UNIVERSITY OF BANJA LUKA
FACULTY OF ELECTRICAL ENGINEERING

“PhD in Information and Communication Technology”

MODULES AND COURSES

Banja Luka, May 2016

CURRICULUM

Important: All courses are elective. By choosing one profile, the courses of that module become mandatory and they are marked as “Main module course” in the table, while courses that student chooses from other modules are marked as “Elective course”. Independent student’s work is not included in the number of research hours stated in the table, but only the work with the mentor.

No	COURSE	semester	ECTS	Hours per week
1	Main module course/ Elective course	I	6	2+1
2	Main module course/	I	6	2+1
3	Main module course/	I	6	2+1
4	Main module course/	I	6	2+1
5	Research	I	6	8
Total I semester			**30**	**20**
6	Main module course/	II	6	2+1
7	Main module course/	II	6	2+1
8	Main module course/	II	6	2+1
9	Main module course/	II	6	2+1
10	Research	II	6	8
Total II semester			**30**	**25**
11	Research	III	30	25
Total III semester			**30**	**25**
12	Research	IV	30	25
Total IV semester			**30**	**25**
10	Research	V	30	25
Total V semester			**30**	**25**
10	Research	VI	30	25
Total VI semester			**30**	**25**

MODULES, COURSES AND LECTURERS

Module	Course title	Name of the lecturer
Software Technologies	Model Driven Software Developement	Dr. Dražen Brđanin, Assistant Professor
	Advanced Concepts in Databases	Prof. Dr. Slavko Marić, Full Professor
	Selected Topics in Internet Programming	Prof. Dr. Zoran Đurić, Associate Professor
	Scientific Computing	Prof. Dr. Momir Ćelić, Full Professor
Software Engineering	Multimedia Security Operating Systems	Prof. Dr. Ratko Dejanović, Full Professor
	Graph Theory	Dr. Duško Jojić, Assistant Professor
	Component-Based Software Engineering	----------
	Simulation	----------
Multimedia	Advanced Multimedia Processing	Prof. Dr. Zdenka Babić, Full Professor
	Multimedia Information Retrieval and Management	Dr. Vladimir Risojević, Assistant professor
	Artificial Intelligence	Prof. Dr. Milorad Božić, Full Professor
	Multi- and many-core processors for multimedia	Prof. Dr. Patricio Bulić, Associate Professor
Communications	Internet of Things Technologies and Applications	Prof. Dr. Gordana Gardašević, Associate Professor
	Advanced Topics in Internet Technologies	Dr. Pavle Vuletić, Assistant Professor
	Cryptography and Computer Systems Security	Prof. Dr. Zoran Djurić, Associate Professor
	Speech Processing and Transmission	Prof. Dr. Vlado Delić, Full Professor

Elective courses:

Robot Vision	Prof. Dr. Petar Marić, Full Professor

“PhD in Information and Communication Technology”

MODULES AND COURSES

MODULE DESCRIPTION

Module letter and title	Course number and title	No. of ECTS	Visiting lecturer		Semester	
			yes	no		
A Software Technologies	1 Model Driven Software Developement	6		no	1	
	2 Advanced Concepts in Databases	6		no	1	
	3 Selected Topics in Internet Programming	6		no		2
	4 Scientific Computing	6		no		2

Objectives (Competences):

The students are to become acquainted with fundamental procedures for the construction of large software systems. They will become familiar with tools and techniques for building complex applications and learn about the advantages and disadvantages of formal and informal specification techniques, as well as tuning and improving. They also will be become familiar with scientific computing tools in research.

Module letter and title	Course number and title	No. of ECTS	Visiting lecturer		Semester	
			yes	no		
B Software Engineering	5 Multimedia Security Operating Systems	6		no	1	
	6 Graph Theory	6		no	1	
	7 Component-Based Software Engineering	6	yes			2
	8 Simulation	6	yes			2

Objectives (Competences):

After fulfilling the module, the student should be able to analyze complex system properties in different technologies and give a specific problem based solutions. They also will have full understanding of mathematical methods connected to computer science and their impact on the theory of algorithms.

Module letter and title	Course number and title	No. of ECTS	Visiting lecturer		Semester	
			yes	no		
C Multimedia	9 Advanced Multimedia Processing	6		no	1	
	10 Multimedia Information Retrieval and Management	6		no	1	
	11 Artificial Intelligence	6		no		2
	12 Multi- and many-core processors for multimedia	6	yes			2

Objectives (Competences):

At the end of this module students are expected to have deep knowledge of recent advances in multimedia processing, artificial intelligence and robotics, ability to recognize and validate problems in this scientific field, as well as to demonstrate original, independent and critical analysis. They will become acquainted with relevant research methodologies, techniques and applications in multimedia.

Module letter and title	Course number and title	No. of ECTS	Visiting lecturer		Semester	
			yes	no		
D Communications	13 Internet of Things Technologies and Applications	6		no	1	
	14 Advanced Topics in Internet Technologies	6	yes		1	
	15 Cryptography and computer systems security	6		no		2
	16 Speech Processing and Transmission	6	yes			2

Objectives (Competences):

The objective of this module is to overcome the gap between the existing state and actual needs in wireless communication, internet technologies and security in ICT.

COURSE SYLLABUS

<table>
<tr><th colspan="3">Course Syllabus</th></tr>
<tr><td colspan="2">Course Title:</td><td>Model Driven Software Developement</td></tr>
<tr><td colspan="2">Course is</td><td>modified ☐ new ☐</td></tr>
<tr><td colspan="2">Explain relation between workload and ECTS credits:</td><td>6 ECTS
26 hours lectures, 13 hours tutorial, 6 hours of other contact activities and 135 hours of individual work</td></tr>
<tr><td colspan="2">Course Date:
(term and dates if already known):</td><td></td></tr>
<tr><td rowspan="5">Lecturer:</td><td>Lecturer’s name:</td><td>Dr. Dražen Brđanin, Assistant Professor</td></tr>
<tr><td>Office location:</td><td>University of Banja Luka, Faculty of Electrical Engineering, Patre 5, 78000 Banja Luka, BiH</td></tr>
<tr><td>Office hours:</td><td>Working day 10:00 – 14:00 or on appointment</td></tr>
<tr><td>Phone:</td><td>+387 51 221 851</td></tr>
<tr><td>email address:</td><td>bdrazen@etfbl.net</td></tr>
<tr><td colspan="2">Course Type
(e.g. seminar, lecture, lab sessions, etc.)</td><td>Lecture</td></tr>
<tr><td colspan="2">Format
(e.g. once per week, block course, etc. – specify number of course sessions)</td><td>block course</td></tr>
<tr><td colspan="2">Content Description:</td><td>The lecture gives an overview over the different methods for model driven software development. The theoretical knowledge is practiced in tutorials and assignments also with the help of practice-relevant tools (e.g. Together, UPPAAL or SPIN).</td></tr>
<tr><td colspan="2">Assessment Modalities:</td><td>examination</td></tr>
</table>

<table>
<tr><td colspan="2">Learning Outcomes:
(show how course contributes to objectives of the module)</td><td>The students are to become acquainted with fundamental procedures for the construction of large software systems as well as to learn working with practice-relevant tools (e.g. Together, UPPAAL or SPIN), learn about the advantages and disadvantages of formal and informal specification techniques and to realize the necessity for design and abstract representation (specification) for the improvement of the software quality. In particular the paradigm of "Model Driven Development" (also: Model Driven Architecture), which is postulated in the surrounding field of the UML, is explained.</td></tr>
<tr><td colspan="2">Teaching Methods:
Please state how the course will be taught.

