

УНИВЕРЗИТЕТ У БАЊОЈ ЛУЦИ
ЕЛЕКТРОТЕХНИЧКИ ФАКУЛТЕТ

СТУДИЈСКИ ПРОГРАМ III циклуса студија

Информационо-комуникационе технологије

Бања Лука, мај 2016.

НАЗИВ И ЦИЉ СТУДИЈСКОГ ПРОГРАМА

НАЗИВ СТУДИЈСКОГ ПРОГРАМА

III циклус студија

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ЦИЉЕВИ СТУДИЈСКОГ ПРОГРАМА

У складу са мисијом Универзитета и Електротехничког факултета (у даљем тексту Факултета), полазећи од дугогодишњег искуства у образовању инжењера и магистара електротехнике као и доктора електротехничких наука, те узимајући у обзир савремене токове високошколског образовања, дефинисани су сљедећи општи циљеви за све студијске програме Електротехничког факултета:

- постизање образовног процеса у складу са највишим стандардима,
- искључиво студентско право избора студијског програма и изборних предмета,
- искључиво једносеместрални предмети,
- равнотежа предмета у студијским програмима у погледу односа опште-образовних и ужестручних предмета,
- избалансиран однос предавања, аудиторних и лабораторијских вјежби, семинарских радова, консултација и самосталног рада студента,
- имплементирање савременог дидактичког приступа,
- образовање оријентисано ка студенту и његовим стварним могућностима и способностима учења,
- подстицање властитог систематског учешћа студента кроз индивидуални и групни рад и презентацију резултата учења,
- ангажовање наставног особља са научним дигнитетом и компетенцијама,
- континуирано праћење и провјеравање знања студената.

Посебни циљеви студија III циклуса

Основни циљ овог студијског програма је да кандидат стекне дубока и специјалистичка знања из области информационо-комуникационих технологија, а посебно из ужег подручја у којем припрема докторску дисертацију.

Кандидат треба да се оспособи за оригинално истраживање и објављивање резултата властитих истраживања, те да стекне системско разумијевање суштине научног и примијењеног научног подручја истраживања у којем ради. Кроз овај циклус студија кандидат треба да се оспособи за формирање судова о комплексним темама, те евалуацију и синтезу нових и комплексних идеја. Један од основних циљева овог студијског програма је и континуирано напредовање у теоријском и примијењеном истраживању и развоју нових техника, идеја и приступа.

ВРСТА СТУДИЈА И ИСХОД ПРОЦЕСА УЧЕЊА

ВРСТА СТУДИЈА

Факултет организује редовне студије и/или ванредне студије III циклуса у комбинацији са учењем на даљину.

ИСХОДИ ПРОЦЕСА УЧЕЊА

Исходе процеса учења представљају одговарајућа образовна постигнућа студента у стицању очекиваних знања и разумијевања области које се изучавају, вјештине и компетенције везане за теоријска знања, практичну и оперативну примјену, те способност исказивања и употребе тих знања након завршетка студијског програма, као и формираност ставови према истраживачком раду и стечена свијест о одговорности у истраживању.

Исходи процеса учења током III циклуса студија

Од кандидата који заврше III циклус студија се очекује да:

- кроз оригинална истраживања генеришу нова знања и објављивљују резултате властитих истраживања, те тако доприносе корпусу знања који се верификује кроз објављивање у национално и/или међународно признатим публикацијама,
- имају системско разумијевање суштине научног и примијењеног аспекта подручја истраживања у којем раде, те да прате савремене токове, разумију и примјењују резултате најновијих истраживања,
- имају способност критичке анализе, евалуације и синтезе нових и комплексних идеја, стварања судова о комплексним темама које укључују и релевантну друштвену, научну и етичку одговорност,

- могу презентовати своје закључке и резултате оригиналног истраживања стручној и општој публици на јасан и ефективан начин,
- су развили квалитете и генеричке вјештине потребне за запошљавање и самозапошљавање, те континуирано напредовање у теоријским и примијењеним истраживањима и развоју нових техника, идеја и приступа.

СТРУЧНИ, АКАДЕМСКИ, ОДНОСНО НАУЧНИ НАЗИВ

Лице које заврши III циклус студија у трајању од минимално 3 године и одбрани докторску дисертацију стиче академски степен доктора наука.

УСЛОВИ ЗА УПИС СТУДИЈСКОГ ПРОГРАМА

Упис на студије III циклуса врши се на конкурентској основи.

