UČNI NAČRT PREDMETA / COURSE SYLLABUS	
Predmet:	**Osnove podatkovnih baz**
Course title:	**Basics of Databases**

Študijski program in stopnja Study programme and level	Študijska smer Study field	Letnik Academic year	Semester Semester
Univerzitetni študijski program prve stopnje Računalništvo in informatika **Interdisciplinarni univerzitetni študijski program prve stopnje Računalništvo in in matematika** **Interdisciplinarni univerzitetni študijski program prve stopnje Upravna informatika**	**ni smeri**	**2**	**zimski**
University study programme Computer and Information Science, 1st cycle **Interdisciplinary university study programme Computer Science and Mathematics , 1st cycle** **Interdisciplinary university study programme in Administrative Informatics 1st Cycle**	**none**	**2**	**fall**

Vrsta predmeta / Course type	**obvezni predmet / compulsory course**
Univerzitetna koda predmeta / University course code:	**63208**

Predavanja Lectures	Seminar Seminar	Vaje Tutorial	Klinične vaje Laboratory work	Druge oblike študija Field work	Samost. delo Individ. work	ECTS
45	/	30	/	/	105	6

Nosilec predmeta / Lecturer:	prof. dr. Marko Bajec

Jeziki / Languages:	**Predavanja / Lectures:**	slovenščina Slovene

Vaje / Tutorial:	slovenščina Slovene

Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:	**Prerequisites:**

Vsebina:	**Content (Syllabus outline):**
predavanja: I. Uvod v PB 1. Zgodovina področja; 2. Sistemi za upravljanje s PB (SUPB); 3. Vrste SUPB; 4. Vloge pri upravljanju PB; II. Opisovanje, shranjevanje ter poizvedovanje v PB 5. tri-nivojska predstavitev podatkov; 6. Shramba in indeksiranje podatkov; 7. Formalni poizvedovalni jeziki; 8. Osnove SQL; 9. Predstavitev QBE; 10. XML PB in XQuery; III. Osnove načrtovanja PB 11. tri-nivojski pristop k načrtovanju PB; 12. Konceptualno načrtovanje; 13. Logično načrtovanja; 14. Osnove normalizacije; 15. Fizično načrtovanje. 16. Podatkovna skladišča in njihovo načrtovanje Opcijsko: noSQL in newSQL osnove	**lectures:** I. Introduction to DB 1. History of data bases; 2. DB management systems (DBMS); 3. Types of DBMS; 4. Roles in DB Management; II. Describing, Storing and Querying data in DB 5. 3-tire data representation; 6. Data storing and indexing; 7. Formal query languages; 8. SQL basics; 9. QBE; 10. XML SUPB, XQuery; III. DB design - basics 11. 3-level data modelling approach; 12. Conceptual data modelling; 13. Logical data modelling; 14. Normalisation - basics; 15. Physical data modelling. 16. Data warehouses and their design; Optional: noSQL and newSQL basics

Temeljni literatura in viri / Readings:

1. Thomas M. Connolly, Carolyn E. Begg (2009). *Database Systems, A Practical Approach to Design, Implementation and Management*, Fifth Edition, Addison-Wesley.
2. Raghu Ramakrishnan, Johannes Gehrke (2003). *Database Management Systems*, Third Edition, McGraw-Hill.

Cilji in kompetence:

Cilj predmeta je študentom računalništva in informatike predstaviti osnove o podatkovnih bazah, kaj so prednosti uporabe podatkovnih baz v primerjavi z drugimi načini shranjevanja podatkov; kako podatkovne baze delujejo in kako upravljamo z njimi; kako poizvedujemo po podatkih v podatkovnih bazah, kako jih načrtujemo ter kako z njimi upravljamo.

Splošne kompetence:

- Sposobnost razumevanja in reševanja strokovnih problemov s področja računalništva in informatike.
- Sposobnost iskanja virov informacij in kritične evaluacije razpoložljivih virov.
- Sposobnost uporabe pridobljenega znanja za samostojno reševanje problemov; sposobnost izpopolnjevanja pridobljenega znanja;

Specifične kompetence:

- Osnovne spretnosti s področja računalništva in informatike;
- Sposobnost prenosa znanja na sodelavce tako v tehničnih kot raziskovalnih skupinah.
- Osnovno znanje in spretnosti, ki so potrebni za nadaljevanje študija na drugi bolonjski stopnji.

Objectives and competences:

The aim of this course is to explain students the basics of databases, i.e. advantages of using database systems over using file systems, how databases and database management systems work, how we manage them; how we design databases, how we query databases etc.

General competencies:

- The ability to understand and solve professional challenges in computer and information science.
- The ability to search knowledge sources and to search for resources and critically evaluate information.
- The ability to apply acquired knowledge in independent work for solving technical and scientific problems in computer and information science; the ability to upgrade acquired knowledge.

Specific competencies:

- Basic skills in computer and information science, which includes basic theoretical skills, practical knowledge and skills essential for the field of computer and information science;
- The ability to transmit knowledge to co-workers in technology and research groups.
- Basic skills in computer and information science, allowing the continuation of studies in the second study cycle.

Predvideni študijski rezultati:

Intended learning outcomes:

Znanje in razumevanje: Poznavanje osnovnih principov delovanja sistemov za upravljanje s podatkovnimi bazami. Poznavanje tehnik načrtovanja podatkovnih baz. Poznavanje formalnih jezikov za poizvedovanje po podatkovnih bazah. Poznavanje prednosti uporabe podatkovnih baz. Uporaba: Uporaba v sklopu razvoja informacijskih sistemov in druge programske opreme, ki zahteva obvladovanje večjih količin podatkov. Refleksija: Zmožnost izboljševanja pristopov modeliranja, predstavitve in hranjenja podatkov v okviru praktičnih problemov. Prenosljive spretnosti - niso vezane le na en predmet: Spretnosti uporabe domače in tuje literature in drugih virov, uporaba IKT, uporaba sistematičnih pristopov, analiza potreb, identifikacija in reševanje problemov, delo v timih.	Knowledge and understanding: Understanding basic principles of systems for database management. Understanding of database design techniques and approaches. Understanding of formal database query languages. Understanding advantages the use of database management systems brings. Application: The use within information system development and development of other computer programs that demand or work with high volumes of data. Reflection: Capability for improving modelling techniques, data representation and storing while solving practical problems. Transferable skills: ability to use domestic and foreign literature, the use of ICT, the use of systematical approaches in solving problems, ability to identification of problems and their resolution, team work.

Metode poučevanja in učenja:	**Learning and teaching methods:**
Predavanja, računske vaje z ustnimi nastopi, projektni način dela pri domačih nalogah in seminarjih.	Lectures, Practical exercises, homeworks and seminars in team.

Načini ocenjevanja:	Delež (v %) / Weight (in %)	**Assessment:**
Način (pisni izpit, ustno izpraševanje, naloge, projekt):		Type (examination, oral, coursework, project):
Sprotno preverjanje (domače naloge, kolokviji in projektno delo)	**50%**	**Continuing** (homework, midterm exams, project work)
Končno preverjanje (pisni in ustni izpit)	**50%**	**Final** (written and oral exam)
Ocene: 6-10 pozitivno, 1-5 negativno (v skladu s Statutom UL)		Grading: 6-10 pass, 1-5 fail.

Reference nosilca / Lecturer's references:

Pet najpomembnejših del:

ŽITNIK, Slavko, ŠUBELJ, Lovro, BAJEC, Marko. SkipCor : skip-mention coreference resolution using linear-chain conditional random fields. *PloS one*, ISSN 1932-6203, Jun. 2014, vol. 9, no. 6, str. 1-14

ŠUBELJ, Lovro, FIALA, Dalibor, BAJEC, Marko. Network-based statistical comparison of citation topology of bibliographic databases. *Scientific reports*, ISSN 2045-2322, 2014, 4, str. 1-10

FIALA, Dalibor, ŠUBELJ, Lovro, ŽITNIK, Slavko, BAJEC, Marko. Do PageRank-based author rankings outperform simple citation counts?. *Journal of informetrics*, ISSN 1751-1577, Apr. 2015, vol. 9, no. 2, str. 334-348

KRALLINGER, Martin, ŽITNIK, Slavko, BAJEC, Marko, et al. The CHEMDNER corpus of chemicals and drugs and its annotation principles. *Journal of cheminformatics*, ISSN 1758-2946. [Online ed.], 2015, vol. 7, suppl. 1, str. 1-17

ŠUBELJ, Lovro, FIALA, Dalibor, BAJEC, Marko. Network-based statistical comparison of citation topology of bibliographic databases. *Scientific reports*, ISSN 2045-2322, 2014, 4, str. 1-10

UČNI NAČRT PREDMETA / COURSE SYLLABUS	
Predmet:	**Razvoj informacijskih sistemov**
Course title:	**Information Systems Development**

Študijski program in stopnja Study programme and level	Študijska smer Study field	Letnik Academic year	Semester Semester
Univerzitetni študijski program prve stopnje Računalništvo in informatika **Interdisciplinarni univerzitetni študijski program prve stopnje Računalništvo in in matematika** **Interdisciplinarni univerzitetni študijski program prve stopnje Upravna informatika**	**Modul: Obvladovanje informatike**	**3**	**zimski**
University study programme Computer and Information Science, 1st cycle **University study programme Computer Science and Mathematics , 1st cycle** **Interdisciplinary university Study Programme in Administrative Informatics 1st Cycle**	**Module: Management of Information Systems**	**3**	**fall**

Vrsta predmeta / Course type	**izbirni predmet / elective course** **obvezni predmet / compulsory course**
Univerzitetna koda predmeta / University course code:	**63252**

Predavanja Lectures	Seminar Seminar	Vaje Tutorial	Klinične vaje Laboratory work	Druge oblike študija Field work	Samost. delo Individ. work	ECTS
45	20	10	/	/	105	6

Nosilec predmeta / Lecturer:	prof. dr. Marko Bajec
Jeziki / Languages:	**Predavanja / Lectures:** slovenščina Slovene

Vaje / Tutorial:	slovenščina Slovene

Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:	**Prerequisites:**

Vsebina:	**Content (Syllabus outline):**
predavanja: I. Splošno o razvoju IS 1. opis življenjskih modelov razvoja IS 2. pristopi in metodologije razvoja IS 3. problem obvladovanja kakovosti razvoja IS; II. Strukturni razvoj 4. osnove strukturnega razvoja; 5. predstavitev osnovnih aktivnosti strukturnega razvoja; III. Objektni razvoj 6. osnove objektnega razvoja; 7. predstavitev osnovnih aktivnosti objektnega razvoja; 8. primerjava objektni-strukturni razvoj; IV. Sodobne lahke in agilne metodologije 9. predstavitev osnovnih konceptov; 10. predstavitev dobrih praks; 11. konkretni primeri lahkih in agilnih pristopov.	Lectures: I. General information about IS development 1. software development life cycles; 2. IS development approaches and methods; 3. Managing quality of IS development; II. Structured IS development 4. Basics of structured IS development; 5. Main activities of structured IS development; III. Object-oriented development 6. Basics of object-oriented IS development; 7. Main activities of object-oriented IS development; 8. Comparison of structured and object-oriented IS development; IV. Light and agile methods for IS development 9. Basic concepts; 10. Good practices; 11. Examples of light and agile approaches.

Temeljni literatura in viri / Readings:

1. Jeffrey A. Hoffer, Joey George, Joe Valacich (2013), Modern Systems Analysis and Design (7th Edition), Addison-Wesley.
2. Martin Fowler (2003). UML Distilled: A Brief Guide to the Standard Object Modeling Language, Third Edition. Addison-Wesley.
3. Thomas A. Pender (2002). UML Weekend Crash Course. Wiley Publishing.
4. Per Kroll, Philippe Kruchten, Grady Booch (2003), The Rational Unified Process Made Easy: A Practitioner's Guide to the RUP), Addison-Wesley.
5. Martin, C. Robert (2003). Agile Software Development: Principles, Patterns and Practices. Prentice Hall.
6. Cockburn, A (2006). Agile Software Development (2nd Edition). Pearson Education.

Cilji in kompetence:

Cilj predmeta je študente naučiti sistematičnih in discipliniranih pristopov k razvoju informacijskih sistemov. V okviru predmeta bodo predstavljeni tako tradicionalni kot tudi modernejši pristopi k razvoju informacijskih sistemov.

Splošne kompetence:

- Sposobnost kritičnega razmišljanja;
- Razvoj spretnosti s kritičnim, analitičnim in sintetičnim razmišljanjem;
- Sposobnost definiranja, razumevanja in reševanja strokovnih izzivov s področja računalništva in informatike;
- Sposobnost uporabe pridobljenega znanja za samostojno reševanje problemov; sposobnost izpopolnjevanja pridobljenega znanja;
- Sposobnost timskega dela v profesionalnem okolju;
- Vodenje manjšega strokovnega tima.

Specifične kompetence

- Sposobnost samostojnega izvajanja lažjih in zahtevnejših inženirskih ter organizacijskih nalog na določenih ožjih področjih računalništva in informatike.
- Osnovno znanje in spretnosti, ki so potrebni za nadaljevanje študija na drugi bolonjski stopnji.

Objectives and competences:

The goal of this course is to teach students how to manage non-trivial IS development using systematical and disciplined approaches. Within the course the students will learn both, traditional and modern approaches and principles of IS development.

General competencies:

- Ability of critical thinking;
- Developing skills in critical, analytical and synthetic thinking;
- The ability to define, understand and solve creative professional challenges in computer and information science;
- The ability to apply acquired knowledge in independent work for solving technical and scientific problems in computer and information science; the ability to upgrade acquired knowledge;
- The ability of teamwork within the professional environment; management of a small professional team.

Specific competencies:

- The ability to independently perform both less demanding and complex engineering and organisational tasks in certain narrow areas and independently solve specific well-defined tasks in computer and information science.
- Basic skills in computer and information science, allowing the continuation of studies in the second study cycle.studies in the second study cycle.

Predvideni študijski rezultati:	**Intended learning outcomes:**
Znanje in razumevanje: Pristopi k razvoju IS; strukturne tehnike; objektne tehnike; sodobne, sociološko naravnane tehnike razvoja; ključni problemi in dejavniki uspeha pri razvoju IS. Uporaba: Izbira in uporaba različnih tehnik pri skupinskem razvoju informacijskih rešitev; obvladovanje razvoja. Refleksija: Poglobljeno razumevanje problematike skupinskega razvoja in zmožnost razvoja novih, posameznim skupinam prilagojenih pristopov. Prenosljive spretnosti - niso vezane le na en predmet: Spretnosti uporabe domače in tuje literature in drugih virov, uporaba IKT, uporaba sistematičnih pristopov, analiza potreb, identifikacija in reševanje problemov, delo v timih.	Knowledge and understanding: Approaches to IS development; Structured techniques; Modern, socio-oriented techniques of IS development; Key problems and success factors in IS development. Application: Selection and use different techniques in collaborative IS development; Management of IS development. Reflection: Understanding of the intrinsic problems of collaborative IS development; skills to tailor or engineer new methods, sound to particular circumstances. Transferable skills: skills to use domestic and international literature and other sources, the use of ICT, employment of systematic approaches, problem analysis, problem identification and resolving, collaborative work…

Metode poučevanja in učenja:	**Learning and teaching methods:**
Predavanja, računske vaje z ustnimi nastopi, projektni način dela.	Lectures, exercises, project work.

Načini ocenjevanja:	Delež (v %) / Weight (in %)	**Assessment:**
Način (pisni izpit, ustno izpraševanje, naloge, projekt):		Type (examination, oral, coursework, project):
Sprotno preverjanje (domače naloge, kolokviji in projektno delo)	**50%**	**Continuing** (homework, midterm exams, project work)
Končno preverjanje (pisni in ustni izpit)	**50%**	**Final** (written and oral exam)
Ocene: 6-10 pozitivno, 1-5 negativno (v skladu s Statutom UL)		Grading: 6-10 pass, 1-5 fail.