Example: This course is taught using a variety of teaching methods including lectures, class discussions, team work, project creation, and electronic discussion (email and website chat room)</td><td>Lectures, assignments and tutorials</td></tr>
<tr><td rowspan="3">Required/ recommended Literature
(include publication details)</td><td>Required book(s)</td><td></td></tr>
<tr><td>Recommended book(s)</td><td>Gamma et.al.: Design Patterns, Addison-Wesley

C. Ghezzi et al.: Fundamentals of Software Engineering, Prentice Hall

G. Berard et.al.: System and Software Verification, Springer</td></tr>
<tr><td>Journals or other material</td><td>T.H. Ng, S.C. Cheung, W.K. Chan, and Y.T. Yu, “Work Experience versus Refactoring to Design Patterns: A Controlled Experiment”, in Proceedings of the 14th ACM SIGSOFT International Symposium on Foundations of Software Engineering SIGSOFT’06/FSE-14), ACM Press, Portland, Oregon, USA, Nov. 2006, pp. 12-22.

A. Zündorf: Rigorous Object Oriented Software Development; Habilitation Thesis, University of Paderborn (2001)

Spivey: The Z Reference Manual. http://spivey.oriel.ox.ac.uk/mike/zrm/zrm.pdf</td></tr>
</table>

		Harel, D. and , H. Kugler al., H. Ehrig et (ed.): The Rhapsody Semantics of Statecharts (or, On the ExecutableCore of the UML)Springer-Verlag, 2004 , 3147 , 325-354

Course Syllabus		
Course Title:		Advanced Concepts in Databases
Course is		modified ☐ new ☐
Explain relation between workload and ECTS credits:		6 ECST 45 contact hours and 135 hours of students' individual work
Course Date: **(term and dates if already known):**		
Lecturer:	Lecturer's name:	Prof. Dr. Slavko Marić, Full Professor
	Office location:	University of Banja Luka, Faculty of Electrical Engineering, Patre 5, 78000 Banja Luka, BiH
	Office hours:	Working day 10:00 – 14:00 or on appointment
	Phone:	+387 51 221 840
	email address:	ms@etfbl.net
Course Type (e.g. seminar, lecture, lab sessions, etc.)		Lecture+seminar+lab sessions.
Format (e.g. once per week, block course, etc. – specify number of course sessions)		Once per week and partly block course
Content Description:		The content of the course will cover the topics at the intersection of database system, operating system, and distributed and parallel computing research and development. The concepts and theory, as well as practice of transaction processing will be studied in details. The effect of different parameters and interaction of different leveles of the system on database application performance will be explored (e.g., index design and concurrency control), and database tuning will be discussed from the hardware to conceptual design, touching on operating systems, transactional subcomponents, index selection, query

		reformulation, normalization decisions, and the comparative advantage of redundant data. Speed up the database performance by parallel processing.
Assessment Modalities:		Homework Problem Solving (40%), project (60%).
Learning Outcomes: (show how course contributes to objectives of the module)		One of the main components of the majority of application s based on ICT technologies are databases. After long period of development of the RDBMS's and accompaning development tools and other supporting software, it's possible to design and develop in technically relatively simple way, robust software systems that work correctly in environments with many concurent users, that are resistent and recoverable from system breakdowns, etc. Often, these application systems put high demands on the speed and throughput of the system. The goal of this course is to study the internals of database systems as an introduction to research and as a basis for rational performance tuning and improving in complex database applications.
Teaching Methods: Please state how the course will be taught. Example: This course is taught using a variety of teaching methods including lectures, class discussions, team work, project creation, and electronic discussion (email and website chat room)		This course will be taught using a variety of teaching methods including lectures, class discussions, team work, project creation.
Required/ recommended Literature (include publication details)	Required book(s)	*Concurrency Control and Recovery in Database Systems* by Bernstein, Hadzilacos, and Goodman, Addison-Wesley, 1987. ISBN 0-201-10715-5. *Database Tuning: principles, experiments, and troubleshooting techniques* by Dennis Shasha and Philippe Bonnet 2002 Morgan Kaufmann Publishers; ISBN: 1558607536
	Recommended book(s)	*TransactionProcessing:Concepts and Techniques*, Jim Andreas Reuter:Morgan Kaufman; 1st edition (1993)

		ISBN:1558601902 *Principles of Distributed Database Systems*, M.Tamer Ozsu and Patrick Valduriez,Prentice-Hall,1999 *Transactional Information Systems:Theory, Algorithms, and the Practice of Concurrency Control and Recovery*, Gerhard Weikum, Gottfried Vossen, The Morgan Kaufmann Series in Data Management Systems, JimGray,Series EditorMay2001,944pages
	Journals or other material	

Course Syllabus		
Course Title:		Selected Topics in Internet Programming
Course is		modified ☐ new ☐
Explain relation between workload and ECTS credits:		6 ECST 45 hours of contact hours and 135 hours of students' individual work
Course Date: **(term and dates if already known):**		-
Lecturer:	Lecturer's name:	Prof. Dr. Zoran Đurić, Associate Professor
	Office location:	Banja Luka
	Office hours:	Working day 10:00 – 14:00 or on appointment
	Phone:	+387 51 221 839
	email address:	zoran@spinter.net
Course Type (e.g. seminar, lecture, lab sessions, etc.)		Lecture + seminar + lab sessions
Format (e.g. once per week, block course, etc. – specify number of course sessions)		- once per week
Content Description:		This course will take participants through the most important issues in Internet programming, including concurrent programming, databases, security, collaborative computing, distributed object-oriented architectures, network publishing, Web technologies, architectures, frameworks, and languages that are used to deliver modern dynamic Web sites and rich Internet applications. Participants will study tools and techniques for building Internet applications, including CGI programming, XML, XSLT, servlets, JSP, JSF, CSS, JavaScript, SOA, Web services, and AJAX. Participants will learn how to develop applications for a

