bibliographic data (author(s), title, publication data, (pages), ISBN)

1. Daniel Galin: Software Quality Assurance From theory to implementation, Pearson Education Limited, ISBN 0201 70945 7,2004
2. Roy Osherove: The Art of Unit Testing, Second Edition, November 2013 ISBN 9781617290893 296 pages
3. Stephen H. Kan:, Metrics and Models in Software Quality Engineering (2nd Edition), ISBN 978-0201729153, 2002
4. Capers Jones: Applied Software Measurement: Global Analysis of Productivity and Quality, ISBN 978-0071502443, 2008,
5. Martin Fowler: Refactoring Improving the Design of Existing Code, Addison-Wesley Professional; 2nd ed. edition, 2018, ISBN 978-0134757599

List of all those professional competences and elements (knowledge, skills etc) which the course most significantly contributes to:

a) knowledge
- Having an English language proficiency sufficient to complete the programme, review English language literature, to comprehend and process texts of specific vocabulary and to perform professional tasks being qualified for as well as to continue professional self-education
- Knowledge of widely applicable problem-solving techniques required to develop technical IT systems

b) skills
- Ability to apply and use the acquired knowledge in practice,
- Ability to use problem-solving techniques for software and application development
- Ability to formulate a valid professional judgment or opinion in IT and engineering fields
- Ability to analyse the performance of IT systems, to use analytical, simulation and measurement methods.
- Understanding of the application requirements

c) attitude
- Ability to perform development tasks at a professionally high level taking quality into consideration, as well as to ascertain the faultlessness of the developed systems
- Examining the opportunities of setting research, development and innovation objectives and striving to achieve them during their work

- Working in a creative and flexible way, recognising and solving problems based on intuition and methodology

d) autonomy and responsibility

- Responsibility for complying with and enforcing deadlines

Course coordinator (*name, position, sci. degree*)**: Dr. Olivér Hornyák associate professor, Ph.D.**
Teachers involved (*name, position, sci. degree*)**: -**

Course: **Introduction to Technical English**	**credits: 3**
Labelling of course: **obligatory**	
Rate of theoretical or practical content: 40-60% (credit%**).**	
Class type: lect. + pract., number of classes/term: **28+28**, (*language***:** *English)* Any other ways of knowledge dissemination (if applied): **Case Report**, **Video-projection / Youtube**	
Assessment (exam/term mark/any other): **term mark** Any other ways of assessment (if applied)**: Thematic presentation**, **Theme developement**	
Frequency of course: **2nd semester**	
Prerequisites: **Intermediate language knowledge**	

Brief description of the course:

Course description:

The subject covers a wide range of lessons on "Classic literature in Technical Science" and "Information Science & Technology" using texts and materials taken from textbooks, newspapers, computer magazines and websites. Classic literature in Technical Science mainly focuses on the comprehensive learning of materials needed to set up students' language skills and ability in classic engineering sciences. The lessons are based on those materials which taken from different textbooks, they include material science, solid mechanics, fluid mechanics, electric, electronic & computer science, oil industry, energy and innovative engineering sciences. The covering topics of Information Science and Technology involve principles on computer architecture, computer application, operating system, application programs, networks, communication systems, and IT (recent and future developments). The main aim of the subject is to provide students' ability in expanding their knowledge in R&D (Research and Development) using the English language.

2-5 compulsory and suggested readings (lecture notes, books), with bibliographic data (author(s), title, publication data, (pages), ISBN)

Required readings:

1. Jamaloddin Jalalipour 2005. *English for the Students of Mechanical Engineering*. The Organization for Researching and Composing University Textbooks in the Humanities (SAMT). ISBN: 964-459-422-3.
2. Eric H. Glendinning–John Mc Ewan 2003. *Oxford English for Information Technology.* Oxford: Oxford University Press. ISBN: 0-19-457375-3.
3. *English for the Students of Engineering – Handbook.* The Organization for Researching and Composing University Textbooks in the Humanities (SAMT). Copies given by the teacher.
4. Presented Lectures.