Reference nosilca / Lecturer's references:

Pet najpomembnejših del:

1. BAJEC, Marko, KRISPER, Marjan. Agilne metodologije razvoja informacijskih sistemov. *Uporab. inform. (Ljubl.)*, apr., maj, jun. 2003, letn. 11, št. 2, str. 68-76, ilustr. [COBISS.SI-ID 3679060]
kategorija: 1C (Z2); upoštevana uvrstitev: MBP; tipologijo je verificiral OSICT
točke: 15, št. avtorjev: 2

2. BAJEC, Marko, VAVPOTIČ, Damjan, KRISPER, Marjan. Practice-driven approach for creating project-specific software development methods. *Inf. softw. technol.*. [Print ed.], 2007, vol. 49, no. 4, str. [345]-365, ilustr. [COBISS.SI-ID 5815124], [JCR, WoS, št. citatov do 24. 5. 2011: 10, brez avtocitatov: 7, normirano št. citatov: 6]
kategorija: 1A3 (Z1); upoštevana uvrstitev: SCI; tipologijo je verificiral OSICT
točke: 21.95, št. avtorjev: 3

3. BAJEC, Marko, VAVPOTIČ, Damjan. A framework and tool-support for reengineering software development methods. *Informatica (Vilnius)*, 2008, vol. 19, no. 3, str. 321-344, ilustr. [COBISS.SI-ID 6701396], [JCR, WoS, št. citatov do 6. 5. 2011: 2, brez avtocitatov: 2, normirano št. citatov: 2]
kategorija: 1A3 (Z1); upoštevana uvrstitev: SCI; tipologijo je verificiral OSICT
točke: 37.85, št. avtorjev: 2

4. VAVPOTIČ, Damjan, BAJEC, Marko. An approach for concurrent evaluation of technical and social aspects of software development methodologies. *Inf. softw. technol.*. [Print ed.], 2009, vol. 51, no. 2, str. 528-545, ilustr. [COBISS.SI-ID 6803284], [JCR, WoS, št. citatov do 6. 8. 2011: 3, brez avtocitatov: 2, normirano št. citatov: 2]
kategorija: 1A1 (Z1); upoštevana uvrstitev: SCI; tipologijo je verificiral OSICT
točke: 52.59, št. avtorjev: 2

5. ŽVANUT, Boštjan, BAJEC, Marko. A tool for IT process construction. *Inf. softw. technol.*. [Print ed.], Apr. 2010, vol. 52, no. 4, str. 397-410, ilustr. [COBISS.SI-ID 7558484], [JCR, WoS, št. citatov do 7. 5. 2010: 0, brez avtocitatov: 0, normirano št. citatov: 0]
kategorija: 1A1 (Z1); upoštevana uvrstitev: SCI; tipologijo je verificiral OSICT
točke: 52.59, št. avtorjev: 2

Celotna bibliografija je dostopna na SICRISu:
http://sicris.izum.si/search/rsr.aspx?lang=slv&id=9270.

UČNI NAČRT PREDMETA / COURSE SYLLABUS	
Predmet:	**Programiranje specifičnih platform**
Course title:	**Platform Based Development**

Študijski program in stopnja Study programme and level	Študijska smer Study field	Letnik Academic year	Semester Semester
Univerzitetni študijski program prve stopnje Računalništvo in informatika **Univerzitetni študijski program prve stopnje Računalništvo in matematika**	**Modul: Razvoj programske opreme**	**3**	**poletni**
University study programme Computer and Information Science, 1st cycle **University study programme Computer Science and Mathematics , 1st cycle**	**Module: Software Development**	**3**	**spring**

Vrsta predmeta / Course type	**izbirni predmet / elective course**
Univerzitetna koda predmeta / University course code:	**63287**

Predavanja Lectures	Seminar Seminar	Vaje Tutorial	Klinične vaje Laboratory work	Druge oblike študija Field work	Samost. delo Individ. work	ECTS
45	/	30	/	/	105	6

Nosilec predmeta / Lecturer:	prof. dr. Zoran Bosnić

Jeziki / Languages:	**Predavanja / Lectures:**	slovenščina Slovene
	Vaje / Tutorial:	slovenščina Slovene

Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:	**Prerequisites:**

Vsebina:

Predmet vsebuje teme s področja programiranja specifičnih platform, ki so priporočene v ACMjevem kurikulu za računalništvo. Konkretna vsebina se bo letno prilagajala trendom, zato kurikulum ni omejen na konkretne platforme.

1. pregled platform (spletne, mobilne, igralne, industrijske, vgradne, robotske, paralelne/skalabilne,…),
2. podprti programski jeziki
3. programiranje z uporabo specifičnih knjižnic,
4. programiranje glede na omejitve posamezne platforme,
5. programski jeziki za mobilne platforme,
6. ravnotežje poraba/zmogljivost in analiza izvrševanja programa,
7. omejitve in izzivi mobilnih platform ter brezžična komunikacija, lokacijske aplikacije in nove tehnologije (navidezna in obogatena resničnost,…),
8. programiranje in pristopi za časovno kritične interaktivne platforme,
9. omejitve platform za časovno kritične interaktivne aplikacije,
10. izbrane vsebine iz programiranja industrijskih/robotskih/vgradnih platform,
11. izbrane vsebine iz programiranja igralnih platform.

Vaje potekajo konzultacijsko in seminarsko. Gradi se projekt skozi sprinte po Scrum metodi razvoja programske opreme.

Content (Syllabus outline):

The course will include topics in platform based development recommended in the ACM curriculum for CS. The topics will continually adapt to contemporary trends, thus the course is not constrained to a specific platform.

1. overview of platforms (web, mobile, game, industrial, embedded, robotic, paralel/scalable,…),
2. supported/domain-specific programming languages
3. programming via platform-specific APIs
4. programming under platform constraints,
5. mobile platform languages,
6. performance/power tradeoffs and profiling,
7. mobile platform constraints and challenges with wireless communication, location-aware applications and emerging technologies (virtual and augmented reality,…)
8. programming languages and approaches for time-critical interactive platforms,
9. platform constraints for time-critical interactive applications,
10. selected topics from industrial/robotic/embedded platforms programming,
11. selected topics from game platforms programming.

Practical part of the course consists of seminar work and consultations (tutorial). Students build the project using sprints as specified by

	Scrum software engineering methodology.

Temeljni literatura in viri / Readings:

1. D. Crockford: JavaScript: The Good Parts, O'Reilly Media; 1st edition (May 2008)
2. P. A. Laplante , S. J. Ovaska :Real-Time Systems Design and Analysis: Tools for the Practitioner, Wiley-IEEE Press; 4 edition (November 22, 2011)
3. M. Neuburg: iOS 9 Programming Fundamentals with Swift: Swift, Xcode, and Cocoa Basics, O'Reilly Media, 2015.
4. R. Meier: Professional Android 4 Application Development, 3rd Edition; Wrox, 2012.
5. R. Ierusalimschy: Programming in LUA, Lua.org, 2013.

Cilji in kompetence:	**Objectives and competences:**
Cilj predmeta je spoznati različne moderne računalniške platforme in se spoznati s specifikami razvoja programske opreme na teh platformah. Splošne kompetence: - Zmožnost kritičnega razmišljanja. - Zmožnost definirati, razumeti in rešiti kreativne strokovne izzive na področju računalništva in informatike. - Zmožnost apliciranja in nadgrajevanja pridobljenega znanja. Predmetno specifične kompetence: - Zmožnost prenosa znanja sodelavcem v tehnoloških ekipah. - Veščine in praktično znanje o posebnih strojni opremi platform, specialnih programskih jezikih in omejitvah posameznih platform.	The aim of the course is to gain expertise on several modern platforms and learn the specifics of software development for these. General competences: - Ability of critical thinking. - The ability to define, understand and solve creative professional challenges in computer and information science. - The ability to apply and upgrade acquired knowledge. Subject specific competences: - The ability to transmit knowledge to co-workers in technology groups. - Practical knowledge and skills of paticular computer hardware of specific platforms, special programming languages and constraints associated with these.

Predvideni študijski rezultati:	**Intended learning outcomes:**
Znanje in razumevanje: razumevanje omejitev, ki jih različne platforme predstavljajo za razvijalce; razumevanje potrebnega ravnotežja med zmogljivostmi in porabo programja; razumevanje prednosti in slabosti programiranja za platformo v primerjavi s programiranjem brez takšnih omejitev. **Uporaba:** razvoj programskega izdelka na izbranih specifičnih oziroma časovno kritičnih platformah, npr. mobilnih, interaktivnih, igralnih in robotskih platformah. **Refleksija:** Poleg konkretnih znanj bodo študenti dobili tudi širok teoretični pregled nad posebnostmi, ki jih prinaša razvoj produkta za različne platforme. **Prenosljive spretnosti - niso vezane le na en predmet:** Znanje programiranja je potrebno za večino drugih predmetov študija.	**Knowledge and understanding**: understanding limitations imposed by various platforms for software developers; mastering the performance/power tradeoff; understanding and comparing specific platform oriented languages with general purpose programming. **Application:** developing a software product for selected mobile or time-critical platforms, e.g., interactive, game and robotic platforms. **Reflection:** Besides practical skills students shall gain theoretical background on particularities associated with platform based development. **Transferable skills:** Programming is the basic skill and an implicitly required prerequisite for most other courses.

Metode poučevanja in učenja:	**Learning and teaching methods:**
Predavanja in domača naloge. Poseben poudarek je na individualnem delu študentov.	Lectures and homework with special emphasis on individual work.

Načini ocenjevanja:	Delež (v %) / Weight (in %)	**Assessment:**
Način (pisni izpit, ustno izpraševanje, naloge, projekt): **Sprotno preverjanje** (domače naloge) **Končno preverjanje** (pisni in ustni izpit) Ocene: 6-10 pozitivno, 1-5 negativno (v skladu s Statutom UL)	 **50%** **50%**	Type (examination, oral, coursework, project): **Continuing** (homework) **Final** (written and oral exam) Grading: 6-10 pass, 1-5 fail (according to the rules of University of Ljubljana)

Reference nosilca / Lecturer's references:

Pet najpomembnejših del:

1. OCEPEK, Uroš, BOSNIĆ, Zoran, NANČOVSKA ŠERBEC, Irena, RUGELJ, Jože. Exploring the relation between learning style models and preferred multimedia types. Computers & Education, ISSN 0360-1315. [Print ed.], Nov. 2013, vol. 69, str. 343-355.
2. BOSNIĆ, Zoran, KONONENKO, Igor. Estimation of individual prediction reliability using the local sensitivity analysis. Appl. intell. (Boston). [Print ed.], Dec. 2008, vol. 29, no. 3, p. 187-203, ilustr.
3. BOSNIĆ, Zoran, KONONENKO, Igor. Comparison of approaches for estimating reliability of individual regression predictions. Data knowl. eng.. [Print ed.], Dec. 2008, vol. 67, no. 3, p. 504-516
4. ŠTRUMBELJ, Erik, BOSNIĆ, Zoran, KONONENKO, Igor, ZAKOTNIK, Branko, GRAŠIČ-KUHAR, Cvetka. Explanation and reliability of prediction models: the case of breast cancer recurrence. Knowledge and information systems, 2010, vol. 24, no. 2, p. 305-324
5. BOSNIĆ, Zoran, KONONENKO, Igor. Automatic selection of reliability estimates for individual regression predictions. Knowl. eng. rev., 2010, vol. 25, no. 1, p. 27-47

Celotna bibliografija je dostopna na SICRISu:
http://sicris.izum.si/search/rsr.aspx?lang=slv&id=31318.

UČNI NAČRT PREDMETA / COURSE SYLLABUS	
Predmet:	**Računalniške komunikacije**
Course title:	**Computer Communications**

Študijski program in stopnja Study programme and level	Študijska smer Study field	Letnik Academic year	Semester Semester
Univerzitetni študijski program prve stopnje Računalništvo in informatika	**ni smeri**	**1**	**poletni**
Interdisciplinarni univerzitetni študijski program prve stopnje Računalništvo in matematika		**2**	
Interdisciplinarni univerzitetni študijski program prve stopnje Upravna informatika		**1**	
University study programme Computer and Information Science, 1st cycle	**none**	**1**	**spring**
Interdisciplinary University study programme Computer Science and Mathematics , 1st cycle		**2**	
Interdisciplinary university Study Programme in Administrative Informatics 1st Cycle		**1**	

Vrsta predmeta / Course type	**obvezni predmet / compulsory course**
Univerzitetna koda predmeta / University course code:	**63209**

Predavanja Lectures	Seminar Seminar	Vaje Tutorial	Klinične vaje Laboratory work	Druge oblike študija Field work	Samost. delo Individ. work	ECTS
45	/	30	/	/	105	6

Nosilec predmeta / Lecturer:	prof. dr. Zoran Bosnić
Jeziki / **Predavanja /**	slovenščina

Languages:		
	Lectures:	Slovene
	Vaje / Tutorial:	slovenščina Slovene

Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:

Prerequisites:

Vsebina:

1. Uvod: računalniška omrežja in internet
2. Osnovni pojmi: plasti, protokoli, storitve, protokolarni sklad. Hrbtenica in krajevna omrežja; kje nastajajo zakasnitve.
3. Aplikacijska plast: storitve, pregled standardnih protokolov. Zasnova omrežnih aplikacij, standardni protokoli HTTP, FTP, SMTP, DNS. Delovanje e-pošte, peer-to-peer aplikacij, vtičev (socket) in uporaba storitev transportne plasti.
4. Predstavitvena in sejna plast: vsebina in storitve, primeri.
5. Transportna plast: storitve, multipleksiranje, povezavni in nepovezavni prenos (TCP in UDP), zanesljiv prenos podatkov, nadzor zasičenja (congestion control), izvedba le tega v TCP.
6. Omrežna plast: storitve, virtualne zveze in datagramske povezave, delovanje usmerjevalnikov, naslavljanje v internetu (IP in IPv6), temelji usmerjanja.
7. Prenosni sistem – povezavna in fizična plast, krajevna omrežja (LAN): storitve, zaznavanje in odpravljanje napak, protokoli za skupinski prenosni medij,. Fizični naslovi (MAC) in preslikava v IP naslove (ARP), delovanje stikal. Ethernet, PPP, brezžična omrežja, aktualni standardi (npr. IEEE 802.11x, Bluetooth). Celularna omrežja, mobilnost. Prenos signalov, prenosni mediji, vrste modulacije.

Content (Syllabus outline):

1. Introduction: Computer networks and internet
2. Basic notions: layer, protocol, service, protocol stack. Backbone and local area networks; transmission latency sources.
3. Application layers: services, network application basics, overview of well-known protocols. Protocols HTTP, FTP, SMTP, DNS. E-mail functionalities, peer-to-peer applications, sockets, use of transport layer services.
4. Presentation and session layer: their purpose and services.
5. Transport layer: services, multiplexing, connection-oriented and connectionless transfer (TCP and UDP), reliable data transfer, congestion control and its implementation inside TCP.
6. Network layer: services, virtual and datagram connections, routing, addressing in internet (IPv4 and IPv6), routers.
7. Transmission system – data link and physical layer, local area networks (LANs): services, error detection and correction techniques, media access protocols, addressing (MAC addresses) and mapping of MAC address to IP addresses (protocol ARP), switches and their functionalities. Ethernet, PPP, wireless networks, current standards (IEEE 802.11x, Bluetooth), cellular networks, mobile networks, transmission of signals, media types, modulations.

8. Omrežna varnost, zanesljivost in zaščita, celovitost sporočil, avtentikacija, pregled varovanja e-pošte, TCP povezav (SSL), omrežne povezave (IPSec), brezžične povezave. Požarne pregrade, IDS, IPS sistemi. Aktualni omrežni napadi in obramba pred njimi. 9. Pomen upravljanja omrežja.	8. Network security, reliability and protections. Message integrity, authentication, protection of e-mail, TCP connections (SSL), network connection (IPSec), wireless connections). Firewalls, IDS/IPS systems. Network attacks and defense from them. 9. Network management.

Temeljni literatura in viri / Readings:

1. J. F. Kurose, K. W. Ross, M. Ciglarič, Z. Bosnić: Računalniške komunikacije. Pearson, England, 2014, ISBN 978-1-78399-776-3.

Dodatna literatura:

1. J. F. Kurose, K. W. Ross: Computer Networking, A top-down Approach Featuring Internet. 4. izdaja, Addison Wesley 2007. Poglavja 2-6 in 8.A.S. Tanenbaum, Computer Networks, 4. izdaja, Prentice Hall PTR, 2002.

Cilji in kompetence:	**Objectives and competences:**
Cilj predmeta je študentom računalništva in informatike predstaviti osnove delovanja računalniških omrežij in pomembnejših protokolov. Kompetence, ki jih bo študent pridobil, so zlasti: • sposobnost uporabe informacijsko-komunikacijske tehnologije in sistemov • razumevanje delovanja večplastnih sistemov sodobnih komunikacij • sposobnost uporabe in načrtovanja omrežnih storitev • usposobljenost za načrtovanje omrežij in smiselno dodeljevanje omrežnih naslovov • usposobljenost za postavitev preprostega omrežja (domače omrežje), za osnovno nastavljanje kompleksnih usmerjevalnikov in za postavitev krajevnega omrežja s stikali in brezžičnimi dostopovnimi točkami.	The main goal is to present the students of computer science and informatics the basics of computer networking and the most important communication protocols in this area. The competences that the students will acquire, are: • capability to use information and communication systems and technology • understanding of how multi-layer communication systems work • use and design of network services • being capable of designing network architectures and implementing network addressing • capability for installing and administering a simple (home) network, performing basic routing settings and configuring switches and wireless access points.