		variety of Web clients, including mobile clients.
Assessment Modalities:		- Solving homework problems - 40% - Project - 40% - Final Exam – 20%
Learning Outcomes: (show how course contributes to objectives of the module)		After completing this course, participants will be able: - To analyze and define specifications of an Internet application - To design, develop and code interactive Internet applications with more than one Internet application programming language, - To develop applications for a variety of Web clients, including mobile clients, using various tools and techniques, - To design, develop and code server-side programs.
Teaching Methods: Please state how the course will be taught. Example: This course is taught using a variety of teaching methods including lectures, class discussions, team work, project creation, and electronic discussion (email and website chat room)		- Lectures - Class discussions - Labs - Team work - Project creation - Email and website discussions
Required/ recommended Literature (include publication details)	Required book(s)	- Core WEB Programming Volume 2, by Hall and Brown; Prentice Hall - J. Mc Govern, S. Tyagi, M. Stevens, S. Mathew - Java WEB Service Architecture
	Recommended book(s)	- Java Web Development Illuminated by Qian, Allen, Gan and Brown; Jones and Bartlett Publishers ISBN 978-0-7637-3423-7
	Journals or other material	http://jsp.org/en/home/index http://java.sun.com/

Course Syllabus		
Course Title:		Scientific Computing
Course is		modified ☐ new ☐
Explain relation between workload and ECTS credits:		6 ECST 45 hours of contact hours and 135 hours of students' individual work
Course Date: **(term and dates if already known):**		-
Lecturer:	Lecturer's name:	Prof. Dr. Momir Celić, Full Professor
	Office location:	University of Banja Luka, Faculty of Electrical Engineering, Patre 5, 78000 Banja Luka, BiH
	Office hours:	Working day 10:00 – 14:00 or on appointment
	Phone:	+38751221831
	email address:	mcelic@etfbl.net
Course Type (e.g. seminar, lecture, lab sessions, etc.)		lecture
Format (e.g. once per week, block course, etc. – specify number of course sessions)		once per week
Content Description:		Introduction to scientific computing Systems of linear equations Linear least squares Eigenvalue problem Nonlinear equations Optimization Interpolation Numerical integration Ordinary differential equations

Assessment Modalities:		examination
Learning Outcomes: (show how course contributes to objectives of the module)		After this course student will be familiar with all the major problems in scientific computing and will be able to use numerical algorithms and software in their research.
Teaching Methods: Please state how the course will be taught. Example: This course is taught using a variety of teaching methods including lectures, class discussions, team work, project creation, and electronic discussion (email and website chat room)		This course is taught using a variety of teaching methods including lectures, class discussions and project creation
Required/ recommended Literature (include publication details)	Required book(s)	M.T. Heath: *Scientific Computing: An Introductory Survey*, McGraw-Hill, New York, Second edition, 2002.
	Recommended book(s)	C.D. Meyer: *Matrix Analysis and Applied Linear Algebra*, SIAM, Philadelphia, 2000. M.V.Ćelić: *Numericka matematika*, Glas srpski, Banja Luka, 2008. D.J. Higham, N.J. Higham, *MATLAB Guide*, SIAM, Philadelphia, 2000.
	Journals or other material	

Course Syllabus		
Course Title:		Multimedia Security Operating Systems
Course is		modified ☐ new ☐
Explain relation between workload and ECTS credits:		6 ECST includes: 26 lecture hours, 19 contact hours for project realization and 135 hours of individual work
Course Date: **(term and dates if already known):**		-
Lecturer:	Lecturer's name:	Prof. dr. Ratko Dejanović, Full Professor
	Office location:	University of Banja Luka, Faculty of Electrical Engineering, Patre 5, 78000 Banja Luka, BiH
	Office hours:	Working day 10:00 – 14:00 or on appointment
	Phone:	+38751 221842
	email address:	ratko@etfbl.net
Course Type (e.g. seminar, lecture, lab sessions, etc.)		Lecture/seminar
Format (e.g. once per week, block course, etc. – specify number of course sessions)		lectures – 13 sessions, projects
Content Description:		Lecture/seminar considers Modern Operating systems focuses on Multimedia Security OS, topics like multimedia files, multimedia process scheduling, multimedia file system paradigms, file placement, caching, disk scheduling for multimedia.
Assessment Modalities:		examination

<table>
<tr><td colspan="2">Learning Outcomes:
(show how course contributes to objectives of the module)</td><td>At the end of this course students will be able to:
• Deeply understand the principle and recent advances in Multimedia Security Operating Systems ;
• Describes the principles underlying both multimedia and security ;
• Discuss the main problems and approaches in this area;
Find a suitable OS solution for complex multimedia and security problems.</td></tr>
<tr><td colspan="2">Teaching Methods:
Please state how the course will be taught.

Example: This course is taught using a variety of teaching methods including lectures, class discussions, team work, project creation, and electronic discussion (email and website chat room)</td><td>The course is taught using lectures, discussing, team work and project creation. The team work focuses on work in small groups on the part of project and their collaboration each to other for whole project.

Copies of project requirements papers will be distributed to the students</td></tr>
<tr><td rowspan="3">Required/ recommended Literature
(include publication details)</td><td>Required book(s)</td><td>A.S. Tanenbaum, “Modern Operating Systems“, Prentice Hall International, 2001</td></tr>
<tr><td>Recommended book(s)</td><td>W. Stallings, “Operating Systems”, Prentice Hall, 2001, others books on OS and Internet sources.</td></tr>
<tr><td>Journals or other material</td><td>Computers, Commun. of the ACM, Symp. On Operating Systems Principles ACM, IEEE Concurrency, Operating Systems Review, Computer Journal.</td></tr>
</table>

Course Syllabus		
Course Title:		Graph Theory
Course is		modified ☐ new ☐
Explain relation between workload and ECTS credits:		6 ECTS 24 hours lectures, 10 hours tutorial, 11 hours of other contact activities and 135 hours of individual work
Course Date: **(term and dates if already known):**		-
Lecturer:	Lecturer's name:	Dr. Duško Jojić, Assistant Professor
	Office location:	
	Office hours:	
	Phone:	
	email address:	ducci68@teol.net
Course Type (e.g. seminar, lecture, lab sessions, etc.)		Lecture/seminar
Format (e.g. once per week, block course, etc. – specify number of course sessions)		Once per week 2 hours lecture plus 2 hours seminar using GrInvIn (this is an interactive software application for studying graphs and their invariants) Planned as Block course in Banjaluka.
Content Description:		The first part of the lecture/seminar considers graph theoretical topics like trees, matching, flows (circulations), connectivity, recursive structures of some graph classes, colorings, and touches some aspects of topological graph theory (embeddings; minors), as well as parts of external graph theory. The last part focuses on algorithmic aspects, the complexity of some decision problems, and gives a short introduction to the algorithmic consequences of the Robertson/Seymour graph minor theory.