Recommended readings:

5. Serope Kalpakjian–Steven Schmid 2007. Manufacturing Processes for Engineering Materials. California: Addision-Wesley Longman Inc. ISBN-13: 978-0132272711.
6. Eric H. Glendinning–John Mc Ewan 2006. Oxford English for Information Technology. Oxford: Oxford University Press. ISBN-13: 978-0-19-457492-1.
7. Rao, P. N. 2007. Manufacturing Technology: Foundry, Forming & Welding. Tata McGraw-Hill Publishing Company Limited. ISBN: 0-07-463180-2.

List of all those professional competences and elements (knowledge, skills etc) which the course most significantly contributes to:

a) knowledge

- Having an English language proficiency sufficient to complete the programme, review English language literature, to comprehend and process texts of specific vocabulary and to perform professional tasks being qualified for as well as to continue professional self-education,
- Knowledge of widely applicable problem-solving techniques required to develop technical IT systems.

b) skills

- Ability to reveal and understand general rules and relationships.,
- Ability to apply and use the acquired knowledge in practice.,
- Ability to process new problems and phenomena arising on the boundaries of knowledge of sciences related to information technology.

c) attitude

- Examining the opportunities of setting research, development and innovation objectives and striving to achieve them during their work.,
- Working in a creative and flexible way, recognising and solving problems based on intuition and methodology.

d) autonomy and responsibility

- Ability to work in team, as a specialist in a subfield, and lead a team in a responsible way.

Course coordinator (*name, position, sci. degree*)**: Dr Samad Dadvandipour**, associate professor, PhD.
Teachers involved (*name, position, sci. degree*)**: -**

Course: **Mobile Communications**	**credits: 4**
Labelling of course: **obligatory**	
Rate of theoretical or practical content: 50-50 (credit%)	
Class type: lect. + pract., number of classes/term: 28+28, (*language***:** *English)* Any other ways of knowledge dissemination (if applied): -	
Assessment (exam/term mark/any other): exam Any other ways of assessment (if applied): Midterm	
Frequency of course: **3rd semester**	
Prerequisites: -	

Brief description of the course:

An overview of the development of mobile communications systems. The mobile radio channel characterization (types, classification and model). Propagation characteristics for mobile radio channel (propagation and simulation model). The propagation attenuation and fading. Diversity techniques. The concept of multiple accesses (FDMA, TDMA, CDMA). Modulation and channel coding procedures. The spread spectrum modulation. Public and closed cellular radio systems: GSM (HSCSD, GPRS), TETRA, DECT, UMTS/IMT-2000. Cellular GSM mobile system. Background and standardization of WCDMA. UMTS services and applications (multimedia, video phone, image, etc.). Radio access network (UTRAN) and architecture. Mobile network design. Mobile ATM, wireless data transmission (mobile IP), WAP, Ad hoc networks, WLAN networks. Mobility security issues. Call routing and mobility management. QoS in the 3-G systems. 4-G systems.

2-5 compulsory and suggested readings (lecture notes, books), with bibliographic data (author(s), title, publication data, (pages), ISBN)

1. Mischa Schwartz.: Mobile Wireless Communications. Cambridge University Press, 2005. pp 457. ISBN 0-521-84-347-2.
2. V.Jeyasri Arokiamary.: Cellular and Mobile Communications, Technical Publications, 2009. pp. 468. ISBN 978-8-184-31585-1.
3. Christopher Cox.: An Introduction to LTE: LTE, LTE-Advanced, SAE and 4G Mobile Communications. ,Wiley, 2012. pp. 352. ISBN 978-1-119-97038-5.
4. Jochen Schiller: Mobile Communications, Pearson Education,2000. pp.416. ISBN 978-0-321-12381-7
5. Jochen Schiller: Mobile Communications, https://drive.google.com/file/d/0B7m9AIM_MgGKdFBUUzNPMktsM1U/view
6. Christopher Cox.: An introduction to LTE : LTE, LTE-advanced, SAE and 4G mobile communications, http://honorcup.ru/upload/iblock/542/542b5f58788c60b2864ffe71d920e820.pdf