Право пријаве на конкурс за упис на студије III циклуса има лице које:

- на претходним студијама има остварено најмање 300 ECTS бодова
- и које има просјек не мањи од осам/8/ на активностима кроз које је остварило 300 ECTS бодова или, уколико је просјечна оцјена мања од осам /8/, има објављене научне радове.

Кандидати који студирали прије увођења студија заснованог на Европском систему преноса бодова, или су ECTS бодове остварили на сродном студијском програму другог факултета, обавезни су прије или приликом конкурисања поднијети захтјев да им се изврши вредновање остварених резултата студирања у еквивалентан број ECTS бодова према студијском програму Рачунарство и информатика и/или Електроника и комуникације Електротехничког факултета Универзитета у Бањој Луци.

Приликом вредновања ових резултата, кандидату који је стекао високо образовање по раније важећим законским прописима, на студијама у трајању од најмање десет /10/ семестара признаје се 300 ECTS бодова, а на студијама у трајању од најмање осам /8/ семестара и додатним временом планираним за израду дипломског рада 270 ECTS бодова, уколико се програм студија по коме је стекао високо образовање у најмање 80% садржаја поклапа са студијским програмима Рачунарство и информатика и/или Електроника и комуникације. Кандидату који је стекао академски назив магистра по раније важећим законским прописима, признаје се најмање 300 ECTS бодова уколико се програм студија по коме је стекао академски назив магистра у

најмање 80% садржаја поклапа са студијским програмима Рачунарство и информатика и/или Електроника и комуникације.

Кандидату који је стекао академски назив магистра по раније важећим законским прописима и кандидату који је уписао магистарске студије по претходно важећим законима о високом образовању или завршио студије II циклуса, као и кандидату који је највише једном изгубио статус студента докторских студија, признају се положени појединачни испити уколико се програм предмета односно активности која се вреднује у најмање 80% садржаја поклапају са предметом односно активношћу студијских програма Рачунарство и информатика и/или Електроника и комуникације.

Приликом вредновања и рачунања припадајућег броја ECTS бодова за појединачне предмете односно активности, по правилу се 30 ECTS бодова, са колико се бодује сваки семестар, распоређује на предмете односно активности које су том семестру припадали процентуално према броју часова предмета. По основу положених испита на магистарским и докторским студијама признаје се највише 48 ECTS бодова. Одбраћен магистарски рад се признаје са 30 ECTS бодова.

Уз наведене услове, лице које се пријављује на конкурс за упис на студије III циклуса мора, на претходним нивоима студија, да има положене испите из предмета који представљају потребну предспрему за студијски програм информационо-комуникационих технологија:

- 12 ECTS бодова из научног поља Математика,
- 180 ECTS бодова из научног поља Електротехника, електроника и информационо инжењерство и/или Рачунарске и информационе науке,
- положени фундаментални предмети из сљедећих ужих научних области: Рачунарски хардвер и системи, Рачунарске науке, Информационе науке и биоинформатика, Телекомуникације.

Кандидату се могу прописати највише три допунска испита из предмета I и II циклуса у максималном износу од 18 ECTS бодова у циљу испуњавања наведених услова. Таквим кандидатима се може условно одобрити упис на III циклус студија са бројем ECTS бодова који је умањен за број ECTS бодова које носе допунски испити.

Кандидат се пријављује на Конкурс и том приликом подноси и предаје Студентској служби Електротехничког факултета сљедећа документа:

- молбу за упис на студије III циклуса,
- кратку биографију,
- дипломе или њихове овјерене копије, стечене на претходним нивоима високошколског образовања,
- додатак дипломи или увјерења о положеним испитима са преписом оцјена и потврде о средњој оцјени у оригиналу или као овјерене копије,
- захтјев за вредновање остварених резултата студирања у еквивалентан број ECTS бодова (за кандидате који студирали прије увођења студија заснованог на ECTS бодовном систему, или су ECTS бодове остварили на сродном студијском програму),

- списак научних и стручних радова (уколико их има),
- фотокопије радова (уколико их има),
- доказ о уплати накнаде за пријаву на конкурс,
- по потреби и друге доказе.

Кандидат својим потписом на молби за упис потврђује да прихвата правила конкурисања на студије III циклуса, као и услове уписа уколико буде остварио право на упис.