Assessment Modalities:		examination
Learning Outcomes: (show how course contributes to objectives of the module)		The students will have full understanding of graph theoretical notions, their connection to theoretical computer science and their impact on the theory of algorithms. Furthermore they will be proficient in using graph theoretical methods.
Teaching Methods: Please state how the course will be taught. Example: This course is taught using a variety of teaching methods including lectures, class discussions, team work, project creation, and electronic discussion (email and website chat room)		The course is taught using lectures, discussing and team work. The team work focuses on the use of GrInvIn (this is an interactive software application for studying graphs and their invariants). Given some graphs and a main invariant (for each student group where each group consists of two students) as input, GrInvIn creates graph theoretical conjectures. Each group has to prove the conjecture or to disprove it by giving a minimum counter-example. I have used this teaching approach before, and it led to an active student discussion about graph theoretical questions. Since the course is taught as a block course it will have lectures (2 hours) and practical work for the students (GrInvIn) (2 hours) alternately, i.e. 2 lect + 2 GrInvIn + 2 lect + 2 GrInvIn (total 8 hours per day) Copies of required original papers will be distributed to the students
Required/ recommended Literature (include publication details)	Required book(s)	R. Diestel: Graph Theory, Graduate Texts in Mathematics, 173. *Springer-Verlag, New York*, 2000 www.grinvin.org (Manual)
	Recommended book(s)	R.L. Graham, M. Grötschel, L. Lovász (ed.) Handbook of Combinatorics, North Holland 1995
	Journals or other material	Journal Combinatorial Theory (Ser. B), Combinatorica, Journal Graph Theory, Discrete Mathematics, Discrete Applied Mathematics, Graphs and Combinatorics

Course Syllabus		
Course Title:		Component-Based Software Engineering
Course is		modified ☐ new ☐
Explain relation between workload and ECTS credits:		6 ECTS 16 hours of lectures, 29 hours of technical reports, seminars and other contact activities and 135 hours of individual work
Course Date: **(term and dates if already known):**		
Lecturer:	Lecturer's name:	
	Office location:	
	Office hours:	
	Phone:	
	email address:	
Course Type (e.g. seminar, lecture, lab sessions, etc.)		Lectures+seminars
Format (e.g. once per week, block course, etc. – specify number of course sessions)		Block course – two blocks + 2 seminars
Content Description:		The lecture gives an overview of software engineering methods for development of component-based systems. An overview of the following topics is given: different component models and technologies, component-based development processes, component compositions: components inter-operability and composition of non-functional properties.

Assessment Modalities:		Project work including a state of the art report
Learning Outcomes: (show how course contributes to objectives of the module)		Advanced knowledge about modelling and designing component-based software systems in different domains, in particular component models for embedded systems. Overview of different component-based technologies. Quality requirements and composition of quality attributes in component-based systems.
Teaching Methods: Please state how the course will be taught. Example: This course is taught using a variety of teaching methods including lectures, class discussions, team work, project creation, and electronic discussion (email and website chat room)		Lectures, assignments, project works and project presentations
Required/ recommended Literature (include publication details)	Required book(s)	
	Recommended book(s)	Ivica Crnkovic and Magnus Larsson, Building Reliable Component-Based Software Systems. - Artech House Publishers
	Journals or other material	Ivica Crnkovic, Magnus Larsson, Otto Preiss, Concerning Predictability in Dependable Component-Based Systems: Classification of Quality Attributes, Architecting Dependable Systems III,, p pp. 257 – 278, Springer, LNCS 3549, Editor(s): R. de Lemos et al. (Eds.):, 2005 Ivica Crnkovic, Michel Chaudron, Stig Larsson Component-based Development Process and Component Lifecycle, Pages, ‚Journal of Computing and Information Technology, vol 13, nr 4, p321-327, University Computer Center, Zagreb, November, 2005 David Garlan, Robert T. Monroe, and David Wile, Acme: Architectural Description of Component-Based Systems, Foundations of Component-Based Systems, Gary T. Leavens and Murali Sitaraman (eds), Cambridge University Press, 2000, pp. 47-68.

		Scott Hissam, Gabriel Moreno, Judith Stafford, & Kurt Wallnau. Packaging Predictable Assembly with Prediction-Enabled Component Technology (CMU/SEI-2001-TR-024).

Course Syllabus		
Course Title:		Simulation
Course is		modified ☐ new ☐
Explain relation between workload and ECTS credits:		6 ECTS 24 hours lectures, 10 hours tutorial, 11 hours other contact activities, 135 hours of individual work
Course Date: **(term and dates if already known):**		-
Lecturer:	Lecturer's name:	
	Office location:	
	Office hours:	
	Phone:	
	email address:	
Course Type (e.g. seminar, lecture, lab sessions, etc.)		Lecture/seminar
Format (e.g. once per week, block course, etc. – specify number of course sessions)		Once per week 2 hours lecture plus 2 hours seminar for practical approach (existing, interactive software for material flow simulation can be used) Planned as Block course in Banjaluka
Content Description:		The first part of the lecture gives an overview on simulation topics, methods and application areas, e.g. Monte-Carlo Simulation in the finance area. Afterwards, the course as well as the assigned seminar will focus on the discrete, event-oriented material flow simulation, with focus on theory as well as application for management as well as simulation experts (experimental design, simulation study procedure model, etc.)
Assessment Modalities:		examination

Learning Outcomes: (show how course contributes to objectives of the module)		The students will have an overview about simulation methods, techniques as well as their specific application areas and fundamental knowledge about the discrete, event-oriented simulation, applicable for the design, control and improvement for material flows. Furthermore, they are able to use and refine the most known tools in this area: graphic oriented simulation tools, based on existing building blocks.
Teaching Methods: Please state how the course will be taught. Example: This course is taught using a variety of teaching methods including lectures, class discussions, team work, project creation, and electronic discussion (email and website chat room)		The course is taught using lectures, discussing and team work. The team work will focus on the practical part in the seminar. Groups of students are to work on specific areas, dealt with in the lecture part. Since the course is taught as a block course it will have lectures (2 hours) and practical work for the students (2 hours) alternately, i.e. 2 lect + 2 seminar+ 2 lect + 2 seminar(total 8 hours per day)
Required/ recommended Literature (include publication details)	Required book(s)	Law A., Kelton D.: Simulation Modeling and Analysis. McGraw-Hill, 3rd Edition, 2000.
	Recommended book(s)	Banks, J.: Handbook of Simulation: Modelling, Estimation and Control, Wiley & Sons, 1998
	Journals or other material	-