List of all those professional competences and elements (knowledge, skills etc) which the course most significantly contributes to:

a) knowledge

- Having an English language proficiency sufficient to complete the programme, review English language literature, to comprehend and process texts of specific vocabulary and to perform professional tasks being qualified for as well as to continue professional self-education
- A deeper theoretical and practical knowledge in one or more of the following fields within information technology, depending on their specialization: software design, system simulation and modelling, communication networks, mobile and resource constrained applications, computer graphics and image processing, critical and embedded systems, media information technology, IT security, parallel systems, intelligent systems, computational theory, databases

b) skills

- Ability to reveal and understand general rules and relationships
- Ability to use the tools and formal methods of information technology on a skill level

c) attitude

- Ability to perform development tasks at a professionally high level taking quality into consideration, as well as to ascertain the faultlessness of the developed systems
- Openness and commitment to self-education, self-development, to deepen and extend their own knowledge and understanding in the field of natural, engineering and information sciences

- Initiative to solve problems, ability to make informed decisions, not avoiding personal responsibility
- Assessing their subordinates' and their own performance in a realistic and unbiased way

d) autonomy and responsibility

- Responsibility for complying with and enforcing deadlines
- Ability to work in team, as a specialist in a subfield, and lead a team in a responsible way
- Ability to develop and operate systems containing operational critical and sensitive information based on their professional competencies

Course coordinator (*name, position, sci. degree*)**: Dr. Amadou Kane, associate professor, CSc**

Teachers involved (*name, position, sci. degree*)**: -**

Course: **Data Analysis and Data Mining**	**credits: 4**
Labelling of course: **Compulsory optional**	
Rate of theoretical or practical content: 60-40% (credit%)	
Class type: lect. + pract., number of classes/term: **28+28**, (*language***:** *English)* Any other ways of knowledge dissemination (if applied): practice in statistics	
Assessment (exam/term mark/any other): Exam Any other ways of assessment (if applied)**:** development of OLAP and DM solutions	
Frequency of course: **3rd semester**	
Prerequisites: -	

Brief description of the course:

Overview of data analysis tools and levels, basic statistical tools, Bayesian network, comparison of OLAP and OTLP; decision support tools, MD data model, semantic MD models, MD algebra, Oracle PE OLAP commands, programming MD databases in PE, Overview of MDX language; basic MDX queries, derived sets and measures; ETL processes, Overview of data mining, Data clustering methods, SOM, data classification methods, BPNN, SVM, mining association rules, detection of outliers, dimension reduction methods, PCA.

2-5 compulsory and suggested readings (lecture notes, books), with bibliographic data (author(s), title, publication data, (pages), ISBN)

1. Han: Data Mining: Concepts and Techniques , The Morgan Kaufmann Publ, 2011
2. Robert Wrembel, Christian Koncilia: Data Warehouses and OLAP: Concepts, Architectures and Solutions, IGI, 2007
3. Aggarwal, Charu C.: Data Mining, The Textbook, Springer, 2015
4. Moodle homepage of the course, course materials, moodle.iit.uni-miskolc.hu
5. https://www.kdnuggets.com/data_mining_course/index.html (introductory course on Data Mining)
6. https://cognitiveclass.ai/courses/data-science-methodology-2/ (data science methodology)

List of all those professional competences and elements (knowledge, skills etc) which the course most significantly contributes to:

a) knowledge
- Having an English language proficiency sufficient to complete the programme, review English language literature, to comprehend and process texts of specific vocabulary and to perform professional tasks being qualified for as well as to continue professional self-education
- Knowledge of widely applicable problem-solving techniques required to develop technical IT systems.
- An understanding of the principle of the scientific and engineering methods required for the development of IT applications.

b) skills
- Ability to reveal and understand general rules and relationships.
- Ability to apply and use the acquired knowledge in practice.
- Ability to use problem-solving techniques for software and application development
- Expertise, analysis, design and implementation skills of their specialization

c) attitude
- Ability to perform development tasks at a professionally high level taking quality into consideration, as well as to ascertain the faultlessness of the developed systems.
- Openness and commitment to self-education, self-development, to deepen and extend their own knowledge and understanding in the field of natural, engineering and information sciences.
- Examining the opportunities of setting research, development and innovation objectives and striving to achieve them during their work.

d) autonomy and responsibility
- Holding an IT position independently, maintaining the whole workflow in a professionally responsible way.
- Ability to work in team, as a specialist in a subfield, and lead a team in a responsible way.