По закључењу конкурса, формира се јединствена ранг листа кандидата који су конкурисали за упис на студије III циклуса. Листа се формира према бодовима који су једнаки просјечној оцјени свих активности које у збиру имају најмање 300 ECTS. Оцјене завршних радова, уколико за исте постоји оцјена, узимају се у обзир равноправно са осталим оцјенама. Уколико кандидат има више од 300 ECTS бодова, узимају се у обзир најбоље оцјене из активности које су у збиру вредноване са најмање 300 ECTS бодова.

Тако добијеном броју додају се бодови за научне радове кандидата, објављене током 5 година које претходе дану отварања конкурса:

- 1,2 бода студент стиче за научни рад из области информационо-комуникационих технологија објављен у признатом научном часопису са међународном рецензијом,
- 0,45 бодова студент стиче за научни рад из области информационо-комуникационих технологија објављен у часопису националног значаја,
- 0,6 бодова студент стиче за научни рад из области информационо-комуникационих технологија објављен на научном скупу са међународном рецензијом,
- 0,3 бода студент стиче за научни рад из области информационо-комуникационих технологија објављен на националном научном скупу са рецензијом.

За ауторство (први аутор рада) јавно објављених радова, рачуна се пуни број бодова. За коауторство се број бодова рачуна тако што се пуни број бодова за другог аутора множи са 75%, за трећег са 50%, а за остале коауторе са 25%.

Право уписа на студије III циклуса имају кандидати са ранг листе формиране на основу овако добијеног укупног броја бодова, уколико је тај број бодова већи или једнак 8 (осам) и уколико се налазе на ранг листи у оквиру укупног броја студената објављеног у конкурсу.

Кандидат који је остварио право на упис на студије III циклуса, мора се уписати у року од двије седмице од дана истицања ранг листе, након чега губи право на упис. Изузетно, кандидати којима је условно одобрен упис на III циклус студија са бројем ECTS бодова који је умањен за број ECTS бодова које носе допунски испити, уписују се након полагања допунских испита и остварених 300 ECTS бодова, а најкасније до краја првог семестра.

Страни држављанин може уписати студије III циклуса под условима дефинисаним Законом о високом образовању, Статутом и другим актима Универзитета и Конкурсом.

ЛИСТА СТУДИЈСКИХ ПРЕДМЕТА СА ОКВИРНИМ
САДРЖАЈЕМ И БОДОВНА ВРИЈЕДНОСТ СВАКОГ
ПРЕДМЕТА ИСКАЗАНА У СКЛАДУ СА ECTS

НАСТАВНИ ПЛАН

Напомена: Сви предмети су изборни. Опредјелјивањем за један профил, предмети одговарајућег модула постају обавезни за тог студента и они су у табели означени са „Предмет основног модула“, док су предмети које студент бира из других модула означени са „Изборни предмет“. У број часова научноистраживачког рада у овој табели није укључен самостални рад студента, већ само рад који се одвија под директним надзором ментора.

| Р.бр. | НАЗИВ ПРЕДМЕТА | семестар | ECTS бодова | Часова седмично |
|----------------------------|---|----------|-------------|-----------------|
| 1 | Предмет основног модула/ Изборни предмет | I | 6 | 2+1 |
| 2 | Предмет основног модула/ Изборни предмет | I | 6 | 2+1 |
| 3 | Предмет основног модула/ Изборни предмет | I | 6 | 2+1 |
| 4 | Предмет основног модула/ Изборни предмет | I | 6 | 2+1 |
| 5 | Научно-истраживачки рад | I | 6 | 8 |
| Ukupno I semestar | | | 30 | 20 |
| 6 | Предмет основног модула/ Изборни предмет | II | 6 | 2+1 |
| 7 | Предмет основног модула/ Изборни предмет | II | 6 | 2+1 |
| 8 | Предмет основног модула/ Изборни предмет | II | 6 | 2+1 |
| 9 | Предмет основног модула/ Изборни предмет | II | 6 | 2+1 |
| 10 | Научно-истраживачки рад | II | 6 | 8 |
| Ukupno II semestar | | | 30 | 25 |
| 11 | Научно-истраживачки рад | III | 30 | 25 |
| Ukupno III semestar | | | 30 | 25 |
| 12 | Научно-истраживачки рад | IV | 30 | 25 |
| Ukupno IV semestar | | | 30 | 25 |
| 10 | Научно-истраживачки рад | V | 30 | 25 |
| Ukupno V semestar | | | 30 | 25 |
| 10 | Научно-истраживачки рад | VI | 30 | 25 |
| Ukupno VI semestar | | | 30 | 25 |
| | | | | |