Course Syllabus		
Course Title:		Multi- and many-core processors for multimedia
Course is		modified √ new □
Explain relation between workload and ECTS credits:		6 ECTS 26 hours lectures, 13 hours tutorial, 6 hours of other contact activities and 135 hours of individual work
Course Date: **(term and dates if already known):**		
Lecturer:	Lecturer's name:	Prof. Dr. Patricio Bulić, Associate Professor
	Office location:	
	Office hours:	
	Phone:	+386 1 4768 361
	email address:	patricio.bulic@fri.uni-lj.si
Course Type (e.g. seminar, lecture, lab sessions, etc.)		Lecture
Format (e.g. once per week, block course, etc. – specify number of course sessions)		block course
Content Description:		The high number of parallel cores poses a great challenge for software design that must expose massive parallelism to benefit from the new hardware. We will describe the modern GPUs that are a highly parallel, highly multithreaded multiprocessor optimized for visual computing. The aim of this course is to teach practical multimedia algorithms design for processors with massively parallel computing resources. Content description: • Introduction to multi- and many-core processors' architecture.

		• GPU System Architectures • CUDA and OpenCL programming in C for GPU architecture. • Programs and Kernels. Memory hierarchy. • Parallelization of two- and three-dimensional imaging. • Parallelization of computer-vision algorithms. • Image and video categorization on massively parallel processors. • Best practices in GPU-based image and video processing. • GPU-based medical image computing techniques. • Reading and discussing research papers.
Assessment Modalities:		examination
Learning Outcomes: (show how course contributes to objectives of the module)		This course is designed for students in all disciplines to learn the essence of these programming interfaces CUDA and OpenCL and how they should orchestrate the use of these interfaces to achieve application goals. After finishing the course, the students will be able to develop multimedia algorithms (image and video processing, medical imaging, etc.) for massively parallel processors.
Teaching Methods: Please state how the course will be taught. Example: This course is taught using a variety of teaching methods including lectures, class discussions, team work, project creation, and electronic discussion (email and website chat room)		Lectures, assignments and tutorials
Required/ recommended Literature (include publication details)	Required book(s)	
	Recommended book(s)	David Kirk and Wen-mei Hwu . Programming Massively Parallel Processors: A Hands-on Approach (Applications of GPU Computing Series), Morgan Kaufmann (Elsevier), ISBN 0123814723.
	Journals or other material	1. van den Sande K.E.A., Gevers T., Snoek

C.G.M. Empowering Visual Categorization With the GPU. *IEEE Transactions on Multimedia*, Vol. 13, No. 1, pp. 60-70, 2011.
2. Lin Shi, Wen Liu, Heye Zhang, Yongming Xie, Defeng Wang. A survey of GPU-based medical image computing techniques. *Quantitative Imaging in Medicine and Surgery*, Vol 2, No. 3. 2012.
3. Brown J.A., Capson D.W. A Framework for 3D Model-Based Visual Tracking Using a GPU-Accelerated Particle Filter, *IEEE Transactions on Visualization and Computer Graphics*, Vol. 18, No. 1, pp. 68-80, 2012.
4. Burger K., Ferstl F., Theisel H., Westermann R. Interactive Streak Surface Visualization on the GPU, *IEEE Transactions on Visualization and Computer Graphics*, Vol. 15, No. 6, pp. 1259-1266, 2009.
5. Markus Happe, Enno Lübbers, Marco Platzner. A self-adaptive heterogeneous multi-core architecture for embedded real-time video object tracking. *Journal of Real-Time Image Processing*, July 2011.
6. Ke-Yan Liu, Yun-Hua Li, Shanqing Li, Liang Tang, Lei Wang. A new parallel particle filter face tracking method based on heterogeneous system. *Journal of Real-Time Image Processing*, September 2012, Volume 7, Issue 3, pp 153-163.
7. Chen-Kuo Chiang et al. Fast JND-Based Video Carving with GPU Acceleration for Real-Time Video Retargeting. *IEEE Transactions On Circuits And Systems For Video Technology*, Vol. 19, No. 11, 2009,
8. S. Avidan and A. Shamir, "Seam carving for content-aware image resizing," *ACM Trans. Graph.*, vol. 26, no. 3, 2007.
9. M. Rubinstein, A. Shamir, and S. Avidan, "Improved seam carving for video retargeting," *ACM Trans. Graph.*, vol. 27, no. 3, Aug. 2008.
10. Rok Češnovar, Vladimir Risojević, Zdenka Babić, Tomaž Dobravec, Patricio Bulić. A GPU Implementation of a Structural-Similarity-Based Aerial-Image Classification. to appear in *Journal of Supercomputing*, 2013.

Course Syllabus		
Course Title:		Advanced Multimedia Processing
Course is		modified ☐ new ☐
Explain relation between workload and ECTS credits:		6 ECST includes: 26 lecture hours, 19 contact hours for project realization and 135 hours of individual work
Course Date: **(term and dates if already known):**		-
Lecturer:	Lecturer's name:	Prof. Dr. Zdenka Babić, Full Professor
	Office location:	University of Banja Luka, Faculty of Electrical Engineering, Patre 5, 78000 Banja Luka, BiH
	Office hours:	Working day 08:00 – 15:30 or on appointment
	Phone:	+387 51 221 846
	email address:	zdenka@etfbl.net
Course Type (E.g. seminar, lecture, lab sessions, etc.)		lectures, projects
Format (e.g. once per week, block course, etc. – specify number of course sessions)		once per week
Content Description:		Multimedia data acquisition. Compressive sensing. Information fusion. Emerging mathematical methods used for multimedia signal processing. Advanced methods of image and video enchancement and restoration. Image segmentation. Motion segmentation, estimation and tracking. Multimedia compression. Application-specific multimedia architecture.