Course coordinator (*name, position, sci. degree*)**: Dr. László Kovács, associate professor, Ph.D.**

Teachers involved (*name, position, sci. degree*)**: Dr. Erika Varga, Baksáné, associate professor, Ph.D.**

Course: **Text Mining and Analysis**	**credits: 4**
Labelling of course: **Compulsory optional**	
Rate of theoretical or practical content: 50-50% (credit%)	
Class type: lect. + pract., number of classes/term: **28+28**, (*language***:** *English)* Any other ways of knowledge dissemination (if applied): -	
Assessment (exam/term mark/any other): exam Any other ways of assessment (if applied)**:** course project and poster presentation	
Frequency of course: **4th semester**	
Prerequisites: -	

Brief description of the course:

Text mining is a special field of data mining where information needs to be retrieved, extracted and summarized from unstructured textual data. Therefore the document representation models are introduced first with special attention to the vector space model. The steps of building a vector space model are studied including tokenization, stemming and lemmatizing, the weight of terms and the TF-IDF measure, term-document matrix and the techniques for reducing its dimensions (feature selection and feature extraction methods), and similarity measures of documents. Then classic information retrieval and extraction methods are matched to text mining problems. The clustering and classification of documents are the next issues to consider, mentioning here the standards and benefits of using ontologies. Also text summarization and abstraction methods are examined. At last but not least the operation of web search engines is analyzed. During the course students get an insight into the text mining capabilites of the R language.

2-5 compulsory and suggested readings (lecture notes, books), with bibliographic data (author(s), title, publication data, (pages), ISBN)

1. Charu C. Aggarwal and ChengXiang Zhai Editors: Mining Text Data, ISBN 978-1-4614-3222-7, Springer 2012.
2. D. Jurafsky and J. H. Martin: Speech and Language Processing, web.stanford.edu/~jurafsky/slp3/
3. J. Silge and D. Robinson: Text Mining with R, O'Reilly, 2017.

List of all those professional competences and elements (knowledge, skills etc) which the course most significantly contributes to:

a) **knowledge**
- Having an English language proficiency sufficient to complete the programme, review English language literature, to comprehend and process texts of specific vocabulary and to perform professional tasks being qualified for as well as to continue professional self-education
- Knowledge of widely applicable problem-solving techniques required to develop technical IT systems

b) **skills**
- Ability to apply and use the acquired knowledge in practice
- Ability to cooperate with the experts in the application environment in a professional way

c) **attitude**
- Openness and commitment to self-education, self-development, to deepen and extend their own knowledge and understanding in the field of natural, engineering and information sciences
- Working in a creative and flexible way, recognising and solving problems based on intuition and methodology

d) **autonomy and responsibility**
- Responsibility for complying with and enforcing deadlines
- Holding an IT position independently, maintaining the whole workflow in a professionally responsible way

Course coordinator (*name, position, sci. degree*)**: Dr. Erika Varga, Baksáné, associate professor, Ph.D.**

Teachers involved (*name, position, sci. degree*)**: -**

Course: **Parallel algorithms**	**credits:** 4
Labelling of course: **Compulsory optional**	
Rate of theoretical or practical content: 50-50% (credit%)	
Class type: lect. + pract., number of classes/term: 28+28, (*language***:** *English)* Any other ways of knowledge dissemination (if applied): -	
Assessment (exam/term mark/any other): exam Any other ways of assessment (if applied): -	
Frequency of course: **3rd semester**	
Prerequisites: -	

Brief description of the course:

Parallel architectures, parallel softwares and environments. Data parallelism. Algorithms of matrices, directions. Communication of processes. Pipeline communication, methods for system of linear equations. Data partitioning. Synchronous parallelism. Relaxed methods and algorithms. Multicomputer architectures, message-passing programs. Parallel numeric algorithms. Parallel Virtual Machine. MPI standard. Jcluster in Java.

2-5 compulsory and suggested readings (lecture notes, books), with bibliographic data (author(s), title, publication data, (pages), ISBN)

1. Bruce P. Lester: The Art of Parallel Programming, 1st World Publishing, Inc.; 2nd edition, 568 pages, ISBN-10: 1595408398, ISBN-13: 978-1595408396, 2006.
2. Al Geist, Adam Beguelin, Jack Dongarra, Weicheng Jiang, Robert Manchek, Vaidy Sunderamarga: PVM: Parallel Virtual Machine, MIT Press, 298 pages, 1994.
3. Iványi Antal: Párhuzamos algoritmusok, ELTE Eötvös Kiadó, Budapest, ISBN: 963 463 759 0, 330 oldal, 2005.