МОДУЛИ, ПРЕДМЕТИ И ОДГОВОРНИ НАСТАВНИЦИ

| Module | Course title | Name of the lecturer |
|-----------------------|--|---|
| Software Technologies | Model Driven Software Development | 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 Čelić, 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 Development | 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 |
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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 |
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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 |
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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

| Course Syllabus | | |
|---|--|---|
| Course Title: | Model Driven Software Development | |
| Course is | modified <input type="checkbox"/> new <input type="checkbox"/> | |
| 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: | Dr. Dražen Brđanin, Assistant 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 51 221 851 |
| | email address: | bdrazen@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) | block course | |
| Content Description: | 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). | |
| Assessment Modalities: | examination | |

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| <p>Learning Outcomes: (show how course contributes to objectives of the module)</p> | <p>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.</p> | |
| <p>Teaching Methods: Please state how the course will be taught.</p> <p>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)</p> | <p>Lectures, assignments and tutorials</p> | |
| <p>Required/ recommended Literature (include publication details)</p> | <p>Required book(s)</p> | |
| | <p>Recommended book(s)</p> | <p>Gamma et.al.: Design Patterns, Addison-Wesley</p> <p>C. Ghezzi et al.: Fundamentals of Software Engineering, Prentice Hall</p> <p>G. Berard et.al.: System and Software Verification, Springer</p> |
| | <p>Journals or other material</p> | <p>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.</p> <p>A. Zündorf: Rigorous Object Oriented Software Development; Habilitation Thesis, University of Paderborn (2001)</p> <p>Spivey: The Z Reference Manual. http://spivey.oriel.ox.ac.uk/mike/zrm/zrm.pdf</p> |

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| | | 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 |
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| Course Syllabus | | |
|---|--|---|
| Course Title: | Advanced Concepts in Databases | |
| Course is | modified <input type="checkbox"/> new <input type="checkbox"/> | |
| 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 levels 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, | |

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| | | <p>transactional subcomponents, index selection, query reformulation, normalization decisions, and the comparative advantage of redundant data. Speed up the database performance by parallel processing.</p> |
| | Assessment Modalities: | <p>Homework Problem Solving (40%), project (60%).</p> |
| | Learning Outcomes: (show how course contributes to objectives of the module) | <p>One of the main components of the majority of applications based on ICT technologies are databases. After long period of development of the RDBMS's and accompanying 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 concurrent users, that are resistant and recoverable from system breakdowns, etc. Often, these application systems put high demands on the speed and throughput of the system.</p> <p>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.</p> |
| | 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) | <p>This course will be taught using a variety of teaching methods including lectures, class discussions, team work, project creation.</p> |
| Required/ recommended Literature (include publication details) | Required book(s) | <p><i>Concurrency Control and Recovery in Database Systems</i> by Bernstein, Hadzilacos, and Goodman, Addison-Wesley, 1987. ISBN 0-201-10715-5. <i>Database Tuning: principles, experiments, and troubleshooting techniques</i> by Dennis Shasha and Philippe Bonnet 2002 Morgan Kaufmann Publishers; ISBN: 1558607536</p> |
| | Recommended book(s) | <p><i>Transaction Processing: Concepts and Techniques</i>, Jim</p> |

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| | | <p>Andreas Reuter:Morgan Kaufman; 1st edition (1993) ISBN:1558601902 <i>Principles of Distributed Database Systems</i>, M.Tamer Ozsü and Patrick Valduriez,Prentice-Hall,1999 <i>Transactional Information Systems:Theory, Algorithms, and the Practice of Concurrency Control and Recovery</i>, Gerhard Weikum, Gottfried Vossen, The Morgan Kaufmann Series in Data Management Systems, Jim Gray, Series Editor May 2001, 944 pages</p> |
| | <p>Journals or other material</p> | |

| Course Syllabus | | |
|---|--|---|
| Course Title: | Selected Topics in Internet Programming | |
| Course is | modified <input type="checkbox"/> new <input type="checkbox"/> | |
| 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. | |