Predvideni študijski rezultati:	**Intended learning outcomes:**
Znanje in razumevanje: Poznavanje glavnih omrežnih modelov (TCP/IP in ISO/OSI). Razumevanje razlike med arhitekturo in strukturo. Poznavanje in ločevanje funkcionalnosti posamezne plasti.	**Knowledge and understanding:** Knowledge of formal network models (TCP/IP and ISO/OSI). Understanding differences between architecture and structure. Differentiating between functionalities of

Sposobnost umestitve konkretnega problema na ustrezno plast v modelu. **Uporaba:** Uporaba omrežnih protokolov in storitev v svojih izvedbah. **Refleksija:** Spoznavanje in razumevanje medsebojne soodvisnosti plasti v različnih večplastnih modelih omrežij in povezava s konkretnimi izvedbami. **Prenosljive spretnosti - niso vezane le na en predmet:** Reševanje različnih problemov na osnovi večplastnih arhitekturnih modelov storitev. Reševanje različnih problemov na osnovi različnih strukturnih modelov omrežij in topologij.	different network layers. Linking the networking challenges with the appropriate network layer. **Application:** Use of network protocols and services in own configurations. **Reflection:** Becoming familiar and acquiring understanding of how the network layers are inter-dependent of each other; linking these findings with particular network implementations. **Transferrable skills:** Solving various problems using various multilayer service architecture models. Solving problems based on the structural network and network topology models.

Metode poučevanja in učenja:	**Learning and teaching methods:**
Predavanja, laboratorijske vaje, seminarski način dela pri domačih nalogah, konzultacije pri izvajanju seminarskih nalog (konkretni projekti). Poseben poudarek je na tekočem sledenju teorije in na timskem delu in medsebojnem usklajevanju pri vajah in seminarjih.	Lectures, tutorials, homeworks in the form of seminars, consultations for preparing of seminars (particular selected projects). Special emphasis is given on the following and understanding of given theoretical knowledge and on team work and cooperation within tutorials and seminars.

Načini ocenjevanja:	Delež (v %) / Weight (in %)	**Assessment:**
Način (pisni izpit ali ustno izpraševanje, naloge, projekt):		Type (examination, oral, coursework, project):
Sprotno preverjanje (domače naloge, kolokviji in laboratorijske vaje)	**40%**	**Continuing** (homework, midterm exams, laboratory exercises)
Končno preverjanje (pisni ali ustni izpit)	**60%**	**Final** (written or oral exam)
Ocene: 6-10 pozitivno, 1-5 negativno (v skladu s Statutom UL)		Grading: 6-10 pass, 1-5 fail.

Reference nosilca / Lecturer's references:

Pet najpomembnejših del:

1. OCEPEK, Uroš, BOSNIĆ, Zoran, NANČOVSKA ŠERBEC, Irena, RUGELJ, Jože. Exploring the relation between learning style models and preferred multimedia types. Computers & Education, ISSN 0360-1315. [Print ed.], Nov. 2013, vol. 69, str. 343-355.

2. BOSNIĆ, Zoran, KONONENKO, Igor. Estimation of individual prediction reliability using the local sensitivity analysis. Appl. intell. (Boston). [Print ed.], Dec. 2008, vol. 29, no. 3, p. 187-203, ilustr.
3. BOSNIĆ, Zoran, KONONENKO, Igor. Comparison of approaches for estimating reliability of individual regression predictions. Data knowl. eng.. [Print ed.], Dec. 2008, vol. 67, no. 3, p. 504-516
4. ŠTRUMBELJ, Erik, BOSNIĆ, Zoran, KONONENKO, Igor, ZAKOTNIK, Branko, GRAŠIČ-KUHAR, Cvetka. Explanation and reliability of prediction models: the case of breast cancer recurrence. Knowledge and information systems, 2010, vol. 24, no. 2, p. 305-324
5. BOSNIĆ, Zoran, KONONENKO, Igor. Automatic selection of reliability estimates for individual regression predictions. Knowl. eng. rev., 2010, vol. 25, no. 1, p. 27-47

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UČNI NAČRT PREDMETA / COURSE SYLLABUS	
Predmet:	**Spletno programiranje**
Course title:	**Web Programming**

Študijski program in stopnja Study programme and level	Študijska smer Study field	Letnik Academic year	Semester Semester
Univerzitetni študijski program prve stopnje Računalništvo in informatika **Univerzitetni študijski program prve stopnje Računalništvo in matematika**	**Modul: Razvoj programske opreme**	**3**	**zimski**
University study programme Computer and Information Science, 1st cycle **University study programme Computer Science and Mathematics , 1st cycle**	**Module: Software Development**	**3**	**fall**

Vrsta predmeta / Course type	**izbirni predmet / elective course**
Univerzitetna koda predmeta / University course code:	**63255**

Predavanja Lectures	Seminar Seminar	Vaje Tutorial	Klinične vaje Laboratory work	Druge oblike študija Field work	Samost. delo Individ. work	ECTS
45	20	10	/	/	105	6

Nosilec predmeta / Lecturer:	izr. prof. dr. Zoran Bosnić

Jeziki / Languages:	**Predavanja / Lectures:**	slovenščina Slovene
	Vaje / Tutorial:	slovenščina Slovene

Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:	**Prerequisites:**

Vsebina:

Predavanja:

Uvod

1. Delovanje spleta; razvoj interneta, arhitektura klient-strežnik; komunikacijski protokol HTTP
2. Osnovni spletni standardi: HTML (DHTML...), CSS; osnove oblikovanja

Tehnologije na strani odjemalcev

3. JavaScript, rokovanje z dogodki, DOM, specifike posameznih brskalnikov, obrazci, validacija vnosov, JQuery
4. HTML5 Canvas
5. asinhnroni zahtevki z Ajax

Strežniške tehnologije

6. Pregled osnov strežniških tehnologij; delovanje skript, dinamično generiranje strani, HTTP GET in POST zahtevki, piškotki (cookies)
7. Spletne aplikacije v tehnologijah PHP, Java, JSP, JSF, ASP.NET, Ruby/Rails.
8. Lastnosti, namestitev in nastavljanje najpomembnejših spletnih strežnikov (IIS, Apache)

Ostalo

9. XML tehnologije. Sintaksa XML. Sheme. Pregledovanje dokumentov XML. Modeli in jeziki: DOM, SAX, XSLT, XPath, XQuery, Open XML.
10. Dostop do podatkovnih baz iz različnih strežniških tehnologij
11. Spletne storitve. Protokoli in opisni jeziki: SOAP, WSDL, UDDI. WS-* standardi. Storitveno usmerjena arhitektura. Pisanje porazdeljenih aplikacij.
12. Varnost na spletu. Upravljanje z

Content (Syllabus outline):

Lectures:

Introduction

1. World Wide Web, rise of internet, client-server architecture, communication protocols and HTTP.
2. Basic web standards: HTML (DHTML, ...), CSS, basics of web design

Client-side technologies

3. JavaScript, event handling, DOM, contemporary web browser specifics, forms, input validation, JQuery
4. HTML5 Canvas
5. Asynchronous requests and Ajax.

Server technologies

6. An overview of server technologies, scripts, dynamic generation of pages, HTTP GET and POST requests, cookies, etc.
7. Web applications in technologies PHP, Java, JSP, JSF, ASP.NET, Ruby/Rails
8. Properties, installation and administration of the most common web servers (IIS, Apache)

Other

9. XML technologies, XML syntax and schemes. Viewing of XML documents. Models and languages: DOM, SAX, XSLT, XPath, XQuery, Open XML.
10. Database access from web applications on different platforms
11. Web services. Protocols and descriptive languages: SOAP, WSDL, UDDI, WS-* standards. Service oriented architecture. Programming distributed applications.
12. Internet security. Identity management,

identitetami. Profiliranje uporabnikov.
13. Web 2.0. Semantični splet.

Vaje:
Laboratorijski projekt izdelave porazdeljene spletne aplikacije, razdeljen v posamezne faze (statične strani, kode na strani klienta, strežniška koda, storitve) in samostojno delo na projektih z zaključno predstavitvijo študentov.

user profiling.
13. Web 2.0. Semantic web.

Tutorials:
Laboratory project: programming of distributed web application, divided into individual phases (static pages, client-side code, server-side code, services). The students will develop the projects that will be introduced with the final presentation.

Temeljni literatura in viri / Readings:

1. Robert W. Sebesta: Programming the World Wide Web, Pearson Education.
2. Paul J. Deitel, Harvey M. Deitel, Abbey Deitel et al.: Internet & World Wide Web: how to program, Pearson, 2012.

Cilji in kompetence:

Cilj predmeta je študentom računalništva in informatike predstaviti tehnologije povezane z razvojem spletnih aplikacij, tako na strani odjemalca, kot strežnika in usposabljanje študentov za samostojen razvoj tovrstnih aplikacij.
Predvidene kompetence:

- poznavanje statičnih tehnologij HTML, CSS, XML,
- poznavanje programskega jezika JavaScript za razvoj na strani klienta,
- poznavanje tehnologij PHP, JSP, ASP.NET in Ruby on Rails za razvoj na strani strežnika,
- razvoj z uporabo spletnih storitev,
- snovanje aplikacij v arhitekturi model-pogled-kontrola,
- razvoj z upoštevanjem principov varnosti.

Objectives and competences:

The main course objective is to introduce the students of computer and information science the technologies, connected with the development of web applications (on the server and the client-side). The students shall be equipped with knowledge to independently develop such applications.
The competences that students gain are:

- knowing static technologies HTML, CSS, XML,
- knowing JavaScript programming language for client-side development
- knowing technologies PHP, JSP, ASP.NET and Ruby on Rails for server-side development,
- using web services within development,
- developing in the model-view-controller architecture,
- consideration of security principles.

Predvideni študijski rezultati:

Znanje in razumevanje:
Poznavanje osnovnih tehnologij za razvoj spletnih aplikacij.
Uporaba:
Razvoj celovitih spletnih rešitev, tako na strani

Intended learning outcomes:

Knowledge and understanding:
Knowing the most common technologies for web applications development.
Application:
Development of complex web solutions, using

odjemalca, kot strežnika. **Refleksija:** Spoznavanje in razumevanje uglašenosti med teorijo in njeno aplikacijo na konkretnih primerih s področja razvoja spletnih aplikacij. **Prenosljive spretnosti - niso vezane le na en predmet:** Razvoj spletnih rešitev na različnih strokovnih področjih. Hitro seznanjanje z novimi tehnologijami. Uporaba spletnih virov in dokumentacij za pomoč pri razvoju aplikacij.	server- and client-side development techniques. **Reflection:** Becoming familiar and understanding the web application development theory and applications on particular examples. **Transferable skills:** Development of web application for various areas connected with computer science. Becoming quickly familiar with new technologies. Using online sources and documentation for help with application development.

Metode poučevanja in učenja:	**Learning and teaching methods:**
Predavanja s praktičnimi demonstracijami, izvajanje laboratorijskega projekta pod mentorstvom asistenta.	Lectures with practical examples/demonstrations, making of laboratory project (guided by the assistant).

Načini ocenjevanja:	Delež (v %) / Weight (in %)	**Assessment:**
Način (pisni izpit, ustno izpraševanje, naloge, projekt):		Type (examination, oral, coursework, project):
Sprotno preverjanje (domače naloge, kolokviji in projektno delo)	**50%**	**Continuing** (homework, midterm exams, project work)
Končno preverjanje (pisni ali ustni izpit)	**50%**	**Final** (written or oral exam)
Ocene: 6-10 pozitivno, 1-5 negativno (v skladu s Statutom UL)		Grading: 6-10 pass, 1-5 fail.

Reference nosilca / Lecturer's references:

Pet najpomembnejših del:

1. OCEPEK, Uroš, BOSNIĆ, Zoran, NANČOVSKA ŠERBEC, Irena, RUGELJ, Jože. Exploring the relation between learning style models and preferred multimedia types. Computers & Education, ISSN 0360-1315., Nov. 2013, vol. 69, str. 343-355.
2. BOSNIĆ, Zoran, KONONENKO, Igor. Estimation of individual prediction reliability using the local sensitivity analysis. Appl. intell. (Boston). [Print ed.], Dec. 2008, vol. 29, no. 3, p. 187-203, ilustr.
3. BOSNIĆ, Zoran, KONONENKO, Igor. Comparison of approaches for estimating reliability of individual regression predictions. Data knowl. eng.. [Print ed.], Dec. 2008, vol. 67, no. 3, p. 504-516
4. ŠTRUMBELJ, Erik, BOSNIĆ, Zoran, KONONENKO, Igor, ZAKOTNIK, Branko, GRAŠIČ-KUHAR,

Cvetka. Explanation and reliability of prediction models: the case of breast cancer recurrence. Knowledge and information systems, 2010, vol. 24, no. 2, p. 305-324
5. BOSNIĆ, Zoran, KONONENKO, Igor. Automatic selection of reliability estimates for individual regression predictions. Knowl. eng. rev., 2010, vol. 25, no. 1, p. 27-47,

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http://sicris.izum.si/search/rsr.aspx?lang=slv&id=31318.

UČNI NAČRT PREDMETA / COURSE SYLLABUS	
Predmet:	**Osnove oblikovanja**
Course title:	**Introduction to Graphics Design**

Študijski program in stopnja **Study programme and level**	**Študijska smer** **Study field**	**Letnik** **Academic year**	**Semester** **Semester**
Univerzitetni študijski program prve stopnje Računalništvo in informatika	Modul: Medijske tehnologije	3	poletni
Interdisciplinarni univerzitetni študijski program prve stopnje Računalništvo in matematika			
Interdisciplinarni univerzitetni študijski program Upravna informatika prve stopnje		3	
Interdisciplinarni univerzitetni študijski program prve stopnje Multimedija		2	
University study programme Computer and Information Science, 1st cycle	Module: Media Technologies	3	spring
Interdisciplinary university study programme Computer Science and Mathematics , 1st cycle			
Interdisciplinary university study programme in Administrative Informatics 1st cycle		3	
Interdisciplinary university study programme Multimedia, 1st cycle		2	

Vrsta predmeta / Course type	izbirni predmet /elective course obvezni predmet / compulsory course
Univerzitetna koda predmeta / University course code:	63271

Predavanja **Lectures**	**Seminar** **Seminar**	**Vaje** **Tutorial**	**Klinične vaje** **Laboratory**	**Druge oblike študija**	**Samost. delo** **Individ.**	**ECTS**

			work	Field work	work	
45	/	30	/	/	105	6

Nosilec predmeta / Lecturer: izr. prof. dr. Narvika Bovcon

Jeziki / Languages:	**Predavanja / Lectures:**	slovenščina Slovene
	Vaje / Tutorial:	slovenščina Slovene

Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:

Prerequisites:

Vsebina:

1. Izbrana poglavja iz zgodovine in razvoja oblikovanja. Umetnost in znanost, oblikovanje in tehnologija.
2. Osnovne likovne prvine, barvna teorija, kompozicija – vaje: vizualne študije, barvne študije.
3. Osnove tipografije in zakonitosti uporabe črkovnih vrst in družin.
4. Oblikovalski prelom formata in strukturiranje formata z likovnimi in tipografskimi elementi.
5. Zakonitosti ekranske slike in principi montaže slik.
6. Strukturiranje sporočila skladno z zakonitostmi komunikacijskega koda in v odvisnosti od družbenega konteksta sporočanja.
7. Koncept interaktivnosti v novih medijih.
8. Načrtovanje uporabniškega vmesnika: – 1. poudarek na inovativnosti komunikacije med uporabnikom in računalnikom; – 2. poudarek na ustrezno strukturirani vizualni

Content (Syllabus outline):

1. Selected topics from the history of graphic design. Art and science, design and technology.
2. Graphic elements, colour theory, composition – practical work: visual studies, colour studies.
3. Typography: the basics and the principles of use.
4. Structuring of the graphic layout with visual and typographic elements.
5. Digital image and the principles of montage of images.
6. Structuring of the message according to the communication medium and with respect to the social context of the communication.
7. The concept of interactivity in new media.
8. Designing of user interfaces: – 1. with focus on the innovative concept of the human-computer interaction design; – 2. with focus on the effective visual communication of the graphical

komunikaciji elementov vmesnika, ki posreduje informacije o interakciji z vmesnikom. 9. Vizualizacija podatkov. Projektna naloga. 10. Uporabniški paket grafičnih programov Adobe: uporaba programov iz paketa.	elements of the interface that guides the interaction. 9. Data visualisation. Project work. 10. The Adobe software package: practical work.