List of all those professional competences and elements (knowledge, skills etc) which the course most significantly contributes to:

a) **knowledge:**
- Knowledge of widely applicable problem-solving techniques required to develop technical IT systems
- A deeper theoretical and practical knowledge in one or more of the following fields within information technology, depending on their specialization: software design, system simulation and modelling, communication networks, mobile and resource constrained applications, computer graphics and image processing, critical and embedded systems, media information technology, IT security, parallel systems, intelligent systems, computational theory, databases.

b) **skills:**
- Ability to apply and use the acquired knowledge in practice.
- Ability to recognise and solve routine problems, as well as to come up with original ideas.
- Understanding of the application requirements.

c) **attitude:**
- Openness and commitment to self-education, self-development, to deepen and extend their own knowledge and understanding in the field of natural, engineering and information sciences.
- Initiative to solve problems, ability to make informed decisions, not avoiding personal responsibility.
- Examining the opportunities of setting research, development and innovation objectives and striving to achieve them during their work.

d) **autonomy and responsibility:**
- Responsibility for complying with and enforcing deadlines.
- Holding an IT position independently, maintaining the whole workflow in a professionally responsible way.
- Ability to develop and operate systems containing operational critical and sensitive information based on their professional competencies.

Course coordinator (*name, position, sci. degree*)**: Dr. Péter Olajos**, associate professor, Ph.D.

Teachers involved (*name, position, sci. degree*)**: -**

Course: **Mobile Application Development**	**credits: 4**
Labelling of course: **Obligatory**	
Rate of theoretical or practical content: 50-50% (credit%)	
Class type: lect. + pract., number of classes/term: **28+28**, (*language***:** *English)* Any other ways of knowledge dissemination (if applied): **computer exercises with usage of mobile phone**	
Assessment (exam/term mark/any other): **exam** Any other ways of assessment (if applied): -	
Frequency of course: **4th semester**	
Prerequisites: -	

Brief description of the course:

The purpose of the Mobile Application Developement is to learn the basic programming techniques on Android systems. The main topics are the followings: Android basics, overview, Structure of Android applications, building graphical user interfaces, making animations, putting vector graphics, media elements into user interface, overview of activities, fragments, intents, services, broadcase receivers, passing parameters to activities, fragments, handling return values, overview of data binding framework, calling web services, introducing google play services, overview of sensors of devices, publishing applications into Google Play Store.

2-5 compulsory and suggested readings (lecture notes, books), with bibliographic data (author(s), title, publication data, (pages), ISBN)

Reto Meier: Professional Android Application Development, ISBN: 978-0-470-34471-2
Ed Burnette: Hello, Android (4th edition), Introducing Google's Mobile Development Platform, ISBN: 978-1-68050-037-0

List of all those professional competences and elements (knowledge, skills etc) which the course most significantly contributes to:

a) knowledge
- Knowledge of widely applicable problem-solving techniques required to develop technical IT systems
- An understanding of the principle of the scientific and engineering methods required for the development of IT applications
- A deeper theoretical and practical knowledge in one or more of the following fields within information technology, depending on their specialization: software design, system simulation and modelling, communication networks, mobile and resource constrained applications, computer graphics and image processing, critical and embedded systems, media information technology, IT security, parallel systems, intelligent systems, computational theory, databases

b) skills
- Ability to apply and use the acquired knowledge in practice
- Ability to use problem-solving techniques for software and application development
- Understanding of the application requirements
- Ability to explain suggestions to the experts in the application environment

c) attitude
- Ability to perform development tasks at a professionally high level taking quality into consideration, as well as to ascertain the faultlessness of the developed systems
- Initiative to solve problems, ability to make informed decisions, not avoiding personal responsibility

d) autonomy and responsibility
- Responsibility for complying with and enforcing deadlines
- Ability to work in team, as a specialist in a subfield, and lead a team in a responsible way