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| | | Participants will learn how to develop applications for a variety of Web clients, including mobile clients. |
| | Assessment Modalities: | <ul style="list-style-type: none"> - Solving homework problems - 40% - Project - 40% - Final Exam – 20% |
| | Learning Outcomes: (show how course contributes to objectives of the module) | <p>After completing this course, participants will be able:</p> <ul style="list-style-type: none"> - 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) | <ul style="list-style-type: none"> - Lectures - Class discussions - Labs - Team work - Project creation - Email and website discussions |
| Required/ recommended Literature (include publication details) | Required book(s) | <ul style="list-style-type: none"> - 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 <input type="checkbox"/> new <input type="checkbox"/> | |
| 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 | |

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| 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: <i>Scientific Computing: An Introductory Survey</i> , McGraw-Hill, New York, Second edition, 2002. |
| | Recommended book(s) | C.D. Meyer: <i>Matrix Analysis and Applied Linear Algebra</i> , SIAM, Philadelphia, 2000. M.V.Ćelić: <i>Numericka matematika</i> , Glas srpski, Banja Luka, 2008. D.J. Higham, N.J. Higham, <i>MATLAB Guide</i> , SIAM, Philadelphia, 2000. |
| | Journals or other material | |

| Course Syllabus | | |
|---|---|---|
| Course Title: | Multimedia Security Operating Systems | |
| Course is | modified <input type="checkbox"/> new <input type="checkbox"/> | |
| 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. | |

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| Assessment Modalities: | | examination |
| Learning Outcomes: (show how course contributes to objectives of the module) | | <p>At the end of this course students will be able to:</p> <ul style="list-style-type: none"> • 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; <p>Find a suitable OS solution for complex multimedia and security problems.</p> |
| 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) | | <p>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.</p> <p>Copies of project requirements papers will be distributed to the students</p> |
| Required/ recommended Literature (include publication details) | Required book(s) | A.S. Tanenbaum, “Modern Operating Systems“, Prentice Hall International, 2001 |
| | Recommended book(s) | W. Stallings, “Operating Systems”, Prentice Hall, 2001, others books on OS and Internet sources. |
| | Journals or other material | Computers, Commun. of the ACM, Symp. On Operating Systems Principles ACM, IEEE Concurrency, Operating Systems Review, Computer Journal. |

| Course Syllabus | | |
|---|--|--------------------------------------|
| Course Title: | Graph Theory | |
| Course is | modified <input type="checkbox"/> new <input type="checkbox"/> | |
| 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. | |

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| 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 <input type="checkbox"/> new <input type="checkbox"/> |
| 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. |

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| 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) |
| | Journals or other material |
| | Ivica Crnkovic and Magnus Larsson, Building Reliable Component-Based Software Systems. - Artech House Publishers |
| | 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. |

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| | | Scott Hissam, Gabriel Moreno, Judith Stafford, & Kurt Wallnau. Packaging Predictable Assembly with Prediction-Enabled Component Technology (CMU/SEI-2001-TR-024). |
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| Course Syllabus | |
|---|---|
| Course Title: | Simulation |
| Course is | modified <input type="checkbox"/> new <input type="checkbox"/> |
| 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.) |

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| 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 <input checked="" type="checkbox"/> new <input type="checkbox"/> | |
| 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: | <p>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.</p> <p>Content description:</p> <ul style="list-style-type: none"> • Introduction to multi- and many-core | |

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| | | <p>processors' architecture.</p> <ul style="list-style-type: none"> • 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. |

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| | <p>Journals or other material</p> | <ol style="list-style-type: none"> 1. van den Sande K.E.A., Gevers T., Snoek C.G.M. Empowering Visual Categorization With the GPU. <i>IEEE Transactions on Multimedia</i>, 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. <i>Quantitative Imaging in Medicine and Surgery</i>, 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, <i>IEEE Transactions on Visualization and Computer Graphics</i>, Vol. 18, No. 1, pp. 68-80, 2012. 4. Burger K., Ferstl F., Theisel H., Westermann R. Interactive Streak Surface Visualization on the GPU, <i>IEEE Transactions on Visualization and Computer Graphics</i>, 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. <i>Journal of Real-Time Image Processing</i>, 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. <i>Journal of Real-Time Image Processing</i>, 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. <i>IEEE Transactions On Circuits And Systems For Video Technology</i>, Vol. 19, No. 11, 2009, 8. S. Avidan and A. Shamir, "Seam carving for content-aware image resizing," <i>ACM Trans. Graph.</i>, vol. 26, no. 3, 2007. 9. M. Rubinstein, A. Shamir, and S. Avidan, "Improved seam carving for video retargeting," <i>ACM Trans. Graph.</i>, 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 <i>Journal of Supercomputing</i>, 2013. |
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| Course Syllabus | | |
|---|---|---|
| Course Title: | Advanced Multimedia Processing | |
| Course is | modified <input type="checkbox"/> new <input type="checkbox"/> | |
| 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 enhancement and restoration. Image segmentation. Motion segmentation, estimation and tracking. Multimedia compression. Application-specific multimedia architecture. | |