Assessment Modalities:		Project work including a state of the art report
Learning Outcomes:		At the end of this course students will be able to: • Deeply understand the principle and recent advances in multimedia processing; • Describe the computational principles underlying both current and emerging multimedia signal processing tasks; • Discuss the main problems and approaches in the area of multimedia processing; • Find a suitable solution for complex multimedia processing problem.
Teaching Methods:		This course is taught using a combination of teaching methods including lectures, class discussions, working on projects and project presentations.
Required/ recommended Literature	Required book(s)	
	Recommended book(s)	1. L. Guan, S.-Y. Kung, J. Larsen, *Multimedia Image and Video Processing*. CRC Press, 2001. 2. Vaseghi, Saeed V. *Multimedia signal processing: Theory and applications in speech, music and communications*. John Wiley & Sons, 2007. 3. Bovik, Alan C. *Handbook of image and video processing*. Academic press, 2010. 4. Plataniotis, Konstantinos, and Anastasios N. Venetsanopoulos. *Color image processing and applications*. Springer Science & Business Media, 2013. 5. Mandal, M. Kr. *Multimedia signals and systems*. Vol. 716. Springer Science & Business Media, 2002. 6. Tekalp, A. M. *Digital video processing*. Prentice-Hall, Inc., 1995. 7. Spanias, Andreas, Ted Painter, and Venkatraman Atti. *Audio signal processing and coding*. John Wiley & Sons, 2006.
	Journals or other material	indexed journal and conference papers on multimedia, image processing, and signal processing

Course Syllabus		
Course Title:		Robot Vision
Course is		modified ☐ new ☐
Explain relation between workload and ECTS credits:		6 ECST 45 hours of contact hours and 135 hours of students' individual work
Course Date: **(term and dates if already known):**		-
Lecturer:	Lecturer's name:	Prof. Dr. Petar Marić, Full Professor
	Office location:	University of Banja Luka, Faculty of Electrical Engineering (2nd floor, room no. 213)
	Office hours:	Working day 08:00 – 15:30 or on appointment
	Phone:	00 387 65 923 280
	email address:	pmaric@etfbl.net
Course Type (e.g. seminar, lecture, lab sessions, etc.)		The course will be done by combination of lectures and laboratory sessions. Every student is obligated to prepare the seminar work.
Format (e.g. once per week, block course, etc. – specify number of course sessions)		The lectures and laboratory exercises will be done once or twice per week, depending of final semesters' scheduling.
Content Description:		Introduction. An overview of computer integrated manufacturing. Perspective transformation. Robot Kinematics. Camera technology. Camera Models. Camera Calibration. Stereo vision. 3D Reconstruction. Image Segmentation. Edge detection. Binary image processing. Tracking of moving objects. Visual Control.

Assessment Modalities:		During course lectures every student has give presentation of idea and general structure of his\her seminar work. Before final written exam student is obligated to finish and present seminar work. On demand of a student oral exam will be done, instead of written one.
Learning Outcomes: (show how course contributes to objectives of the module)		Upon completion of this course, the students will be familiar with fundamental principles of robotics, automation and computer integrated manufacturing. Furthermore, they will get deep knowledge of robotic vision in particular on image enhancement and image analysis and image based control.
Teaching Methods: Please state how the course will be taught. Example: This course is taught using a variety of teaching methods including lectures, class discussions, team work, project creation, and electronic discussion (email and website chat room)		The course will be taught throughout lectures which will include: teaching about theoretical state of art in the topics, class discussions and illustrative laboratory exercises. Furthermore, team work will be promoted by students' short presentation and discussions about seminar work of every student. All activities will be supported by the LMS (Learning Management System) at Faculty of Electrical Engineering.
Required/ recommended Literature (include publication details)	Required book(s)	1. L. Scilavicco, B. Siciliano, Modelling and Contrtol of Robot Manipulators, 2nd Edition, Springer, 2000. 2. S. E. Palmer, Vision Science, MIT Press, 1999. 3. O. Faugeras, Three-dimensional Computer Vision, MIT Press, 1993. 4. R. Jain et al., Machine Vision, McGraw-Hill, 1995. 5. Hartly R., Zissermann A., Multiple View Geometry in Computer Vision, Cambridge, 2001
	Recommended book(s)	1. Berthold Horn, Robot Vision, MIT Press, 1986
	Journals or other material	1. International Journal of Computer Vision, Springer Netherlands 2. IEEE Transaction on Robotics

Course Syllabus		
Course Title:		Multimedia Information Retrieval and Management
Course is		modified √ new ☐
Explain relation between workload and ECTS credits:		6 ECST 45 hours of contact hours and 135 hours of students' individual work
Course Date: **(term and dates if already known):**		-
Lecturer:	Lecturer's name:	Dr. Vladimir Risojević, Assistant Professor
	Office location:	University of Banja Luka, Faculty of Electrical Engineering, Patre 5, 78000 Banja Luka, BiH
	Office hours:	Working day 11:00 – 15:00 or on appointment
	Phone:	+387 51 221 847
	email address:	vlado@etfbl.net
Course Type (e.g. seminar, lecture, lab sessions, etc.)		lecture, seminar
Format (e.g. once per week, block course, etc. – specify number of course sessions)		once per week
Content Description:		Overview of the multimedia information retrieval and management approaches. Content-based retrieval and classification. Feature extraction from multimedia content: text, audio, images, and video. Multimodal retrieval. Application of machine learning techniques in multimedia information retrieval. Evaluation in multimedia information retrieval.
Assessment Modalities:		Project work including a state of the art report

<table>
<tr><td colspan="2">Learning Outcomes:
(show how course contributes to objectives of the module)</td><td>The students will have an advanced knowledge of multimedia information retrieval techniques, as well as their application areas. They will understand advantages and drawbacks of various approaches and how they fit into the global framework for multimedia information retrieval and management. Furthermore, they will be able to apply and improve multimedia information retrieval techniques in different application scenarios.</td></tr>
<tr><td colspan="2">Teaching Methods:
Please state how the course will be taught.

Example: This course is taught using a variety of teaching methods including lectures, class discussions, team work, project creation, and electronic discussion (email and website chat room)</td><td>This course is taught using a combination of teaching methods including lectures, class discussions, working on projects and project presentations.</td></tr>
<tr><td rowspan="3">Required/ recommended Literature
(include publication details)</td><td>Required book(s)</td><td>1. Christopher D. Manning, Prabhakar Raghavan and Hinrich Schütze, Introduction to Information Retrieval, Cambridge University Press. 2008.
2. Richard Szeliski, Computer Vision: Algorithms and Applications, Springer, 2011.
3. George Tzanetakis, Music Information Retrieval, draft, http://marsyas.cs.uvic.ca/mirBook/book/</td></tr>
<tr><td>Recommended book(s)</td><td>1. Michael Nielsen, Neural Networks and Deep Learning, online http://neuralnetworksanddeeplearning.com/
2. Ian Goodfellow, Yoshua Bengio and Aaron Courville, Deep Learning, draft, http://www.deeplearningbook.org/</td></tr>
<tr><td>Journals or other material</td><td>1. Casey, M.A.; Veltkamp, R.; Goto, M.; Leman, M.; Rhodes, C.; Slaney, M., "Content-Based Music Information Retrieval: Current Directions and Future Challenges," in Proceedings of the IEEE , vol.96, no.4, pp.668-696, April 2008