Course coordinator (*name, position, sci. degree*)**: Dr. Péter Barabás, lecturer, PhD**

Teachers involved (*name, position, sci. degree*)**: -**

Course: **Graphics Programming**	**credits: 4**
Labelling of course: **Obligatory**	
Rate of theoretical or practical content: 50-50% (credit%)	
Class type: lect. + pract., number of classes/term: **28+28,** (*language***:** *English)* Any other ways of knowledge dissemination (if applied): -	
Assessment (exam/term mark/any other): exam Any other ways of assessment (if applied): -	
Frequency of course: **3rd semester**	
Prerequisites: -	

Brief description of the course:

Computer graphics fundamentals; Framebuffer; Platform specific display, the pipeline model of the graphics card; Resources, memory management. Drawing states, overview of Developer Tools and Platforms, Programming graphics cards in OpenGL environment; Elements of graphics rendering in platform independent environment; Texturing basics;The general structure and design of a graphical game engine. Relationship of models and entities. 2D visualization, animation, visibility and collision detection; Font management; Image synthesis, and graphics frameworks designs questions in 3D environments; Camera handling and speed optimization. Multi-texturing; Lightning and shadows; Visibility algorithms and space subdivision; Terrain mapping, Particle System. Applying the GLSL shading language. Dynamic lighting, shadows, post-processing effects using GLSL. Alternative display technologies: ray tracing, voxel-based visualization. Extending game engine with scripting.

2-5 compulsory and suggested readings (lecture notes, books), with bibliographic data (author(s), title, publication data, (pages), ISBN)

1. Andre LaMothe, Tricks of the 3D Game Programming Gurus-Advanced 3D Graphics and Rasterization, Sams publisher, 2003, 978-0672318351.
2. David H. Eberly, 3D Game Engine Design: A Practical Approach to Real-Time Computer Graphics (Morgan Kaufmann Series in Interactive 3D Technology) [Hardcover], CRC Press; 2 edition, 2006, 978-0122290633.
3. Jason Gregory, Game Engine Architecture [Hardcover], A K Peters/CRC Press, 2009, 978-1568814131.
4. Tomas Akenine-Moller, Eric Haines, Naty Hoffman, Real-Time Rendering (Third Edition),A K Peters/CRC Press, 978-1568814247.
5. Learn Opengl: https://learnopengl.com/, 2018.
6. LWJGL obline book: https://github.com/lwjglgamedev/lwjglbook, 2018.
7. Unity Game Engine: https://unity3d.com/, 2018.

List of all those professional competences and elements (knowledge, skills etc) which the course most significantly contributes to:

a) **knowledge**
- A deeper theoretical and practical knowledge in one or more of the following fields within information technology, depending on their specialization: software design, system simulation and modelling, communication networks, mobile and resource constrained applications, computer graphics and image processing, critical and embedded systems, media information technology, IT security, parallel systems, intelligent systems, computational theory, databases

b) **skills**
- Ability to process new problems and phenomena arising on the boundaries of knowledge of sciences related to information technology

c) **attitude**
- Openness and commitment to self-education, self-development, to deepen and extend their own knowledge and understanding in the field of natural, engineering and information sciences

d) **autonomy and responsibility**
- Responsibility for complying with and enforcing deadlines

Course coordinator (*name, position, sci. degree*)**: Dr. Péter Mileff, associate professor, PhD**

Teachers involved (*name, position, sci. degree*)**: -**

Course: **Physical Basis of Information Technology**	**credits: 4**
Labelling of course: **Obligatory**	
Rate of theoretical or practical content: 50-50% (credit%)	
Class type: lect. + pract., number of classes/term: **28+28,** (*language***:** *English)* Any other ways of knowledge dissemination (if applied): -	
Assessment (exam/term mark/any other): exam Any other ways of assessment (if applied): -	
Frequency of course: **2nd semester**	
Prerequisites: -	

Brief description of the course:

The course is an introduction to the fundamental concepts, phenomena, models and laws of electrodynamics and modern physics, especially some basic elements of condensed matter physics. Based on these the students can understand the operation of the most important parts of the computer hardware, e.g. the CPU and the hard disk.

Course coordinator (*name, position, sci. degree*)**: Dr. Endre Kovács, associate professor, PhD**