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| Assessment Modalities: | | Project work including a state of the art report |
| Learning Outcomes: | | <p>At the end of this course students will be able to:</p> <ul style="list-style-type: none"> • 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) | <ol style="list-style-type: none"> 1. L. Guan, S.-Y. Kung, J. Larsen, <i>Multimedia Image and Video Processing</i>. CRC Press, 2001. 2. Vaseghi, Saeed V. <i>Multimedia signal processing: Theory and applications in speech, music and communications</i>. John Wiley & Sons, 2007. 3. Bovik, Alan C. <i>Handbook of image and video processing</i>. Academic press, 2010. 4. Plataniotis, Konstantinos, and Anastasios N. Venetsanopoulos. <i>Color image processing and applications</i>. Springer Science & Business Media, 2013. 5. Mandal, M. Kr. <i>Multimedia signals and systems</i>. Vol. 716. Springer Science & Business Media, 2002. 6. Tekalp, A. M. <i>Digital video processing</i>. Prentice-Hall, Inc., 1995. 7. Spanias, Andreas, Ted Painter, and Venkatraman Atti. <i>Audio signal processing and coding</i>. 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 <input type="checkbox"/> new <input type="checkbox"/> | |
| 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 (2 nd 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. | |

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| 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) | <ol style="list-style-type: none"> 1. L. Scilavico, B. Siciliano, Modelling and Control 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) | <ol style="list-style-type: none"> 1. Berthold Horn, Robot Vision, MIT Press, 1986 |
| | Journals or other material | <ol style="list-style-type: none"> 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 <input checked="" type="checkbox"/> new <input type="checkbox"/> | |
| 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. | |

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| Assessment Modalities: | | Project work including a state of the art report |
| Learning Outcomes: (show how course contributes to objectives of the module) | | 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. |
| 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 combination of teaching methods including lectures, class discussions, working on projects and project presentations. |
| Required/ recommended Literature (include publication details) | Required book(s) | <ol style="list-style-type: none"> 1. Christopher D. Manning, Prabhakar Raghavan and Hinrich Schütze, <i>Introduction to Information Retrieval</i>, Cambridge University Press. 2008. 2. Richard Szeliski, <i>Computer Vision: Algorithms and Applications</i>, Springer, 2011. 3. George Tzanetakis, <i>Music Information Retrieval</i>, draft, http://marsyas.cs.uvic.ca/mirBook/book/ |
| | Recommended book(s) | <ol style="list-style-type: none"> 1. Michael Nielsen, <i>Neural Networks and Deep Learning</i>, online http://neuralnetworksanddeeplearning.com/ 2. Ian Goodfellow, Yoshua Bengio and Aaron Courville, <i>Deep Learning</i>, draft, http://www.deeplearningbook.org/ |
| | Journals or other material | <ol style="list-style-type: none"> 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 <i>Proceedings of the IEEE</i> , vol.96, no.4, pp.668-696, April 2008 |

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| | | <p>Journals: IEEE Transactions on Multimedia, IEEE Transactions on Pattern Analysis and Machine Intelligence, IEEE Transactions on Image Processing International Journal on Computer Vision</p> <p>Conference proceedings: IEEE Computer Vision and Pattern Recognition IEEE International Conference on Computer Vision European Conference on Computer Vision IEEE International Conference on Image Processing</p> |
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| Course Syllabus | | |
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| Course Title: | Artificial Intelligence | |
| Course is | modified <input type="checkbox"/> new <input type="checkbox"/> | |
| 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 | |

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| | | <p>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.</p> <p>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.</p> |
| | 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) | Bertsekli/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 <input type="checkbox"/> new <input checked="" type="checkbox"/> | |
| 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. | |