Journals:
IEEE Transactions on Multimedia,
IEEE Transactions on Pattern Analysis and Machine Intelligence,
IEEE Transactions on Image Processing
International Journal on Computer Vision</td></tr>
</table>

		Conference proceedings: IEEE Coputer Vision and Pattern Recognition IEEE International Conference on Computer Vision European Conference on Computer Vision IEEE International Conference on Image Processing

Course Syllabus		
Course Title:		Artificial Intelligence
Course is		modified ☐ new ☐
Explain relation between workload and ECTS credits:		6 ECST 45 hours of contact hours and 135 hours of students' individual work
Course Date: **(term and dates if already known):**		-
Lecturer:	Lecturer's name:	Prof. Dr. Milorad Božić, Full Professor
	Office location:	University of Banja Luka, Faculty of Electrical Engineering, Patre 5, 78000 Banja Luka, BiH
	Office hours:	Working day 08:00 – 16:00 or on appointment
	Phone:	+387 51 221 879
	email address:	mbozic@etfbl.net
Course Type (e.g. seminar, lecture, lab sessions, etc.)		Lecture+seminar
Format (e.g. once per week, block course, etc. – specify number of course sessions)		Once per week and partly block course
Content Description:		Machine learning methods are presented which allow artificial systems to learn successful action policies. The artificial agent could be a robot, an Internet browser, etc. In general there is no teacher available, who could tell the agent which action would be optimal in a given situation. Instead, the agent just gets occasional "rewards" or "penalty", and has to find out on its own how much each action of a sequence contributed to a reward. From this information the agent has to develop efficient strategies for future tasks. Reinforcement Learning algorithms have been particularly successful for solving problems of this kind. Therefore we will

		concentrate on this learning approach during the lecture and discuss both the theoretical background (dynamic programming, Markov decision processes) and applications. In these lecture we will also cover genetic algorithms, which is another interesting approach to machine learning of successful policies. Here the computer simulates evolution by randomly mutating and crossing-over different promising strategies.
Assessment Modalities:		Written examination and presentation of seminar work.
Learning Outcomes: (show how course contributes to objectives of the module)		Students will deeply learn of machine learning methods for artificial agents, and to apply such methods for the solution of problems in various fields.
Teaching Methods: Please state how the course will be taught. Example: This course is taught using a variety of teaching methods including lectures, class discussions, team work, project creation, and electronic discussion (email and website chat room)		This course will be taught using a variety of teaching methods including lectures, class discussions, team work, project creation.
Required/ recommended Literature (include publication details)	Required book(s)	R. Sutton and A. Barto: Reinforcement Learning - An Introduction, MIT Press
	Recommended book(s)	Bertseklis/Tsitsiklis: Neuro-Dynamic Programming, Athena Scientific Russel/Norwig: Artificial Intelligence: A Modern Approach, Prentice Hall
	Journals or other material	

Course Syllabus		
Course Title:		Internet of Things Technologies and Applications
Course is		modified □ new √
Explain relation between workload and ECTS credits:		6 ECST 45 hours of contact hours and 135 hours of students' individual work
Course Date: **(term and dates if already known):**		-
Lecturer:	Lecturer's name:	Prof. Dr. Gordana Gardašević, Associate Professor
	Office location:	University of Banja Luka, Faculty of Electrical Engineering, Patre 5, 78000 Banja Luka, BiH
	Office hours:	on appointment
	Phone:	+387 51 221 877
	email address:	gordana.gardasevic@etfbl.net
Course Type (e.g. seminar, lecture, lab sessions, etc.)		Lectures, projects, lab sessions
Format (e.g. once per week, block course, etc. – specify number of course sessions)		Once per week
Content Description:		Internet of Things (IoT) standards, architectures and protocols. IoT protocol stack examination. Features and constraints of embedded systems. Performance parameters of packet networks. Wireless technologies for IoT (Layer 1 & 2). IoT device programming. IoT application development. Case studies: IoT for smart cities and healthcare applications.

Assessment Modalities:		Written/oral examination and presentation of project work
Learning Outcomes: (show how course contributes to objectives of the module)		Upon completion of this course, students will be able to: - comprehensively understand the IoT standards, architectures and protocols - understand actual hardware platforms, test-beds and simulators - apply up-to-date technologies to implement IoT solutions - develop and build IoT design projects and applications - link IoT networks to cloud computing networks
Teaching Methods: Please state how the course will be taught. Example: This course is taught using a variety of teaching methods including lectures, class discussions, team work, project creation, and electronic discussion (email and website chat room)		The course is taught using lectures, class discussions, supervised team work, project creation.
Required/ recommended Literature (include publication details)	Required book(s)	[1] Bassi A, Bauer M, Fiedler M, Kramp T, van Kranenburg R, Lange S, Meissner S - Enabling things to talk. Springer, Berlin, Heidelberg, 2013. [2] Internet of Things - Global Technological and Societal Trends - Smart Environments and Spaces to Green ICT; Ed. Ovidiu Vermesan,SINTEF, NO & Peter Friess, EU, BE; The River Publishers Series in Communications; ISBN: 978-87-92329-67-7
	Recommended book(s)	[3] Adrian McEwen, Hakim Cassimally - Designing the Internet of Things, Wiley, 1st edition, 2013.
	Journals or other material	IEEE Internet of Things Journal, IEEE Wireless Communications, IEEE Trans. on Wireless Comunications, IEEE Sensor Journal, IEEE Access

Course Syllabus		
Course Title:		Advanced Topics in Internet Technologies
Course is		modified √ new □
Explain relation between workload and ECTS credits:		6 ECST 30 lecture hours, 15 other contact hours and 135 hours of individual work
Course Date: **(term and dates if already known):**		-
Lecturer:	Lecturer's name:	Dr. Pavle Vuletić, Assistant Professor
	Office location:	University of Belgrade, Faculty of Electrical Engineering, Bulevar kralja Aleksandra 73, 11120 Beograd, Srbija
	Office hours:	Working day 09:00 – 17:00 or on appointment
	Phone:	+381 63 237 359
	email address:	pavle.vuletic@etf.bg.ac.rs
Course Type (e.g. seminar, lecture, lab sessions, etc.)		Lecture+seminar+lab sessions.
Format (e.g. once per week, block course, etc. – specify number of course sessions)		Lecture, block course, 4 sessions
Content Description:		The course will cover selected topics in computer networks and Internet such as: • BGP routing protocol and Internet architecture • Virtual Private Networks • Quality of Service QoS • Multicast • Network management