Temeljni literatura in viri / Readings:

- Data Flow: Visualising Information in Graphic Design. Berlin: Gestalten, 2008.
- Flusser, V. Digitalni videz. Ljubljana: Študentska založba, 2000.
- Manovich, L. The Language of New Media. MIT, 2001.
- Samara, T. Design Elements: A Graphic Style Manual. Rockport Publishers, 2007.
- Strehovec, J. Besedilo in novi mediji. Ljubljana: LUD Literatura, 2007.
- Tufte, R. E. The Visual Display of Quantitative Information. Graphics Press LLC, 2001.
- Virtualni učitelji in priročniki za programe Adobe: Illustrator, Photoshop, After Effects, Premiere.

Cilji in kompetence:	**Objectives and competences:**
Cilj predmeta je študentom predstaviti osnove načrtovanja vizualnih komunikacij. Oblikovalske načrtovalske metode bodo študenti računalništva in informatike uporabili pri načrtovanju novomedijskih vmesnikov, vizualizacij podatkov, elektronskih dokumentov in spletnih strani.	The aim of the course is to introduce the students of computer and information sciences to the elements of visual language and the strategies of visual communication. The students will employ design methods to conceptualize new media interfaces, they will be able to effectively use graphic design elements to visualize data and present the contents of electronic documents and web pages.

Predvideni študijski rezultati:	**Intended learning outcomes:**
Znanje in razumevanje: Poznavanje zakonitosti likovnega izražanja, od osnovnih likovnih prvin do principov gradnje podobe. Poznavanje zakonitosti uporabe črkovnih vrst. Poznavanje medijskih zakonitosti ekranske slike. Razumevanje strukturiranosti komunikacije v odvisnosti od komunikacijskega koda in ciljne skupine sporočanja. Uporaba: Uporaba oblikovalskih metod in uporabniških oblikovalskih programov za oblikovanje spletnih strani, elektronskih dokumentov,	Knowledge and understanding: The laws of visual expression: the elements of visual language and the principles of image composition. The use of typography. Media specific design and design for the screen. The structure of communication and its dependence on the communicative code and the target audience. Application: The use of graphic design methods and the design software for designing web pages, digital documents, computer interfaces, visualising

računalniških vmesnikov, vizualizacijo podatkov. Refleksija: Spoznavanje in razumevanje oblikovalskega procesa kot integralnega dela pri načrtovanju komunikacije med računalnikom in uporabnikom. Prenosljive spretnosti - niso vezane le na en predmet: Reševanje problemov pri načrtovanju uporabniku prijaznih računalniških vmesnikov in elektronskih dokumentov, ki temelji na zakonitostih oblikovalske stroke in metodah vizualnega sporočanja.	information. Reflection: The understanding of graphic design process as an integral part of the human-computer interaction design. Transferable skills: Problem solving in human friendly approaches to interface design and digital document design, which draws on graphic design methods.

Metode poučevanja in učenja:	**Learning and teaching methods:**
Predavanja, vaje v šoli, seminarji zajemajo domače delo. Poseben poudarek je na sprotnem študiju. Poseben vidik je vpeljevanje v skupinsko delo na kompleksnem oblikovalskem projektu.	Lectures, practical work in school, project work at home. Emphasis on continuous work parallel to the lectures. Team-work experience on a complex multimedia design project.

Načini ocenjevanja:	Delež (v %) / Weight (in %)	**Assessment:**
Način (pisni izpit, ustno izpraševanje, naloge, projekt): **Sprotno preverjanje** (domače naloge, kolokviji in projektno delo). Ocene: 6-10 pozitivno, 1-5 negativno (v skladu s Statutom UL)	**50%** **50%**	Type (examination, oral, coursework, project): **Continuing** (homework, midterm exams, project work). Grading: 6-10 pass, 1-5 fail.

Reference nosilca / Lecturer's references:

Pet najpomembnejših del:

1.01 Izvirni znanstveni članek
1. BOVCON, Narvika. Literary aspects in new media art works. CLCWeb, ISSN 1481-4374. [Online ed.], 2014, vol. 15, no. 7, str. 1-13, ilustr. http://docs.lib.purdue.edu/cgi/viewcontent.cgi?article=2391&context=clcweb. [COBISS.SI-ID 10410068]

2. BOVCON, Narvika, VAUPOTIČ, Aleš, KLEMENC, Bojan, SOLINA, Franc. "Atlas 2012"

augmented reality : a case study in the domain of fine arts. V: First International Conference, SouthCHI 2013, Maribor, Slovenia, July 1-3, 2013. HOLZINGER, Andreas (ur.), et al. Human factors in computing and informatics : proceedings, (Lecture notes in computer science, ISSN 0302-9743, 7946). Heidelberg [etc.]: Springer, cop. 2013, str. 477-496, ilustr. http://eprints.fri.uni-lj.si/2098/. [COBISS.SI-ID 2782459] tipologija 1.08 -> 1.01

3. BOVCON, Narvika. Jezik gibljivih slik v računalniških vizualizacijah literarnozgodovinske podatkovne zbirke. *Literatura in gibljive slike : tematski sklop = Literature and moving images : thematic section*, (Primerjalna književnost, ISSN 0351-1189, letn. 37, št. 2). Ljubljana: Slovensko društvo za primerjalno književnost, 2014, letn. 37, št. 2, str. 119-133, 235-242, [244], ilustr. [COBISS.SI-ID 55119202]

4. BOVCON, Narvika. Pomenske mreže v arhivskih zbirkah - čas računalnikov in čas fotografije. Dialogi, ISSN 0012-2068, 2010, letn. 46, št. 11/12, str. 24-45, ilustr. http://eprints.fri.uni-lj.si/1387/. [COBISS.SI-ID 8148564]

3.12 Razstava
5. BOVCON, Narvika, MERVIČ, Vanja, VAUPOTIČ, Aleš. *Tehniške slike = Technical images : razstava na festivlu Speculum Artium 2015, 15.-17. oktober 2015, 7. mednarodni festival novomedijske kulture Integriteta realnosti*. [COBISS.SI-ID 4119547]

Celotna bibliografija je dostopna na SICRISu:
http://www.sicris.si/search/rsr.aspx?lang=slv&id=33966.

UČNI NAČRT PREDMETA / COURSE SYLLABUS	
Predmet:	**Osnove umetne inteligence**
Course title:	**Introduction to Artificial Intelligence**

Študijski program in stopnja Study programme and level	Študijska smer Study field	Letnik Academic year	Semester Semester
Univerzitetni študijski program prve stopnje Računalništvo in informatika **Univerzitetni študijski program prve stopnje Računalništvo in matematika**	**ni smeri**	**3**	**zimski**
University study programme Computer and Information Science, 1st cycle **University study programme Computer Science and Mathematics , 1st cycle**	**none**	**3**	**fall**

Vrsta predmeta / Course type	**obvezni predmet / compulsory course**
Univerzitetna koda predmeta / University course code:	**63214**

Predavanja Lectures	Seminar Seminar	Vaje Tutorial	Klinične vaje Laboratory work	Druge oblike študija Field work	Samost. delo Individ. work	ECTS
45	/	30	/	/	105	6

Nosilec predmeta / Lecturer:	akad. prof. dr. Ivan Bratko

Jeziki / Languages:	**Predavanja / Lectures:**	slovenščina Slovene
	Vaje / Tutorial:	slovenščina Slovene

Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:	**Prerequisites:**

Vsebina:

- Uvod v umetno inteligenco in primeri uporabe
- Prostor stanj in osnovni algoritmi preiskovanja: globinsko, širinsko, iterativno poglabljanje, zahtevnost teh algoritmov
- Hevristično preiskovanje, algoritma A* in IDA*, izrek o popolnosti A*, lastnosti ocenitvenih funkcij ter analiza časovne in prostorske zahtevnosti
- Dekompozicija problemov z AND/OR grafi, algoritmi iskanja v AND/OR grafih, hevristično preiskovanje in algoritem AO*
- Strojno učenje: problem učenja iz podatkov, iskanje zakonitosti v podatkih in podatkovno rudarjenje, opisni jeziki in prostori hipotez, učenje odločitvenih dreves, regresijskih dreves, modelnih dreves, ter pravil. Programska orodja strojnega učenja in primeri uporabe.
- Predstavitev znanja in ekspertni sistemi: predstavitev znanja s pravili, ogrodji, semantičnimi mrežami, ontologije; algoritmi sklepanja in generiranje razlage; obravnavanje negotovega znanja, bayesovske mreže
- Planiranje po principu sredstev in ciljev, planiranje s popolno in delno urejenostjo, regresiranje ciljev, primeri uporabe v robotiki in logistiki

Content (Syllabus outline):

- Introduction to Artificial Intelligence, examples of applications
- State space and basic search algorithms: depth-first, breadth-first and iterative deepening, complexity of these algorithms
- Heuristic search, algorithms A* and IDA*, admissibility theorem for A*, properties of heuristic function and analysis of time and space complexity
- Problem decomposition with AND/OR graphs, search in AND/OR graphs, heuristic search algorithm AO*
- Machine learning: problem of learning from data, data mining, description languages and hypothesis spaces, induction of decision trees, regression trees, model trees, and rules. Software tools for machine learning and applications.
- Knowledge representation and expert systems: knowledge representation with rules, frames, semantic networks, ontologies; inference algorithms and generationg explanation; handling uncertain knowledge, Bayesian networks
- Means-ends planning, total-order and partial-order planning, goal regression, applications in robotics and logistics

Temeljni literatura in viri / Readings:

I. Bratko, Prolog Programming for Artificial Intelligence, 4th edition, Pearson Education, Addison-Wesley 2011, ISBN: 0201403757.

S. Russell, P. Norvig, Artificial Intelligence: A Modern Approach, Third edition, Pearson Education, Prentice-Hall 2010, ISBN: 0136042597.

I. Bratko, Prolog in umetna inteligenca, Založba FE in FRI, ponatis 2011.

I. Kononenko, Strojno učenje, Založba FE in FRI, 2005.

Materiali na spletu (Spletna učilnica FRI; Ivan Bratko home page): Prosojnice predavanj, naloge.

Cilji in kompetence:

- Seznaniti slušatelje z osnovnimi koncepti, idejami, metodami in tehnikami umetne inteligence
- Sposobnost reševanja problemov z metodami umetne inteligence
- Zmožnost razumevanja literatura s področja umetne inteligence
- Prispevati k razumevanju relevantnosti tehničnih dosežkov umetne inteligence glede na njihove implikacije v filozofiji in psihologiji

Objectives and competences:

- Teach basic concepts, ideas, methods and techniques of artificial intelligence (AI)
- Ability to solve problems with methods of artificial intelligence
- Ability to understand the literature in the area of AI
- Contribute to the understanding of the relevance of technical achievements of AI with respect to their implications in philosophy and psychology

Predvideni študijski rezultati:

Znanje in razumevanje:
Študent spozna in razume osnovne in najpogostejše uporabljane metode umetne inteligence.
Uporaba:
Študent je zmožen uporabiti metode umetne inteligence pri načrtovanju in izvedbi konkretnih računalniških aplikacij na širokem področju uporabe.
Refleksija:
Študent je zmožen presoditi o implikacijah tehničnih dosežkov umetne inteligence na možnosti in omejitve pri uporabi računalnikov, meje računalniške inteligence, podobnosti in razlike z naravno inteligenco ter nekaterimi vprašanji področja kognitivne znanosti.
Prenosljive spretnosti - niso vezane le na en predmet:

Intended learning outcomes:

Knowledge and understanding:
The student recognises and understands the most frequently applied techniques of AI
Application:
The students is capable of applying methods of AI in the planning and development of concrete computer applications in various application areas
Reflection:
The student is capable of judging the implications of technical achievements of AI regarding the possibilities and limitations in computer applications, the limits of computer intelligence, similarities and differences with human intelligence, and some questions of cognitive science.
Transferable skills:
Skills are not limited to one subject; the student is capable of applying the learned methods in

Je zmožen uporabiti obdelane metode v sklopu načrtovanja računalniških aplikacij in sistemov.	the development of computer applications and systems in general.

Metode poučevanja in učenja:	**Learning and teaching methods:**
Predavanja, laboratorijske vaje, domače naloge, individualni ali skupinski projekti	Lectures, laboratory exercises, homework, individual and team projects

Načini ocenjevanja:	Delež (v %) / Weight (in %)	**Assessment:**
Način (pisni izpit, ustno izpraševanje, naloge, projekt):		Type (written and oral exam, coursework, project):
Sprotno preverjanje (domače naloge, kolokviji in projektno delo)	**50%**	**Continuing** (homework, project work)
Končno preverjanje (pisni in ustni izpit)	**50%**	**Final** (written and oral exam)
Ocene: 6-10 pozitivno, 1-5 negativno (v skladu s Statutom UL)		Grading: 6-10 pass, 1-5 fail.

Reference nosilca / Lecturer's references:

Pet najpomembnejših del:

I. Bratko. *Prolog Programming for Artificial Intelligence*, 4th edition, Pearson Education – Addison-Wesley, 2011.
M. Možina, J. Žabkar, I. Bratko. Argument based machine learning. *Artificial Intelligence*. Vol. 171 (2007), 922-937.
M. Luštrek, M. Gams, I. Bratko. Is real-valued minimax pathological? *Artificial Intelligence*.Vol. 170 (2006), 620-642.
D. Šuc, D. Vladušič, I. Bratko. Qualitatively faithful quantitative prediction. *Artificial Intelligence*. Vol. 158 (2004), 189-214.
I. Bratko, I. Mozetič, N. Lavrač. *Kardio: a study in deep and qualitative knowledge for expert systems*. Cambridge (Mass.); London: The MIT Press, 1989.

Celotna bibliografija je dostopna na SICRISu / For complete bibliography see SICRIS: http://sicris.izum.si/search/rsr.aspx?lang=slv&id=4496.

UČNI NAČRT PREDMETA / COURSE SYLLABUS	
Predmet:	**Principi programskih jezikov**
Course title:	**Principles of Programming Languages**

Študijski program in stopnja Study programme and level	Študijska smer Study field	Letnik Academic year	Semester Semester
Univerzitetni študijski program prve stopnje Računalništvo in informatika **Univerzitetni študijski program prve stopnje Računalništvo in matematika**	**ni smeri**	**2**	**poletni**
University study programme Computer and Information Science, 1st cycle **University study programme Computer Science and Mathematics , 1st cycle**	**none**	**2**	**spring**

Vrsta predmeta / Course type	**izbirni predmet / elective course**
Univerzitetna koda predmeta / University course code:	**63220**

Predavanja Lectures	Seminar Seminar	Vaje Tutorial	Klinične vaje Laboratory work	Druge oblike študija Field work	Samost. delo Individ. work	ECTS
45	/	30	/	/	105	6

Nosilec predmeta / Lecturer:	akad. prof. dr. Ivan Bratko

Jeziki / Languages:	**Predavanja / Lectures:**	slovenščina Slovene
	Vaje / Tutorial:	slovenščina Slovene

Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:	**Prerequisites:**

Vsebina:

- Modeli računanja in paradigme programiranja: imperativno, postopkovno programiranje; deklarativno, nepostopkovno, programiranje; objektno programiranje; funkcijsko programiranje; logično in relacijsko programiranje; programiranje z omejitvami; paralelno programiranje; genetsko programiranje; programiranje s primeri; itd.
- Pregled programskih jezikov za razne paradigme programiranja
- Elementi jezikov postopkovnega programiranja
- Nepostopkovno programiranje, logično programiranje in programski jezik prolog: logika kot programski jezik, postopkovni pomen programa kot avtomatsko dokazovanje izrekov, primeri simboličnega programiranja in deklarativnega snovanja programov
- Programiranje z omejitvami: ideje, principi in primeri, logično programiranje z omejitvami (CLP)
- Obravnavanje sintakse in semantike programskih jezikov: gramatike, operativna, prevajalska, denotacijska in aksiomatska semantika
- Denotacijska semantika, povezava s gramatiko jezika, primeri denotacijskih definicij
- Aksiomatska semantika in dokazovanje pravilnosti programov: parcialna in totalna pravilnost, invariantni pogoji, tehnike dokazovanja pravilnosti programov, uporaba najšibkejših predpogojev, avtomatsko dokazovanje pravilnosti

Content (Syllabus outline):

- Computational models and programming paradigms: imperative, procedural programming; declarative, non-procedural programming; functional programming; logic and relational programming; programming with constraints; parallel programming; genetic programming; programming by examples; etc.
- Overview of programming languages for various programming paradigms
- Elements of languages for imperative programming
- Declarative programming, logic programming and the Prolog language: logic as a programming language, procedural meaning of programs as automatic theorem proving, examples of symbolic programming and declarative program design
- Programming with constraints: ideas, principles and examples, constraint logic programming (CLP)
- Handling of syntax and semantics of programming languages: grammars, operational, translational, denotational and axiomatic semantics
- Denotational semantics, relation to the the grammar of a language, examples of denotational definitions
- Axiomatic semantics and proving correctness of programs: partial and total correctness, invariant conditions, techniques of proving program correctness, using weakest preconditions, automatic correctness

	proving

Temeljna literatura in viri / Readings:

Robert W. Sebesta, Concepts of Programming Languages, 8th edition, Addison-Wesley 2007.