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| Assessment Modalities: | | Written/oral examination and presentation of project work |
| Learning Outcomes: (show how course contributes to objectives of the module) | | <p>Upon completion of this course, students will be able to:</p> <ul style="list-style-type: none"> - 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 Communications, IEEE Sensor Journal, IEEE Access |

| Course Syllabus | | |
|---|---|--|
| Course Title: | Advanced Topics in Internet Technologies | |
| Course is | modified <input checked="" type="checkbox"/> new <input type="checkbox"/> | |
| 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: | <p>The course will cover selected topics in computer networks and Internet such as:</p> <ul style="list-style-type: none"> • BGP routing protocol and Internet architecture • Virtual Private Networks • Quality of Service QoS • Multicast • Network management | |

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

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| | | <p><i>Adaptive Systems</i>, 1(2), 223–259. doi:10.1145/1186778.1186782</p> <p>Tsagkaris, K., Nguengang, G., Galani, A., Grida Ben Yahia, I., Ghader, M., Kaloxylou, A., ... Demestichas, P. (2013). A survey of autonomic networking architectures: towards a Unified Management Framework. <i>International Journal of Network Management</i>, 23(6), 402–423. doi:10.1002/nem.1841</p> |
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| Course Syllabus | | |
|---|---|---|
| Course Title: | Cryptography and Computer Systems Security | |
| Course is | modified <input type="checkbox"/> new <input type="checkbox"/> | |
| 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. | |

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| Assessment Modalities: | | <ul style="list-style-type: none"> - Solving homework problems - 40% - Project - 40% - Final Exam – 20% |
| Learning Outcomes: (show how course contributes to objectives of the module) | | <p>After completing this course, participants will:</p> <ul style="list-style-type: none"> - 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. |
| 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) | | <ul style="list-style-type: none"> - Lectures - Class discussions - Labs - Team work - Project creation - Email and website discussions |
| Required/ recommended Literature (include publication details) | Required book(s) | <ul style="list-style-type: none"> - 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 |
| | Recommended book(s) | <ul style="list-style-type: none"> - 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 |
| | Journals or other material | <ul style="list-style-type: none"> - Security Group PhD Guide, University of Cambridge, http://www.cl.cam.ac.uk/~mgk25/group-curriculum.html - |

| Course Syllabus | | |
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| Course Title: | Speech Processing and Transmission | |
| Course is | modified <input type="checkbox"/> new <input type="checkbox"/> | |
| 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. | |

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| 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 | |

НАЧИН ИЗВОЂЕЊА СТУДИЈА И ПОТРЕБНО ВРИЈЕМЕ ЗА ИЗВОЂЕЊЕ ПОЈЕДИНИХ ОБЛИКА СТУДИЈА

Студије III циклуса изводе се у складу са правилима студирања заснованим на Европском систему преноса бодова (ECTS), кроз научноистраживачки рад и наставу.

Студије III циклуса трају три године и вреднују се са 180 ECTS. Докторска дисертација је завршни дио студијског програма III циклуса.

Студије III циклуса се организују у виду наставе и самосталног рада на савладавању предмета дефинисаних студијским програмом, те кроз научноистраживачки рад. На другој и трећој години студиј се изводи само кроз научноистраживачки рад који је непосредно у функцији израде докторске дисертације.

Настава на студијама III циклуса се, по правилу, изводи на једном од језика народа Босне и Херцеговине. Студиј III циклуса, односно његови поједини дијелови, може бити организован и на неком од свјетских језика.

Студије на студијама III циклуса се реализују кроз активну наставу. Активна настава се састоји од предавања, консултација, семинарских радова, других облика наставе и студијског научноистраживачког рада.

Настава из наставних предмета се изводи групно и/или индивидуално.

Уз одобрење Научно-наставног вијећа факултета, научноистраживачки рад се може обавити и у другој научноистраживачкој институцији.

Студентима који не истражују у пуном радном времену може се продужити трајање научноистраживачког рада, с тим да укупно трајање студија III циклуса не може де буде дуже од шест година.

Прије почетка трећег семестра студент је обавезан поднијети извјештај о резултатима научноистраживачки рада у току прве године студија.

Након полагања свих предвиђених испита и докторског квалификацијског испита, студент има право и обавезу да поднесе пријаву за тему докторске дисертације која треба да садржи свеобухватан преглед предложеног подручја истраживања, циљеве, методе и очекиване доприносе докторске дисертације, као и приједлог начина достизања предложених циљева.