Assessment Modalities:		Assignments (40%), project (60%).
Learning Outcomes: (show how course contributes to objectives of the module)		Deep knowledge in internet technologies.
Teaching Methods: Please state how the course will be taught. Example: This course is taught using a variety of teaching methods including lectures, class discussions, team work, project creation, and electronic discussion (email and website chat room)		This course will be taught using a variety of teaching methods including lectures, class discussions, team work and final project creation.
Required/ recommended Literature (include publication details)	Required book(s)	Peterson, Davie, Computer Networks, A Systems Approach, Elsevier, Fifth edition, 2012, ISBN: 978-0-12-385059-1
	Recommended book(s)	Wiliamson B. Developing IP Multicast Networks, Volume I, 1999, Cisco Press ISBN-10: 1-58714-289-9 Halabi S. Internet Routing Architectures (2nd Edition), 2000, Cisco Press ISBN-13: 978-1-57870-233-6
	Journals or other material	Pavlou, G. (2007). On the Evolution of Management Approaches, Frameworks and Protocols: A Historical Perspective. *Journal of Network and Systems Management*, *15*(4), 425–445. doi:10.1007/s10922-007-9082-9 Edwards, R. (2007). History and Status of Operations Support Systems. *Journal of Network and Systems Management*, *15*(4), 555–567. doi:10.1007/s10922-007-9077-6 Famaey, J., & Turck, F. De. (2012). Federated management of the Future Internet: status and challenges. *International Journal of Network Management*, *22*(6), 508–528. doi:10.1002/nem.1813 Dobson, S., Zambonelli, F., Denazis, S., Fernández, A., Gaïti, D., Gelenbe, E., … Schmidt, N. (2006). A survey of autonomic communications. *ACM Transactions on Autonomous and*

		Adaptive Systems, *1*(2), 223–259. doi:10.1145/1186778.1186782 Tsagkaris, K., Nguengang, G., Galani, A., Grida Ben Yahia, I., Ghader, M., Kaloxylos, A., … Demestichas, P. (2013). A survey of autonomic networking architectures: towards a Unified Management Framework. *International Journal of Network Management*, *23*(6), 402–423. doi:10.1002/nem.1841

Course Syllabus		
Course Title:		Cryptography and Computer Systems Security
Course is		modified ☐ new ☐
Explain relation between workload and ECTS credits:		6 ECST 45 hours of contact hours and 135 hours of students' individual work
Course Date: **(term and dates if already known):**		-
Lecturer:	Lecturer's name:	Prof. Dr. Zoran Djurić, Assistant Professor
	Office location:	Patre 5, Banja Luka
	Office hours:	Working day 09:00 – 13:00 or on appointment
	Phone:	+387 51 221 820
	email address:	zoran@spinter.net
Course Type (e.g. seminar, lecture, lab sessions, etc.)		Lecture + seminar + lab sessions
Format (e.g. once per week, block course, etc. – specify number of course sessions)		- once per week
Content Description:		This course will take participants through the most important issues in cryptography and computer systems security, including general security concepts, potential risks and attacks identification, software exploitation, infrastructure security, communication activity monitoring, OS and application and network devices hardening, cryptographic algorithms, cryptographic systems, Public Key Infrastructure, cryptographic standards, operational/organizational security, security management and computer forensics, Legal issues, Economic issues and Ethics.

<table>
<tr><td colspan="2">Assessment Modalities:</td><td>- Solving homework problems - 40%
- Project - 40%
- Final Exam – 20%</td></tr>
<tr><td colspan="2">Learning Outcomes:
(show how course contributes to objectives of the module)</td><td>After completing this course, participants will:
- Understand potential threats, vulnerabilities and attacks
- Know how to adopt various security measures,
- Have hands-on experience in security-related tools and technologies
- Be able to analyze, design, and build secure systems of moderate complexity.</td></tr>
<tr><td colspan="2">Teaching Methods:
Please state how the course will be taught.

Example: This course is taught using a variety of teaching methods including lectures, class discussions, team work, project creation, and electronic discussion (email and website chat room)</td><td>- Lectures
- Class discussions
- Labs
- Team work
- Project creation
- Email and website discussions</td></tr>
<tr><td rowspan="3">Required/ recommended Literature
(include publication details)</td><td>Required book(s)</td><td>- Stallings, W.: Cryptography and Network Security, Prentice Hall, 1999
- Dieter Gollmann: Computer Security, Wiley-Liss, 1999
- Simson Garfinkel, Gene Spafford: Practical Unix and Internet Security, O'Reilly, 1996</td></tr>
<tr><td>Recommended book(s)</td><td>- Douglas R. Stinson: Cryptography - Theory and Practice, CRC Press, 1995
- Alfred J. Menezes, Paul C. van Oorschot, Scott A. Vanstone: Handbook of Applied Cryptography, CRC Press, October 1996
- Bruce Schneier: Applied Cryptography - Protocols, Algorithms, and Source Code in C. Second edition, John Wiley & Sons Inc., 1996</td></tr>
<tr><td>Journals or other material</td><td>- Security Group PhD Guide, University of Cambridge, http://www.cl.cam.ac.uk/~mgk25/group-curriculum.html
-</td></tr>
</table>

Course Syllabus		
Course Title:		Speech Processing and Transmission
Course is		modified ☐ new ☐
Explain relation between workload and ECTS credits:		6 ECST 45 hours of contact hours and 135 hours of students' individual work
Course Date: **(term and dates if already known):**		-
Lecturer:	Lecturer's name:	Prof. Dr. Vlado Delić, Full Professor
	Office location:	
	Office hours:	
	Phone:	
	email address:	vlado.delic@ktios.net
Course Type (e.g. seminar, lecture, lab sessions, etc.)		seminar, lecture, lab sessions
Format (e.g. once per week, block course, etc. – specify number of course sessions)		once per week
Content Description:		Discrete model for speech signal generation. Speech perception. Basic parameters of speech signal (fundamental frequencies, formant frequencies, predictor's coefficients, etc.). Speech signal coding and transformation, modern techniques. Comparison of techniques for speech signal coding. Perspective of men-machine interaction.

Assessment Modalities:		Project (50%), final exam (50%).
Learning Outcomes: (show how course contributes to objectives of the module)		Deep knowledge in speech processing and transmission.
Teaching Methods: Please state how the course will be taught. Example: This course is taught using a variety of teaching methods including lectures, class discussions, team work, project creation, and electronic discussion (email and website chat room)		Lectures and presentation.
Required/ recommended Literature (include publication details)	Required book(s)	1. Flanagan, J.L.: "Speech Analysis, Synthesis and Perception", Second, Expanded Edition, Springer-Verlag Berlin-Heidelberg, New York. 2. Koestoer, N.P.: "Robust Linear Prediction Analysis for Low Bit-Rate Speech Coding", in Proc. Fourth Australian Workshop on Signal Processing Applications, Brisbane, Australia, Dec.2002.
	Recommended book(s)	
	Journals or other material	