Peter van Roy, Seif Haridi, Concepts, Techniques, and Models of Computer Programming, MIT Press 2004.

Ivan Bratko, Prolog Programming for Artificial Intelligence, 4th edition, Pearson Education, Addison-Wesley, 2001.

Ivan Bratko, Prolog in umetna inteligenca, Založba FE in FRI, ponatis 2011.

Cilji in kompetence:	**Objectives and competences:**
Cilj je predstaviti principe in pregled vrst programskih jezikov, vključno z raznimi modeli računanja, formalnim obravnavanjem sintakse in semantike jezikov ter pravilnosti programov; Razumevanje različnih vzorcev oz. paradigem programiranja ter njihove uporabe v ustreznih programskih jezikih; Praktična uporaba simboličnega programiranja, nepostopkovnega programiranja in programiranja z omejitvami	To introduce the principles and types of programming languages, including models of computation, formal treatment of the syntacs and semantics of languages and program correctness; Understanding of various programming paradigms and their use in corresponding programming languages; Practical applications of symbolic, declarative and constraint programming

Predvideni študijski rezultati:	**Intended learning outcomes:**
Znanje in razumevanje: Razumevanje različnih pristopov k programiranju in primernost raznih pristopov za reševanje raznih problemov; Pregled principov in mehanizmov raznih vrst programskih jezikov; Razumevanje načinov za opisovanje sintakse in pomena programskih jezikov ter formalno dokazovanje pravilnosti programov. Uporaba: Razvoj spretnosti simboličnega programiranja, programiranja v logiki in programiranja z omejitvami.	Knowledge and understanding: Understanding of various approaches to programming and suitability of these approaches to solving various problems; Overview of the principles and mechanisms of types of programming languages; Understanding ways of defining the syntax and semantics of languages, and formal proofs of program correctness. Application: Skill of symbolic programming, logic and constrain programming

Refleksija: Sposobnost razmišljanja o alternativnih formulacijah problemov ter pristopov k njihovemu reševanju; Kako različni modeli računanja, paradigme programiranja in vrste jezikov spodbujajo alternativne pristope k računalniškemu reševanju problemov. Prenosljive spretnosti - niso vezane le na en predmet: Razširjene spretnosti snovanja programov.	Reflection: Ability of thinking about alternative formulations of problems and approaches to their solution; How different computational models, programming paradigms and languages, support alternative approaches to computer problem solving Transferable skills: Enhanced skills of program design

Metode poučevanja in učenja:	**Learning and teaching methods:**
Predavanja, avditorne vaje and exercises, domače naloge	Lectures, practical work and exercises, home work

Načini ocenjevanja:	Delež (v %) / Weight (in %)	**Assessment:**
Način (pisni izpit, ustno izpraševanje, naloge, projekt):		Type (examination, oral, coursework, project):
Sprotno preverjanje (domače naloge)	**50%**	**Continuing** (homework)
Končno preverjanje (pisni in ustni izpit)	**50%**	**Final** (written and oral exam)
Ocene: 6-10 pozitivno, 1-5 negativno (v skladu s Statutom UL)		Grading: 6-10 pass, 1-5 fail.

Reference nosilca / Lecturer's references:

Pet najpomembnejših del:

I. Bratko. *Prolog Programming for Artificial Intelligence*, 4th edition, Pearson Education – Addison-Wesley, 2011.

M. Možina, J. Žabkar, I. Bratko. Argument based machine learning. *Artificial Intelligence*. Vol. 171 (2007), 922-937.

M. Luštrek, M. Gams, I. Bratko. Is real-valued minimax pathological? *Artificial Intelligence*.Vol. 170 (2006), 620-642.

D. Šuc, D. Vladušič, I. Bratko. Qualitatively faithful quantitative prediction. *Artificial Intelligence*. Vol. 158 (2004), 189-214.

I. Bratko, I. Mozetič, N. Lavrač. *Kardio: a Study in Deep and Qualitative Knowledge for Expert Systems*. Cambridge (Mass.); London: The MIT Press, 1989.

Celotna bibliografija je dostopna na SICRISu / For complete bibliography see SICRIS: http://sicris.izum.si/search/rsr.aspx?lang=slv&id=4496.

UČNI NAČRT PREDMETA / COURSE SYLLABUS	
Predmet:	**Digitalno načrtovanje**
Course title:	**Digital Design**

Študijski program in stopnja Study programme and level	Študijska smer Study field	Letnik Academic year	Semester Semester
Univerzitetni študijski program prve stopnje Računalništvo in informatika **Univerzitetni študijski program prve stopnje Računalništvo in matematika**	**Modul: Računalniški sistemi**	**3**	**zimski**
University study programme Computer and Information Science, 1st cycle **University study programme Computer Science and Mathematics , 1st cycle**	**Module: Computer systems**	**3**	**fall**

Vrsta predmeta / Course type	**izbirni predmet /elective course**
Univerzitetna koda predmeta / University course code:	**63260**

Predavanja Lectures	Seminar Seminar	Vaje Tutorial	Klinične vaje Laboratory work	Druge oblike študija Field work	Samost. delo Individ. work	ECTS
45	10	20	/	/	105	6

Nosilec predmeta / Lecturer:	izr. prof. dr. Patricio Bulić

Jeziki / Languages:	**Predavanja / Lectures:**	slovenščina Slovene
	Vaje / Tutorial:	slovenščina Slovene

Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:	**Prerequisites:**

Vsebina:

1. Uvod v načrtovanje in testiranje digitalnih sistemov;
2. Jeziki HDL za opis strojne opreme (VHDL, Verilog), napotki za kodiranje, simulacija, sinteza;
3. Tehnologija in pregled programabilnih vezij;
4. Računalniška aritmetika ter načrtovanje in sinteza odločitvenih vezij;
5. Načrtovanje sekvenčnih vezij: sinhrona in asinhrona vezja, pomnilne celice, register, registerski niz, števci, splošni končni avtomat, pomnilnik);
6. Urin signal: sinteza, distribucija, »clock gating«, sinhronizacija;
7. Načrtovanje (mikro)procesorja: podatkovne poti, kontrolna enota, cevovod
8. Načrtovanje sinhronskih komunikacijskih vmesnikov (PS/2, I2C, PCI)
9. Načrtovanje asinhronskih komunikacijskih vmesnikov (USART)
10. Sinteza pomnilnikov RAM in ROM, sinteza dvokanalnih pomnilnikov
11. Sinteza grafičnih vmesnikov
12. Modularna gradnja sistemov: sistem na čipu (SOC, System-on-Chip).

Content (Syllabus outline):

1. Introduction to design and testing of digital systems;
2. Languages for hardware description (VHDL, Verilog, Abel-HDL, …);
3. Technology and survey of programmable logic circuits
4. Computer arithmetics: design and synthesis of decision digital circuits,
5. Design of time dependant synchronous and asynchronous circuits, flip-flops, counters, registers, finite automata;
6. Clock signal, distribution and clock gating, synchronization;
7. Design of microprocessor, data paths, control unit, pipeline;
8. Design of synchronous communication adapters (PS/2, I2C, PCI);
9. Design of asynchronous comm. adapters (USART);
10. Memory synthesis: RAM,ROM, dual-channel
11. Design of simple graphics interfaces
12. Modular system synthesis: system on chip (SOC).

Temeljni literatura in viri / Readings:

1. Wakerly, John F. Digital design : principles and practices, Upper Saddle River : Pearson/Prentice Hall, 2006;
2. Enoch Hwang. Digital Logic and Microprocessor Design with VHDL. Thomson/Nelson, 2006.
3. Richard E. Haskell & Darrin M. Hanna, Digital Design. 2nd Ed. LBE Books 2012.
4. Zapiski s predavanj, gradivo za vaje / Lecture notes, exercises

Cilji in kompetence:	**Objectives and competences:**
Študenta želimo naučiti samostojne uporabe in načrtovanja digitalnih vezij z uporabo sodobnih jezikov HDL in načrtovalskih orodij za simulacijo in sintezo. Pri tem jih opozorimo na specifičnosti le-teh in naučimo upoštevati optimalne pristope. Pri predmetu študentje pridobijo znanje in izkušnje pri načrtovanju in testiranju digitalnih sistemov ter uporabi sodobnih načrtovalskih orodij, razvijejo spretnosti za skupinsko razvojno delo ter poglobijo tehnično znanje.	We instruct students how computer-aided design tools are used to both simulate the VHDL or Verilog design and to synthesize the design to actual hardware. Specific behaviour of HDL tools is emphasized. We present the design of digital circuit using optimal approaches. As part of the course, students develop familiarity and confidence with designing, building and testing digital circuits, including the use of CAD tools, develop team-building skills and enhance technical knowledge through both written assignments and design projects.
Predvideni študijski rezultati:	**Intended learning outcomes:**
Znanje in razumevanje: 104 Osnove digitalnih vezij 202 Arhitektura računalniških sistemov 208 Organizacija računalniških sistemov Načrtovanje in implementacija kombinatoričnih in sekvenčnih vezij z uporabo VHDL/Verilog, časovna analiza vezij, načrtovanje končnih avtomatov, načrtovanje kompleksnih digitalnih gradnikov kot delov končnih sistemov, ustno in pisno poročanje o načrtovanih sistemih Uporaba: Načrtovanje kompleksnih digitalnih vezij, oziroma delov sistemov na čipu (SoC). Refleksija: Razumevanje delovanja in sposobnost načrtovanja samostojnih digitalnih sistemov. Prenosljive spretnosti - niso vezane le na en predmet: Izdelava seminarja in preizkus vezja.	Knowledge and understanding: 104 Introduction to Digital Circuits 202 Computer Systems Architecture 208 Organisation of Computer Systems Design and implement combinational and sequential logic circuits using VHDL/Verilog, analyze the timing of digital circuits, design and implement state machines, use a complex sequential logic circuit as part of a solution to an open-ended design problem, give oral and written reports on all aspects of a design project. Application: Design of some complex digital circuits or a part of system on chip (SOC). Reflection: Understanding and the ability to design complex digital systems. Transferable skills: They are not connected only to this particular work. Project report and the design implementation.
Metode poučevanja in učenja:	**Learning and teaching methods:**

Predavanja, laboratorijske vaje na katerih se uporabljajo sodobna orodja za načrtovanje digitalnih sistemov ter vezij FPGA, domače naloge, končni projekt	Lectures, a series of lab assignments using modern CADF tools and FPGAs, homeworks, final project

Načini ocenjevanja:	Delež (v %) / Weight (in %)	**Assessment:**
Način (pisni izpit, ustno izpraševanje, naloge, projekt):		Type (examination, oral, coursework, project):
Sprotno preverjanje (domače naloge, kolokviji in projektno delo)	**50%**	**Continuing** (homework, midterm exams, project work)
Končno preverjanje (pisni in ustni izpit)	**50%**	**Final** (written and oral exam)
Ocene: 6-10 pozitivno, 1-5 negativno (v skladu s Statutom UL)		Grading: 6-10 pass, 1-5 fail.

Reference nosilca / Lecturer's references:

Pet najpomembnejših del: / **Five most important works:**

1. AVRAMOVIĆ, Aleksej, BABIĆ, Zdenka, RAIČ, Dušan, STRLE, Drago, BULIĆ, Patricio. An approximate logarithmic squaring circuit with error compensation for DSP applications. *Microelectronics journal*, 2014, vol. 45, iss. 3, str. 263-271.
2. ČEŠNOVAR, Rok, RISOJEVIĆ, Vladimir, BABIĆ, Zdenka, DOBRAVEC, Tomaž, BULIĆ, Patricio. A GPU implementation of a structural-similarity-based aerial-image classification. *J. supercomput*., Aug. 2013, vol. 65, no. 2, str. 978-996.
3. BULIĆ, Patricio, GUŠTIN, Veselko, ŠONC, Damjan, ŠTRANCAR, Andrej. An FPGA-based integrated environment for computer architecture. *Comput. appl. eng. educ.*, Mar. 2013, vol. 21, no. 1, str. 26-35.
4. LOTRIČ, Uroš, BULIĆ, Patricio. Applicability of approximate multipliers in hardware neural networks. *Neurocomputing*, Nov. 2012, vol. 96, str. 57-65.
5. BABIĆ, Zdenka, AVRAMOVIĆ, Aleksej, BULIĆ, Patricio. An iterative logarithmic multiplier. *Microprocess. microsyst.*. , 2011, vol. 35, no. 1, str. 23-33.

Celotna bibliografija izr. prof. Patricia Bulića je dostopna na SICRISu: http://sicris.izum.si/search/rsr.aspx?lang=slv&id=4520.

UČNI NAČRT PREDMETA / COURSE SYLLABUS	
Predmet:	**Komunikacijski protokoli**
Course title:	**Communication Protocols**

Študijski program in stopnja Study programme and level	Študijska smer Study field	Letnik Academic year	Semester Semester
Univerzitetni študijski program prve stopnje Računalništvo in informatika **Univerzitetni študijski program prve stopnje Računalništvo in matematika**	**Modul: Računalniška omrežja**	**3**	**zimski**
University study programme Computer and Information Science, 1st cycle **University study programme Computer Science and Mathematics , 1st cycle**	**Modul: Computer Networks**	**3**	**fall**

Vrsta predmeta / Course type	**izbirni predmet / elective course**
Univerzitetna koda predmeta / University course code:	**63258**

Predavanja Lectures	Seminar Seminar	Vaje Tutorial	Klinične vaje Laboratory work	Druge oblike študija Field work	Samost. delo Individ. work	ECTS
45	/	30	/	/	105	6

Nosilec predmeta / Lecturer:	izr. prof. dr. Mojca Ciglarič

Jeziki / Languages:	**Predavanja / Lectures:**	slovenščina Slovene
	Vaje / Tutorial:	slovenščina Slovene

Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:	**Prerequisites:**

Opravljen izpit Računalniške komunikacije in solidno znanje s tega področja.	Passed Computer communications. Solid knowledge from the area of networking.

Vsebina:	**Content (Syllabus outline):**
1. Uvod, vloga komunikacijskih protokolov in njihov pomen v sodobnih omrežjih. Protokolarni skladi in protokolarne storitve. 2. Načrtovanje komunikacijskih protokolov 3. Formalna specifikacija komunikacijskih protokolov 4. Metode, tehnike in orodja za analizo in testiranje komunikacijskih protokolov 5. Standardni usmerjevalni protokoli (usmerjanje znotraj avtonomnega sistema, globalno usmerjanje med avtonomnimi sistemi). 6. Večpredstavni protokoli (protokoli za prenos zvoka in videa prek IP, kakovost storitve) in razpošiljanje (multicast). 7. Analiza in primerjava delovanja značilnih protokolov v IPv4 in IPv6; prehodni mehanizmi. Študije izbranih protokolov omrežne in povezavne plasti. 8. Protokoli za zagotavljanje varnosti (avtentikacija, integriteta, nezanikanje...) 9. Protokoli v porazdeljenih sistemih (usklajevanje ure in globalnih stanj, volitve, vzajemno izključevanje, konsenzus) 10. Namenski protokoli: mobilnost, signalizacija v telekomunikacijah, nadzor omrežij, upravljanje z identitetami in imeniki, LDAP, protokoli v prekrivnih (»overlay«) omrežjih, v navideznih omrežjih, v avtomobilskih omrežjih....	1. Introduction and role of communication protocols in modern networks. Protocol stack and protocol services. 2. Communication protocol design. 3. Formal specification of communication protocols. 4. Communication protocol analysis and testing methods and techniques. 5. Standard routing protocols: intradomain routing, interdomain routing. 6. Multimedia (voice and video over IP, quality of service), multicast protocols. 7. Comparison of advanced protocols in IPv4 and IPv6; transition mechanisms. Case studies in network and data link layer. 8. Security-related protocols (authentication, integrity, nonrepudiation, ...) 9. Distributed protocols: time synchronization, global states, election, mutual exclusion, consensus) 10. Studies of selected protocols: mobility, signalling, network management, identity management and directories, LDAP, overlay network protocols, virtual networking protocols, vehicle networking...

Temeljni literatura in viri / Readings:

1. J. F. Kurose, K. W. Ross: Computer Networking, A top-down Approach Featuring Internet. 6. izdaja, Pearson 2012.
2. Mojca Ciglarič, Zoran Bosnić, James F. Kurose, Keith W. Ross: Računalniške komunikacije, Pearson Education, 2014.
3. IETF: RFC specifications and standards. http://www.ietf.org
4. D. Malone, N.R. Murphy: IPv6 Network Administration, O'Reilly 2005.