Докторска дисертација мора да буде резултат оригиналног научноистраживачког рада кандидата. Докторска дисертација мора да садржи самостални научни допринос кандидата, који се верификује у научној јавности кроз радове објављене у часописима и приказане на конференцијама.

Вријеме и начин остваривања појединих облика студија утврђује се годишњим распоредом рада који се дефинише за сваку студијску групу засебно, у складу са Законом о високом образовању и важећим актима Универзитета, те у складу са квантитативном количином рада потребном за успјешно завршавање сваког појединачног предмета и циклуса истраживања, израженом кроз придружене ECTS бодове.

БОДОВНА ВРИЈЕДНОСТ ЗАВРШНОГ РАДА ИСКАЗАНА У СКЛАДУ СА ECTS

Завршни рад III циклуса студија (докторска дисертација) носи 42 ECTS бода.

ПРЕДУСЛОВИ ЗА УПИС ПОЈЕДИНИХ ПРЕДМЕТА И ГРУПЕ ПРЕДМЕТА

Да би стекао услове за упис на студије III циклуса, а самим тим и за избор предмета кандидат мора, на претходним нивоима студија, да има положене испите из предмета који представљају потребну предспрему за студијски програм информационо-комуникационих технологија.

Приликом конкурисања кандидат се одређује за основни модул са четири предмета, који одређује његов профил. Преостала четири предмета бира из других модула, по препоруци ментора. Ментор може кандидату одредити додатно факултативно слушање предмета са нижих циклуса студија који су неопходни за праћење појединих предмета, односно групе предмета III циклуса, у зависности од одабраног профила и предспреме кандидата.

НАЧИН ИЗБОРА ПРЕДМЕТА ИЗ ДРУГИХ СТУДИЈСКИХ ПРОГРАМА У ОКВИРУ ИСТИХ ИЛИ СРОДНИХ ОБЛАСТИ СТУДИЈА

На Универзитету у Бањој Луци тренутно не постоји студијски програм III циклуса у оквиру истих или сродних области студија.

КРИТЕРИЈУМИ И НАЧИН ОСИГУРАЊА КВАЛИТЕТА

На Факултету се редовно, од 2004. године, а раније повремено, проводи процес самоевалуације. Од 2008. године самоевалуација се проводи на нивоу Универзитета у Бањој Луци, али је Факултет још увијек задржао и своје процедуре самоевалуације. Кроз TEMPUS пројекте TEMPUS CD-Nr.16110-2001 “*Development of curricula and study programs for three-stage information technology program with international degrees in Bosnia and Herzegovina*“, TEMPUS SM-SCM-C014B06-2006 “*EU oriented self-evaluation report procedures for BIH Universities*“, TEMPUS SCM C010B06-2006 “*IT-Qualifikationsrahmen fur den Hochschulraum in Bosnien-Herzegowina*“, TEMPUS SCM C024A06-2006 “*Quality management procedure for promoting university-enterprise cooperation*“, Факултет је дефинисао критеријуме и процедуре и прошао и процес самоевалуације и пробне екстерне евалуације.

УСЛОВИ ЗА ПРЕЛАЗАК СА ДРУГИХ СТУДИЈСКИХ ПРОГРАМА У ОКВИРУ ИСТИХ ИЛИ СРОДНИХ ОБЛАСТИ СТУДИЈА

Преласци са других студијских програма ван Факултета, у оквиру истих или сродних области студија, врше се у складу са правилим које доноси Сенат Универзитета. Прелазак са друге високошколске установе и наставак школовања одвија се у складу са уговором који студент закључује са Универзитетом и/или билатералним уговором између универзитета о признавању ECTS бодова. Уколико не постоји билатерални уговор са универзитетом са којег студент долази, врши се појединачно признавање ECTS бодова за сваки испит и друге активности.

ОБАВЕЗЕ СТУДЕНАТА, ДИНАМИКА СТУДИРАЊА

Обавезе студената и динамика студирања су дефинисани Законом о високом образовању и одговарајућим актима Универзитета у Бањој Луци.

НАСТАВНО ОСОБЉЕ

У наставном процесу, менторству и другим активностима III циклуса студија учествују, осам стално запослених наставника Електротехничког факултета Универзитета у Бањој Луци, и гостујући наставници са других универзитета.