Cilji in kompetence:

Cilj predmeta je študentom računalništva in informatike predstaviti principe načrtovanja, analize in delovanja protokolov na splošno ter podrobno predstaviti nekatere standardne internetne protokole. Kompetence, ki jih bo študent pridobil, so zlasti

- Sposobnost kritičnega razmišljanja
- Razumevanje delovanja protokolov in protokolarnih skladov
- Sposobnost načrtovanja, analize, popravljanja in implementacije lastnih komunikacijskih protokolov
- Poznavanje pomembnejših standardnih protokolov posameznih komunikacijskih plasti
- Usposobljenost za programsko uporabo standardnih omrežnih/komunikacijskih protokolov
- Usposobljenost za postavitev, konfiguriranje in administracijo izbranih protokolarnih strežnikov
- Sposobnost razumevanja in reševanja strokovnih izzivov v računalništvu
- Razvoj profesionalne odgovornosti in etike
- Skladnost z varnostnimi, funkcionalnimi, ekonomskimi in okoljskimi vodili.
- Sposobnost iskanja virov znanja in njihovega kritičnega vrednotenja
- Sposobnost uporabe pridobljenega znanja za reševanje tehničnih in znanstvenih problemov v računalništvu; sposobnost nadgrajevanja pridobljenega znanja.
- Sposobnost prenašanja znanja sodelavcem v strokovnih in raziskovalnih skupinah

Objectives and competences:

The objective of the course is overview of the protocol design principles, protocol analysis and operation in general, as well as detailed study of a few actual protocols.
The students will gain the following competencies:

- Ability of critical thinking
- Understanding of protocol stacks and protocol operation,
- ability to design, analyze, debug and implement own protocols,
- In-depth knowledge of the most important standard protocols for each layer
- Ability to use standard network / communication protocols in own applications
- Ability to install, configure and manage protocol servers.
- The ability to understand and solve professional challenges in computer and information science
- Development of professional responsibility and ethics.
- Compliance with security, functional, economic and environmental principles.
- The ability to search knowledge sources and to search for resources and critically evaluate information.
- The ability to apply acquired knowledge in independent work for solving technical and scientific problems in computer and information science; the ability to upgrade acquired knowledge.
- The ability to transmit knowledge to co-workers in technology and research groups.
- Practical knowledge and skills of

• Praktično znanje in spretnosti na področju strojne in programske opreme ter informatike, potrebno za uspešno strokovno delo v računalništvu	computer hardware, software and information technology necessary for successful professional work in computer and information science.

Predvideni študijski rezultati:	**Intended learning outcomes:**
Znanje in razumevanje: Dobro poznavanje omrežnih, internetnih in usmerjevalnih protokolov, razumevanje formalne predstavitve in pomena analize protokolov. Razumevanje medsebojne odvisnosti in komplementarnosti protokolov. Uporaba: Uporaba omrežnih protokolov in storitev v svojih izvedbah. Sposobnost izgradnje, analize in kritičnega ovrednotenja lastnih protokolov. Sposobnost zagotavljanja osnovnega nivoja sistemske varnosti. Refleksija: Spoznavanje in razumevanje medsebojne soodvisnosti protokolov različnih arhitekturnih plasti. Razumevanje pomena formalizacije komunikacije v obliko protokola. Zavedanje o (ne)varnosti sistema. Prenosljive spretnosti - niso vezane le na en predmet: Sposobnost abstrakcije različnih problemov v formalni model protokola. Sposobnost videnja možnosti rešitve problemov v obliki protokolov.	Knowledge and understanding: Solid knowledge of network protocols, IP and routing protocols, understanding of protocol formal description and protocol analysis. Awareness of mutual co-dependence and complementarity of protocols Application: Use of existing protocols and / or services in own applications. Ability to build, analyse and critically assess own protocols. Ability to provide a basic level of system security. Reflection: Learning and understanding mutual co-dependency of protocols in different (adjacent) architectural layers of protocol stack. Understanding the communication formalization into the form of protocol. Security awareness. Transferable skills: Ability to abstract different problems into the protocol formal model. Ability to see problem solutions in the form of protocols.

Metode poučevanja in učenja:	**Learning and teaching methods:**
Predavanja, laboratorijske vaje, seminarski način dela pri domačih nalogah, konzultacije pri izvajanju seminarskih nalog (konkretni projekti). Poseben poudarek je na timskem delu, delo je podprto s sodobnimi oblikami komunikacije (internet, forumi, spletna učilnica, virtualni laboratorij).	Lectures, exercises, laboratory work, seminal work, individual homework, consultation, teamwork projects. Individual work is supported by modern communication means – internet, form, LMS, virtual laboratory.

Načini ocenjevanja:	Delež (v %) / Weight (in %)	**Assessment:**

Način (pisni izpit, ustno izpraševanje, naloge, projekt): **Sprotno preverjanje** (domače naloge, kolokviji in projektno delo) **Končno preverjanje** (pisni izpit) Ocene: 6-10 pozitivno, 1-5 negativno (v skladu s Statutom UL)	 **50%** **50%**	Type (examination, oral, coursework, project): **Continuing** (homework, midterm exams, project work) **Final** (written exam) Grading: 6-10 pass, 1-5 fail.

Reference nosilca / Lecturer's references:

Pet najpomembnejših del:

ŠKOBERNE, Nejc, MAENNEL, Olaf, PHILLIPS, Iain, BUSH, Randy, ŽORŽ, Jan, CIGLARIČ, Mojca. IPv4 address sharing mechanism classification and tradeoff analysis. IEEE/ACM transactions on networking, ISSN 1063-6692, 2014, vol. 22, no. 2, pp. 391-404.

PORENTA, Jernej, CIGLARIČ, Mojca. Comparing commercial IP reputation databases to open-source IP reputation algorithms. Computer systems science and engineering, ISSN 0267-6192, 2013, vol. 28, no. 1, pp. 1-14.

ŠKOBERNE, Nejc, CIGLARIČ, Mojca. Practical evaluation of stateful NAT64/DNS64 translation. Advances in electrical and computer engineering, ISSN 1582-7445. [Print ed.], 2011, vol. 11, no. 3, pp. 49-54.

PANČUR, Matjaž, CIGLARIČ, Mojca. Impact of test-driven development on productivity, code and tests: a controlled experiment. Information and software technology, ISSN 0950-5849. [Print ed.], Jun. 2011, vol. 53, no. 6, pp. 557-573.

CIGLARIČ, Mojca. Effective message routing in unstructured peer-to-peer overlays. IEE proc., Commun. [Print ed.], October 2005, vol. 152, no. 5, str. 673-678.

Celotna bibliografija je dostopna na SICRISu: http://sicris.izum.si/search/rsr.aspx?lang=slv&id=8265.

UČNI NAČRT PREDMETA / COURSE SYLLABUS	
Predmet:	**Sistemska programska oprema**
Course title:	**System Software**

Študijski program in stopnja **Study programme and level**	**Študijska smer** **Study field**	**Letnik** **Academic year**	**Semester** **Semester**
Univerzitetni študijski program prve stopnje Računalništvo in informatika Univerzitetni študijski program prve stopnje Računalništvo in matematika	Modul: Algoritmi in sistemski programi	3	zimski
University study programme Computer and Information Science, 1st cycle University study programme Computer Science and Mathematics , 1st cycle	Module: Algorithms and system programs	3	fall

Vrsta predmeta / Course type	izbirni predmet /elective course
Univerzitetna koda predmeta / University course code:	63264

Predavanja **Lectures**	**Seminar** **Seminar**	**Vaje** **Tutorial**	**Klinične vaje** **Laboratory work**	**Druge oblike študija** **Field work**	**Samost. delo** **Individ. work**	**ECTS**
45	10	20	/	/	105	6

Nosilec predmeta / Lecturer:	doc. dr. Tomaž Dobravec

Jeziki / **Languages:**	**Predavanja /** **Lectures:**	slovenščina Slovene
	Vaje / Tutorial:	slovenščina Slovene

Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:	**Prerequisites:**

Vsebina:

1. osnova zbirnih in strojnih jezikov;
2. vsebina in organizacija objektnih datotek;
3. zbirnik, nalagalnik in povezovalnik;
4. statično in dinamično povezovanje
5. makro procesorji;
6. sistemski klici in prekinitve;
7. implementacija vhoda in izhoda ter orodja datotečnega sistema;
8. upravljanje s pomnilnikom
9. razhroščevalniki;
10. jedro operacijskega sistema Linux;
11. navidezni stroji.
12. nalaganje, povezovanje in izvajanje v javanskem navideznem stroju

Content (Syllabus outline):

1. basics about machine and assembly languages
2. content and organization of object files
3. assembler, linker, loader
4. static and dynamic linking
5. macro processors
6. system calls and interrupts
7. input/output implementation and file system tools
8. memory management
9. debugging
10. linux kernel
11. virtual machines
12. loading, linking and running in java virtual machine

,

Temeljni literatura in viri / Readings:

- Leland L. Beck: System software: An Introduction to Systems Programming (3. izdaja). Addison-Wesley, 1997.
- K. Robbins and S. Robbins: UNIX Systems Programming: Communication, Concurrency and Threads (2.izdaja). Prentice Hall, 2003.
- Damjan Zazula, Mitja Lenič: Principi sistemske programske opreme. Založba FERI 2008

Cilji in kompetence:

Cilj:
Cilj predmeta je študentom računalništva in informatike predstaviti sistemske programe, orodja in standarde sistemske programske opreme, ter prikazati podobnosti in razlike med pristopi, ki se uporabljajo v aktualnih operacijskih sistemih.

Objectives and competences:

Objectives:
The main goal of this course is to introduce the concepts, tools and standards of system programming and to show the current implementations in the actual operating systems.

Kompetence:	Competences:
- Razvijanje sposobnosti kritičnega, analitičnega in sintetičnega razmišljanja.	- Developing skills in critical, analytical and synthetic thinking.
- Sposobnost razumevanja in reševanja strokovnih izzivov na področju računalništva in informatike.	- The ability to understand and solve professional challenges in computer and information science.
- Sposobnost opredelitve, razumevanja in reševanja poklicnih izzivov.	- The ability to define, understand and solve creative professional challenges in computer and information science;
- Sposobnost za uporabo pridobljenega znanja pri samostojnem reševanju tehničnih in znanstvenih problemov v računalništvu in informatiki; sposobnost nadgradnje pridobljenega znanja.	- The ability to apply acquired knowledge in independent work for solving technical and scientific problems in computer and information science; the ability to upgrade acquired knowledge.
- Osnovna znanja iz računalništva in informatike, ki vključujejo osnovne teoretične spretnosti, praktična znanja in spretnosti, ki so pomembne za področje računalništva in informatike.	- Basic skills in computer and information science, which includes basic theoretical skills, practical knowledge and skills essential for the field of computer and information science;
- Praktično znanje in poznavanje računalniške strojne opreme, programske opreme in informacijske tehnologije, ki je potrebno za uspešno strokovno delo na področju računalništva in informatike.	- Practical knowledge and skills of computer hardware, software and information technology necessary for successful professional work in computer and information science.

Predvideni študijski rezultati:	**Intended learning outcomes:**
Znanje in razumevanje: Poznavanje osnovnih pojmov sistemske programske opreme, delovanja operacijskega sistema in njegovih komponent ter obstoječih implementacij. Razumevanje principov delovanja sistemskih programov in nekaterih drugih osnovnih gradnikov operacijskega sistema. **Uporaba:** Uporaba in razvoj sistemskih programov pri izdelavi uporabniške programske in strojne opreme. **Refleksija:** Poznavanje osnovnih pojmov sistemske programske opreme je ključnega pomena za razumevanje delovanja računalniškega sistema kot celote. Znanje je uporabno tako pri uporabi in razvoju uporabniške opreme kot tudi pri načrtovanju in izdelavi strojne opreme. **Prenosljive spretnosti:** Poznavanje osnovnih gradnikov računalniškega sistema pomeni poznavanje mej mogočega in zato prispeva h kvalitetnejši delu na praktično vseh področjih uporabe računalnika in razvoja programske in strojne opreme.	**Knowledge and understanding:** The knowledge of the basic terms of system programming, operating systems and tools with implementation. Understanding the principles of system programs and some other basic building blocks of the operating system. **Application:** Use and development of system software. **Reflection:** Knowledge of the basic concepts of system software is crucial to understanding how a computer system works. Knowledge is useful both in application and development of user software, as well as in the design and manufacture of hardware. **Transferable skills:** The knowledge of the basic building blocks of a computer system helps us to find the limits of computer system and therefore contributes to higher quality work in virtually all areas of computer use and development of software and hardware.

Metode poučevanja in učenja:	**Learning and teaching methods:**
Predavanja, laboratorijske vaje, domače naloge.	Lectures, exercises and home work

Načini ocenjevanja:	Delež (v %) / Weight (in %)	**Assessment:**
Način (pisni izpit, ustno izpraševanje, naloge, projekt): **Sprotno preverjanje** (domače naloge, kolokviji in projektno delo)	**50%**	Type (examination, oral, coursework, project): **Continuing** (homework, midterm exams, project work)

Končno preverjanje (pisni in ustni izpit) Ocene: 6-10 pozitivno, 1-5 negativno (v skladu s Statutom UL)	**50%**	**Final** (written and oral exam) Grading: 6-10 pass, 1-5 fail.

Reference nosilca / Lecturer's references:

Pet najpomembnejših del:

MIHELIČ, Jurij, DOBRAVEC, Tomaž. SicSim: a simulator of the educational SIC/XE computer for a system-software course. Computer applications in engineering education, ISSN 1061-3773, 2015, vol. 23, no. 1, pp. 137-146

ČEŠNOVAR, Rok, RISOJEVIĆ, Vladimir, BABIĆ, Zdenka, DOBRAVEC, Tomaž, BULIĆ, Patricio. A GPU implementation of a structural-similarity-based aerial-image classification. The journal of supercomputing, ISSN 0920-8542, 2013, vol. 65, no. 2, pp. 978-996

BULIĆ, Patricio, DOBRAVEC, Tomaž. An approximate method for filtering out data dependencies with a sufficiently large distance between memory references. The journal of supercomputing, ISSN 0920-8542, 2011, vol. 56, no. 2, pp. 226-244

DOBRAVEC, Tomaž, ŽEROVNIK, Janez, ROBIČ, Borut. An optimal message routing algorithm for circulant networks. *J. systems archit.*. [Print ed.], 2006, vol. 52, no. 5, str. [298]-306

DOBRAVEC, Tomaž, ROBIČ, Borut. Restricted shortest paths in 2-circulant graphs. *Comput. commun.*. [Print ed.], March 2009, vol. 32, no. 4, str. 685-690

Celotna bibliografija je dostopna na SICRISu: http://sicris.izum.si/search/rsr.aspx?lang=slv&id=10416.

UČNI NAČRT PREDMETA / COURSE SYLLABUS	
Predmet:	**Organizacija in management**
Course title:	**Organisation and Management**

Študijski program in stopnja Study programme and level	Študijska smer Study field	Letnik Academic year	Semester Semester
Univerzitetni študijski program prve stopnje Računalništvo in informatika **Interdisciplinarni univerzitetni študijski program prve stopnje Računalništvo in matematika** **Interdisciplinarni univerzitetni študijski program prve stopnje Multimedija**	**Modul: Informacijski sistemi**	**3**	**poletni**
University study programme Computer and Information Science, 1st cycle **Interdisciplinary university study programme Computer Science and Mathematics , 1st cycle** **Interdisciplinary university study programme Multimedia, 1st cycle**	**Module: Information systems**	**3**	**spring**

Vrsta predmeta / Course type	**izbirni predmet / elective course**
Univerzitetna koda predmeta / University course code:	**63250**

Predavanja Lectures	Seminar Seminar	Vaje Tutorial	Klinične vaje Laboratory work	Druge oblike študija Field work	Samost. delo Individ. work	ECTS
45	10	20	/	/	105	6

Nosilec predmeta / Lecturer:	doc. dr. Tomaž Hovelja

Jeziki / Languages:	**Predavanja / Lectures:**	slovenščina Slovene
	Vaje / Tutorial:	slovenščina

Slovene

Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:	**Prerequisites:**

Vsebina:	**Content (Syllabus outline):**
Predmet pokriva ključne teme sodobnega managementa in vedenja v organizacijah in sicer: opredelitev pojmov (organizacija, poslovanje, poslovni model); določljivke vedenja posameznikov v organizaciji za uspešno delovanje (osebne lastnosti, motivacija, znanje, spretnosti, medsebojna interakcija) razumevanje gradnikov poslovnega modela (predpostavka vrednosti, ključni redki viri, ključne poslovne aktivnosti, profitna formula); analiza poslovnega modela (spoznavanje poslovnega modela, vrednotenje ustreznosti poslovnega modela, diagnosticiranje vzrokov odstopanj od želenega stanja, opcijski pristop k iskanju sprememb poslovnega modela).	The content covers the following contemporary key topics from organization, management and organizational behaviour: key definitions (firm, organization, business, business model); determinants of individual behaviour in organizations (personality characteristics, motivation, knowledge, skills, interpersonal interactions); fine-grained look at the elements of the business model (value proposition, scarce resources, business activities, and profit formula); analysis of the business model (identifying the business model, evaluation of the business model, diagnosis of the problems of the business model, strategic options approach to the identification of solution for the problems).

Temeljni literatura in viri / Readings:

Daft Richard L. and Marcic Dorothy: Understanding Management: Seventh Edition. Mason, Ohio: South-Western Cengage Learning, 2010, 672 pages.
Izbor temeljnih in sodobnih znanstveni članki s področja managementa, aplikativne psihologije in sociologije (a selection of fundamental and contemporary scientific articles from the field of management, applied psychology and sociology).

Cilji in kompetence:	**Objectives and competences:**

Temeljni cilj predmeta je seznanitev študentov s ključnimi vsebinami organizacije in managementa in jim tako omogočiti uspešno opravljanje managerske funkcije v podjetjih in zavodih. Za dosego svojega cilja bo pri študentih potrebno razviti sledeče sposobnosti: 1. študenti morajo osvojiti znanja o ključnih organizacijskih in managerskih vsebinah, 2. študente je potrebno usposobiti za preučevanje in reševanje organizacijskih in managerskih problemov v podjetjih in zavodih, 3. študenti morajo razumeti povezanost problematike poslovanja in organizacije ter problematike vzpostavitve in spreminjanja informacijskih sistemom v podjetjih in zavodih.	The objective of the course is to present to students key topics from the field of organization and management, which will enable them to successfully perform in management roles in enterprises and government institutions. To reach this objective the following student competences need to be developed: 1. students have to acquire the knowledge from key topics of organization and management, 2. students need to learn how to examine and solve organizational and management issues in enterprises and government institutions, 3. students need to understand the interconnectedness of organization and management issues with information system deployment and change issues.
Predvideni študijski rezultati:	**Intended learning outcomes:**
Znanje in razumevanje: Študenti bodo temeljito spoznali ključne vsebine organizacije in managementa Uporaba: Študentom bo omogočeno uspešno vključevanje v management podjetij in zavodov z razvojem njihove sposobnosti preučevanja in reševanja organizacijskih in managerskih problemov Refleksija: Predmet bo študentom omogočil kritično ovrednotenje lastnega delovanja v podjetju, kot tudi razumevanje problematike odmikov med od njega pričakovanim in dejansko opravljenim delom. Prenosljive spretnosti - niso vezane le na en predmet:	Knowledge and understanding: The students will gain a thorough understanding of key topics in organization and management. Application: The students will be able to examine and solve organizational and management issues thus enabling them to occupy management positions. Reflection: The course will enable students to critically evaluate their work as well as what is expected of them in a managerial role in enterprises and government institutions. Transferable skills:

Študenti bodo pridobili širši pogled na potrebo po skladnosti posameznikovih kompetenc z organizacijskimi pričakovanji, skladnosti me poslovanjem in organizacijo ter informacijskim sistemom v podjetjih in zavodih.	The students will gain a broader view and understanding about the needed person-organization fit, needed alignment in enterprises and government institutions between business and organization on one side and information system on the other.

Metode poučevanja in učenja:	**Learning and teaching methods:**
Predavanja, vaje s skupinsko diskusijo, igro vlog in simulacijami resničnih situacij, študije primerov, praktično timsko projektno delo na seminarskih nalogah s predstavitvijo narejenega.	Lectures, exercises with group discussion, role playing, simulations or real world situations, case studies, team project work on seminars with required presentation of the results.

Načini ocenjevanja:	Delež (v %) / Weight (in %)	**Assessment:**
Način (pisni izpit, ustno izpraševanje, naloge, projekt):		Type (examination, oral, coursework, project):
Individualna seminarska naloga	**20%**	**Individual project work**
Sprotno preverjanje z domačimi nalogami na vajah, sodelovanje na predavanjih	**40%**	**Continuing** homework from exercises, in-class participation.
Pisni izpit	**40%**	**Final written exam**
Ocene: 6-10 pozitivno, 1-5 negativno (v skladu s Statutom UL)		Grading: 6-10 pass, 1-5 fail.

Reference nosilca / Lecturer's references:

doc.dr. Tomaž Hovelja

Objavljeni članki v revijah z visokim faktorjem vpliva - na primer:

a. HOVELJA, Tomaž, VAVPOTIČ, Damjan, ŽVANUT, Boštjan. A balanced scorecard-based model for evaluating e-learning and conventional pedagogical activities in nursing. Assessment & evaluation in higher education, ISSN 1469-297X, August 2015, ilustr. http://dx.doi.org/10.1080/02602938.2015.1075957, doi: 10.1080/02602938.2015.1075957

b. VRHOVEC, Simon, HOVELJA, Tomaž, VAVPOTIČ, Damjan, KRISPER, Marjan. Diagnosing organizational risks in software projects : Stakeholder resistance. International journal of project management, ISSN 0263-7863. [Print ed.], Aug. 2015, vol. 33, iss. 6, str. 1262-1273, graf. prikazi, tabele, doi: 10.1016/j.ijproman.2015.03.007

c. HOVELJA, Tomaž, VASILECAS, Olegas, VAVPOTIČ, Damjan. Exploring the influences of the use of elements comprising information system development methodologies on strategic business goals.

Technological and economic development of economy, ISSN 2029-4913. [Print ed.], 2015, vol. 21, no. 6, str. 885-898, ilustr. http://www.tandfonline.com/doi/pdf/10.3846/20294913.2015.1074130, doi: 10.3846/20294913.2015.1074130.

d. MAHNIČ, Viljan, HOVELJA, Tomaž. Teaching user stories within the scope of a software engineering capstone course : analysis of students' opinions. *International journal of engineering education*, ISSN 0949-149X, 2014, vol. 30, no. 4, str. 901-915.

e. HOVELJA, Tomaž, VASILECAS, Olegas, RUPNIK, Rok. A model of influences of environmental stakeholders on strategic information systems planning success in an enterprise. Technological and economic development of economy, ISSN 2029-4913. [Print ed.], 2013, vol. 19, no. 3, str. 465-488, ilustr. http://www.tandfonline.com/doi/pdf/10.3846/20294913.2013.818591, doi: 10.3846/20294913.2013.818591

f. VAVPOTIČ, Damjan, HOVELJA, Tomaž. Improving the evaluation of software development methodology adoption and its impact on enterprise performance. Computer science and information systems, ISSN 1820-0214. [Print ed.], Jan. 2012, vol. 9, no. 1, str. 165-187

g. MAHNIČ, Viljan, HOVELJA, Tomaž. On using planning poker for estimating user stories. The Journal of Systems and Software, ISSN 0164-1212. [Print ed.], Sep. 2012, vol. 85, no. 9, str. 2086-2095.

UČNI NAČRT PREDMETA / COURSE SYLLABUS	
Predmet:	**Postopki razvoja programske opreme**
Course title:	**Software Development Processes**

Študijski program in stopnja Study programme and level	Študijska smer Study field	Letnik Academic year	Semester Semester
Univerzitetni študijski program prve stopnje Računalništvo in informatika **Univerzitetni študijski program prve stopnje Računalništvo in matematika**	**Modul: Razvoj programske opreme**	**3**	**zimski**
University study programme Computer and Information Science, 1st cycle **University study programme Computer Science and Mathematics , 1st cycle**	**Module: Software Development**	**3**	**Fall**

Vrsta predmeta / Course type	**izbirni predmet / elective course**
Univerzitetna koda predmeta / University course code:	**63254**

Predavanja Lectures	Seminar Seminar	Vaje Tutorial	Klinične vaje Laboratory work	Druge oblike študija Field work	Samost. delo Individ. work	ECTS
45	10	20	/	/	105	6

Nosilec predmeta / Lecturer:	prof. dr. Branko Matjaž Jurič

Jeziki / Languages:	**Predavanja / Lectures:**	slovenščina Slovene
	Vaje / Tutorial:	slovenščina Slovene

Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:	**Prerequisites:**

Vsebina:

1. Razvoj večslojnih aplikacijskih rešitev, spoznavanje postopkov razvoja.
2. Razvoj vmesnega sloja in poslovne ter funkcionalne logike.
3. Arhitekture večslojnih informacijskih sistemov
4. Porazdeljeni objektni modeli
5. Oddaljeno proženje metod
6. Strežniške komponentne tehnologije in vsebniki
7. Strežniška javanska zrna
8. Vzorci za vmesni sloj
9. Sporočilni sistemi, vrste in teme ter spoznavanje JMS
10. Zagotavljanje trajnega stanja podatkov
11. Objektno-relacijska preslikava in uporaba JPA
12. Razvoj predstavitvenega nivoja z uporabo JSP in Servletov
13. Pristopi k razvoju programske opreme:
    a. Objektno orientiran pristop
    b. Storitveno orientiran pristop (SOA)
14. Spoznavanje platforme Java EE
15. Praktični primer razvoja strežniške aplikacije z uporabo Java EE
16. Upravljanje z izvorno kodo, preoblikovanje kode
17. Verzioniranje in upravljanje sprememb
18. Testiranje programske opreme, avtomatsko testiranje, testno voden razvoj programske opreme
19. Upravljanje izvorne kode in delo v skupinah
20.

Content (Syllabus outline):

1. Development of multi-tier application solutions, learn about development processes.
2. Development of the middle tier and the business and functional logic.
3. Multi-tier architecture of information systems
4. Distributed object models
5. Remote method invocation
6. Server component technologies and component containers
7. Enterprise Java Beans
8. Patterns for the middle-tier
9. Messaging systems, queues and topics, learn about JMS
10. Ensuring data persistence
11. Object-relational mapping and the use of JPA
12. Development of presentation layer using JSP and Servlets
13. Approaches to software development:
    a. Object-oriented approach
    b. Service-oriented approach (SOA)
14. Understanding the Java EE Platform
15. A practical example of development of server applications using Java EE
16. Source code management, code refactoring
17. Versioning and change management
18. Software testing, automated testing, test-driven software development
19. Source code management and collaborative work

Temeljni literatura in viri / Readings:

1. I. Sommerville: Software Engineering: (8th Edition), Addison Wesley, 2006.
2. S. McConnell Code Complete: A Practical Handbook of Software Construction, Microsoft Press; 2nd edition, 2004.
3. JURIČ, Matjaž B., LOGANATHAN, Ramesh, SARANG, Poornachandra G., JENNINGS, Frank. *SOA approach to integration: XML, web services, ESB, and BPEL in real-world SOA projects*. Birmingham; Mumbai: Packt Publishing, cop. 2007. VIII, 366 str., ilustr. ISBN 978-1-904811-17-6
4. JURIČ, Matjaž B., KRIŽEVNIK, Marcel. WS-BPEL 2.0 for SOA composite applications: define, model, implement, and monitor real-world BPEL business processes with SOA-powered BPM. Birmingham: Packt Publishing, cop. 2010. 616 str., ilustr. ISBN 978-1-847197-94-8
5. D. Phillips: The Software Project Manager's Handbook: Principles That Work at Work (Practitioners), Wiley-IEEE Computer Society Press, 2004.

Cilji in kompetence:

Cilj predmeta je študente seznaniti z osnovami sodobnih metod razvoja programske opreme in inženirskim pristopom k razvoju ter na praktičnem primeru preizkusiti postopke razvoja, kot se uporabljajo v realnem svetu v podjetjih. Tako se študentje spoznajo z najsodobnejšimi postopki razvoja programske opreme in se bodo po zaključku študija lažje vključili v ekipe razvijalcev in vodij projektov.

Objectives and competences:

The objective is to get familiar with the contemporary software development methods and engineering approach to development, and to verify the development approaches on a practical example, as software development is done in real-world projects in companies. Students will get familiar with the state-of-the-art software development approaches and will be able to seamlessly integrate with real world projects and teams.

Predvideni študijski rezultati:

Znanje in razumevanje:
Poznavanje sodobnih postopkov razvoja programske opreme in razumevanje njihovega izvora ter medsebojne povezanosti.
Uporaba:
Uporaba inženirskih metod pri razvoju programske opreme.
Refleksija:
Razumevanje primernosti uporabe določenih postopkov razvoja programske opreme glede na tip in zahteve.
Prenosljive spretnosti - niso vezane le na en predmet:
Poznavanje in uporaba metod za delo v skupini, ki rešuje intelektualno zahtevne naloge, trening učinkovitega pisnega in ustnega sporazumevanja s sodelavci.

Intended learning outcomes:

Knowledge and understanding:
Understanding of contemporary software development approaches, familiarity with their origins and interdependencies.
Application:
Application of engineering methods for software development.
Reflection:
Understanding of applicability of specific software development methods based on types and requirements.
Transferable skills:
Familiarity with and usage of methods for team-work, which help to solve intellectually advanced tasks, training of efficient written and oral communication within the team.

Metode poučevanja in učenja:	**Learning and teaching methods:**
Predavanja, praktično delo na primerih, seminarska naloga s praktičnim preizkusom razvoja programske opreme z uporabo najsodobnejših metod.	Lectures, practical work on examples, seminar work with practical verification of software development using contemporary methods.

Načini ocenjevanja:	Delež (v %) / Weight (in %)	**Assessment:**
Način (pisni izpit, ustno izpraševanje, naloge, projekt):		Type (examination, oral, coursework, project):
Sprotno preverjanje (domače naloge, kolokviji in projektno delo)	**50%**	**Continuing** (homework, midterm exams, project work)
Končno preverjanje (pisni izpit)	**50%**	**Final** (written exam)
Ocene: 6-10 pozitivno, 1-5 negativno (v skladu s Statutom UL)		Grading: 6-10 pass, 1-5 fail.

Reference nosilca / Lecturer's references:

Pet najpomembnejših del:
Najpomembnejše objave:
WSDL and BPEL extensions for event driven architecture. *Inf. softw. technol.*. [Print ed.], 2010, vol. 52, iss. 10, str. 1023-1043, doi: 10.1016/j.infsof.2010.04.005.
WSDL and UDDI extensions for version support in web services. *J. syst. softw.*. [Print ed.], 2009, vol. 82, iss. 8, str. 1326-1343.
WS-BPEL extension for versioning. *Inf. softw. technol.*. [Print ed.], 2009, vol. 51, iss. 8, str. 1261-1274.
Business process execution language for web services: an architect and developer's guide to orchestrating web services using BPEL4WS. Birmingham: Packt Publishing, 2006. X, 353 str., ilustr. ISBN 1-904811-81-7.
SOA approach to integration: XML, web services, ESB, and BPEL in real-world SOA projects. Birmingham; Mumbai: Packt Publishing, cop. 2007. VIII, 366 str., ilustr. ISBN 978-1-904811-17-6.
Business process driven SOA using BPMN and BPEL: from business process modeling to orchestration and service oriented architecture. Birmingham; Mumbai: Packt Publishing, cop. 2008. V, 311 str., ilustr. ISBN 978-1-84719-146-5.
Oracle fusion middleware patterns: real-world composite applications using SOA, BPM, Enterprise 2.0, business intelligence, identity management, and application infrastructure: 10 unique architecture patterns powered by Oracle Fusion Middleware. Birmingham: Packt Publishing, cop. 2010. 224 str., ilustr. ISBN 978-1-847198-32-7.
WS-BPEL 2.0 for SOA Composite Applications with IBM WebSphere 7: define, model, implement, and monitor real-world BPEL 2.0 business processes with SOA-powered BPM. Birmingham: Packt Publishing, cop. 2010. 644 str., ilustr. ISBN 978-1-849680-46-2.

Celotna bibliografija je dostopna na SICRISu:
http://sicris.izum.si/search/rsr.aspx?lang=slv&id=10545.

UČNI NAČRT PREDMETA / COURSE SYLLABUS	
Predmet:	**Algoritmi in podatkovne strukture 1**
Course title:	**Algorithms and data structures 1**

Študijski program in stopnja Study programme and level	Študijska smer Study field	Letnik Academic year	Semester Semester
Univerzitetni študijski program prve stopnje Računalništvo in informatika **Univerzitetni študijski program prve stopnje Računalništvo in matematika**	**ni smeri**	**2**	**zimski**
University study programme Computer and Information Science, 1st cycle **University study programme Computer Science and Mathematics , 1st cycle**	**none**	**2**	**fall**

Vrsta predmeta / Course type	**obvezni predmet / compulsory course**
Univerzitetna koda predmeta / University course code:	**63279**

Predavanja Lectures	Seminar Seminar	Vaje Tutorial	Klinične vaje Laboratory work	Druge oblike študija Field work	Samost. delo Individ. work	ECTS
45	/	30	/	/	105	6

Nosilec predmeta / Lecturer:	prof. dr. Igor Kononenko

Jeziki / Languages:	**Predavanja / Lectures:**	slovenščina Slovene
	Vaje / Tutorial:	slovenščina Slovene

Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:	**Prerequisites:**

Poznavanje osnov programiranja.	Knowledge of basic programming.

Vsebina:	**Content (Syllabus outline):**
predavanja: 1. Iteracija in rekurzija 2. Reševanje problemov in algoritmi 3. Analiza časovne zahtevnosti algoritmov 4. Abstraktni podatkovni tip; ADT seznam 5. Osnovni abstraktni podatkovni tipi: množica, vrsta, sklad, preslikava 6. Zgoščene tabele 7. Abstraktni podatkovni tip drevo; primer: Izrazna drevesa 8. Abstraktni podatkovni tip slovar, Iskalna drevesa: binarna, rdeče-črna 9. Iskalna drevesa: AVL, B-drevesa 10. Abstraktna podatkovna tipa prioritetna vrsta (kopica) disjunktne množice 11. Abstraktna podatkovna tipa graf in usmerjeni graf 12. Iskanje najdaljših poti z dinamičnim programiranjem (kritična pot) 13. Iskanje najkrajših poti v usmerjenem grafu (algoritem Dijkstra) 14. Minimalno vpeto drevo v neusmerjenem grafu; Primov in Kruskalov algoritem. 15. Dokazovanje parcialne in totalne pravilnosti programov **vaje:** Na vajah bodo študenti utrjevali snov, ki so jo obravnavali na predavanjih, tako da jo bodo uporabili pri reševanju praktičnih problemov. Pri tem bodo poudarki na samostojnem delu študentov ob pomoči asistentov. Na vajah bodo študenti implementirali več manjših programov (tudi kot domače naloge) ter obsežnejše programe v obliki seminarskih nalog, ki jih bodo zagovarjali na vajah in s tem	**Lectures:** 1. Iteration and recursion 2. Problem solving and algorithms 3. Analysing time-complexity of algorithms 4. Abstract data type; ADT list 5. Basic abstract data types: set, queue, stack, mapping 6. Hash tables 7. Abstract data type tree; example: expression trees 8. Abstract data type dictionary, search trees: binary, red-black 9. Search trees: AVL, B-trees 10. Abstract data type priority queue (heap) and disjunctive sets 11. Abstract data types graph and directed graph (digraph) 12. Searching for longest paths with dynamic programming (critical path) 13. Searching for shortest paths in directed graphs (algorithm Dijkstra) 14. Minimum spanning tree in undirected graphs; Prim and Kruskal algorithms. 15. Verification of partial and total program correctness **tutorials:** Practical applications of the knowledge gained through lectures. The emphasis is on the autonomous work of students with the help of assistants. During tutorials (as well at home work), students will implement several short programs and will get grades for their presentation of seminar works. **Home works**:

dobili oceno iz vaj. **domače naloge**: Namen domačih nalog je ponuditi študentom priložnost za reševanje preprostejših problemov s samostojnim razvojem krajših programov in jih s tem spodbuditi k sprotnemu študiju.	The purpose of home works is to offer each student the opportunity to autonomously develop short programs and to encourage them for continuous study.

Temeljni literatura in viri / Readings:

1. I. Kononenko in sod.: **Programiranje in algoritmi**, Založba FE in FRI, 2008.

Pomožna literatura:

1. I.Kononenko in M. Robnik-Šikonja: **Algoritmi in podatkovne strukture 1**, Založba FE in FRI, 2003.
2. A.V.Aho, J.E.Hopcroft, J.D.Ullman: Data Structures and Algorithms, Addison Wesley, 1983.
3. Thomas H. Cormen, Stein Clifford, Charles E. Leiserson, Robert L. Rivest: Introduction to Algorithms, second edition. The MIT Press, 2001.

Cilji in kompetence:	**Objectives and competences:**
Cilj predmeta je spoznavanje osnovnih principov načrtovanja in analize algoritmov na osnovnih in dinamičnih podatkovnih strukturah. **Kompetence:** Zmožnost kritičnega, analitičnega in sintetičnega razmišljanja. Zmožnost razumevanja in reševanja profesionalnih problemov iz računalništva in informatike. .). Zmožnost uporabiti pridobljenega znanja za reševanje tehničnih in znanstvenih problemov v računalništvu in informatiki, zmožnost nadgrajevanja pridobljenega znanja. Osnovne veščine iz računalništva in infromatike, ki vključujejo teoretične veščine, praktično znanje in veščine, ki so bistvene za področje računalništva in informatike. . Osnovne veščine iz računalništva in infromatike, ki omogočajo nadaljevanje študija na 2. stopnji.	The goal of the course is to acquiring the basic principles of design and analysis of algorithms and basic and dynamic data structures. **Competences:** Developing skills in critical, analytical and synthetic thinking. The ability to understand and solve professional challenges in computer and information science. The ability to apply acquired knowledge in independent work for solving technical and scientific problems in computer and information science; the ability to upgrade acquired knowledge. Basic skills in computer and information science, which includes basic theoretical skills, practical knowledge and skills essential for the field of computer and information science; Basic skills in computer and information science, allowing the continuation of studies in the second study cycle.

Predvideni študijski rezultati:	**Intended learning outcomes:**

Znanje in razumevanje: Sposobnost samostojnega razvoja programov, poznavanje osnovnih podatkovnih struktur in algoritmov, sposobnost samostojnega načrtovanja podatkovnih struktur in algoritmov. Uporaba: Uporaba naučenih principov pri programiranju in načrtovanju podatkovnih struktur in algoritmov za razvoj obsežnih programskih sistemov. Refleksija: Razumevanje osnovnih principov načrtovanja programov in algoritmov in razumevanje njihove vloge pri razvoju programskih sistemov. Prenosljive spretnosti - niso vezane le na en predmet: Zmožnost načrtovanja rešitve različnih problemov s programi in algoritmi, zmožnost uporabe naučenih principov pri programiranju v poljubnem programskem jeziku.	Knowledge and understanding: The ability to autonomously develop programs, the familiarity with basic data structures and algorithms, the ability to independently design data structures and algorithms. Application: The use of the learned principles for programming and design of data structures and algorithms for the development of large systems. Reflection: Understanding of basic principles of designing programs and algorithms and understanding of their role for the development of large systems. Transferable skills: The ability to design the solution of different problems using programs and algorithms, the ability to use the learned concepts for programming in an arbitrary programming language.

Metode poučevanja in učenja:	**Learning and teaching methods:**
Predavanja, domače naloge, seminarski način dela pri vajah. Poseben poudarek je na sprotnem študiju in na samostojnem delu pri domačih nalogah, vajah in seminarjih.	Lectures, home works, seminar works during tutorials. The emphasis is on continuous study and on autonomous and independent work at home works, exercises and seminars.

Načini ocenjevanja:	Delež (v %) / Weight (in %)	**Assessment:**
Način (pisni izpit, ustno izpraševanje, naloge, projekt): **Sprotno preverjanje** (domače naloge, kolokviji in projektno delo) **Ocena vaj** **Končno preverjanje** (pisni in ustni izpit) Ocene: 6-10 pozitivno, 1-5 negativno	**50%** **50%**	Type (examination, oral, coursework, project): **Continuing** (homework, midterm exams, project work) **Grade for tutorials** **Final** (written and oral exam) Grading: 6-10 pass, 1-5 fail.

Reference nosilca / Lecturer's references:

Pet najpomembnejših del:

1. KONONENKO, Igor, KUKAR, Matjaž. *Machine learning and data mining: introduction to principles and algorithms*. Chichester: Horwood Publishing, cop. 2007. XIX, 454 str.
2. ŠTRUMBELJ, Erik, KONONENKO, Igor. An efficient explanation of individual classifications using game theory. *J. mach. learn. res.*, Jan. 2010, vol. 11, no. [1], str. 1-18.
3. ROBNIK ŠIKONJA, Marko, KONONENKO, Igor. Theoretical and empirical analysis of ReliefF and RReliefF. *Mach. learn*., 2003, vol. 53, str. 23-69.
4. KONONENKO, Igor, BRATKO, Ivan. Information-based evaluation criterion for classifier's performance. *Mach. learn.*, 1991, vol. 6, no. 1, str. 67-80.
5. KONONENKO, Igor. Machine learning for medical diagnosis: history, state of the art and perspective. *Artif. intell. med.*, 2001, vol. 23, no. 1, str. 89-109.

Celotna bibliografija prof. dr. Igorja Kononenka je dostopna na SICRISu: http://sicris.izum.si/search/rsr.aspx?lang=slv&id=5066.

UČNI NAČRT PREDMETA / COURSE SYLLABUS	
Predmet:	**Inteligentni sistemi**
Course title:	**Intelligent Systems**

Študijski program in stopnja Study programme and level	Študijska smer Study field	Letnik Academic year	Semester Semester
Univerzitetni študijski program prve stopnje Računalništvo in informatika Univerzitetni študijski program prve stopnje Računalništvo in matematika	Modul: Umetna inteligenca	3	zimski
University study programme Computer and Information Science, 1st cycle University study programme Computer Science and Mathematics , 1st cycle	Module: Artificial Intelligence	3	fall

Vrsta predmeta / Course type	izbirni predmet /elective course
Univerzitetna koda predmeta / University course code:	63266

Predavanja Lectures	Seminar Seminar	Vaje Tutorial	Klinične vaje Laboratory work	Druge oblike študija Field work	Samost. delo Individ. work	ECTS
45	6	24	/	/	105	6

Nosilec predmeta / Lecturer:	prof. dr. Igor Kononenko, izr. prof. dr. Marko Robnik Šikonja

Jeziki / Languages:	**Predavanja / Lectures:**	slovenščina Slovene
	Vaje / Tutorial:	slovenščina Slovene

Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:	**Prerequisites:**
Za uspešno delo je potrebno poznavanje osnov statistike in programiranja.	Knowledge of basic statistics and programming.

Vsebina:

Teme predavanj:

1. Inteligenca in umetna inteligenca ter interakcija človek-stroj: temeljna filozofska vprašanja glede inteligence in umetne inteligence, vloga umetne inteligence.
2. Strojno učen je in podatkovno rudarjenje, pregled osnovnih algoritmov.
3. Predprocesiranje podatkov, diskretizacija, vizualizacija.
4. Inteligentna analiza podatkov.
5. Osnovni principi strojnega učenja, ocenjevanje učenja, kombiniranje algoritmov strojnega učenja .
6. Paralelno distribuirano procesiranje in umetne nevronske mreže.
7. Evolucijsko računanje in genetski algoritmi.
8. Osnovni principi modeliranja: učenje kot modeliranje, kakovost modelov, evaluacija modelov.
9. Statistično modeliranje: bayesovsko sklepanje, linearni in regresijski modeli, multivariatni modeli, neparametrični modeli, stohastični procesi.
10. Sistemi za podporo odločanju: klasična teorija odločanja, teorija uporabnosti in teorija iger, večkriterijsko odločanje, negotovost in upoštevanje tveganj, skupinsko odločanje, kakovost odločitvenih modelov.
11. Inteligentni agenti: pregled področja, agentne arhitekture in teorija agentov, večagentni sistemi.
12. Procesiranje naravnega jezika: vektorska predstavitev besedil, korpusne metode, pridobivanje informacij, povzemanje., tekstovno rudarjenje.
13. Spodbujevano učenje: osnovni pristopi in algoritmi, Q učenje, TD učenje
14. Hevristično preiskovanje: princip minimaksa, alfa-beta rezanje, Monte Carlo drevesno preiskovanje.

Content (Syllabus outline):

Lecture topics:

1. Intelligence, artificial intelligence (AI) and human-machine interaction: basic philosophical questions about intelligence and AI, the role of AI
2. Machine learning and data mining, overview of basic algorithms
3. Data preprocessing, discretization, visualization.
4. Intelligent data analysis
5. Basic principles of machine learning (ML), evaluation of learning, combining ML algorithms
6. Parallel distributed processing and artificial neural networks
7. Evolutionary computation and genetic algorithms
8. Basic principles of modelling: learning as modelling, model quality, model evaluation
9. Statistical modelling: Bayesian reasoning, linear models, regression models, multivariate models, non-parametric models, stochastic processes
10. Decision support systems: classical decision theory, utility functions, game theory, multi-parameter decision models, uncertainty and risk management, group decision making, quality of decision models
11. Intelligent agents: overview and state-of-the-art, agent architectures , multiagent systems.
12. Natural language processing: vector presentation of documents, corpus based methods, information extraction, automatic summarization, text mining.
13. Reinforcement learning: basic approaches and algorithms, Q learning, TD learning
14. Heuristic search: minimax principle, alpha-beta pruning, Monte Carlo tree search.

Temeljni literatura in viri / Readings:

- Kononenko, M. Robnik-Šikonja: Inteligentni sistemi, Založba FE in FRI, Ljubljana, 2010.
- I. Kononenko, M. Kukar: Machine Learning and Data Mining, Horwood publ., 2007.
- S.J. Russell, P. Norvig: Artificial Intelligence: A Modern Approach, 3rd ed. Prentice Hall, 2009.

Cilji in kompetence:

Cilj predmeta je študente seznaniti s področjem inteligentnih sistemov, ki vsebuje nabor orodij in pristopov za reševanje problemov, ki jih je težko ali nepraktično reševati z drugimi metodami. Študenti morajo biti sposobni teoretično znanje praktično uporabiti na realnih problemih iz znanstvenega in poslovnega okolja. Študenti morajo biti za dani problem sposobni presoje, katero od predstavljenih tehnik uporabiti, ter sestaviti prototip rešitve.

Splošne kompetence:

- sposobnost razumevanja in reševanja profesionalnih izzivov,
- sposobnost profesionalne komunikacije v domačem in tujem jeziku,
- sposobnost samostojne uporabe pridobljenega znanja za reševanje tehničnih in znanstvenih problemov v računalništvu in informatiki,
- seznanjenost z raziskovalnimi metodami na področju računalništva in informatike.

Predmetno-specifične kompetence:

- uporaba osnovnih algoritmov strojnega učenja
- predpriprava podatkov za podatkovno rudarjenje
- izbira pomembnih atributov
- vrednotenje odločitvenih modelov
- uporaba sistemov za podatkovno rudarjenje
- uporaba sistemov za optimizacijo z evolucijskim računanjem
- analiza besedil s tehnikami podatkovnega rudarjenja
- uporaba orodij za spodbujevano učenje.

Objectives and competences:

The goal of the course is the students to become acquainted with the field of intelligent systems, which includes a collection of tools and approaches for solving problems which are difficult or unpractical to tackle with other methods. Students will be able to apply the gained theoretical knowledge on real-world problems from scientific and business environment. The students shall be able to decide which of the presented techniques should be used for a given problem, and to develop a prototype solution.

General competences:

- the ability to understand and solve professional challenges in computer and information science,
- the ability of professional communication in the native language as well as a foreign language,
- the ability to apply acquired knowledge in independent work for solving technical and scientific problems in computer and information science,
- familiarity with research methods in the field of computer science.

Subject-specific competences:

- using basic machine learning algorithms
- preprocessing data for data mining
- feature subset selection
- evaluation of decision models
- using data mining systems
- using optimizations packages with evolutionary techniques
- text analysis and text mining
- using reinforcement learning tools

Predvideni študijski rezultati:	Intended learning outcomes:
Znanje in razumevanje: Poznavanje različnih tehnik in metod, ki se uporabljajo pri modeliranju inteligentnih sistemov. Sposobnost za analizo, sintezo in predvidevanje rešitev ter njihovih posledic na konkretnih problemih z uporabo znanstvenih metod. **Uporaba:** Uporaba predstavljenih metod na konkretnih problemih iz znanstvenega in poslovnega okolja. Poznavanje in uporaba orodij za statistično modeliranje in podatkovno rudarjenje. **Refleksija:** Spoznavanje in razumevanje pomena temeljnega matematičnega in statističnega znanja, uglašenosti med teorijo in njeno aplikacijo na konkretnih primerih s področja inteligentnega modeliranja. Avtonomnost, (samo)kritičnost, (samo)refleksivnost, prizadevanje za kakovost. **Prenosljive spretnosti - niso vezane le na en predmet:** Prenos naučenih principov na načrtovanje obsežnih sistemov, kjer lahko principi inteligentnih rešitev pomagajo izboljšati uporabnost in uspešnost sistema. Sposobnost pridobivanja, selekcije in ocenjevanja novih informacij in zmožnost ustrezne interpretacije v kontekstu. Sposobnost za upravljanje s časom, za samo pripravo in načrtovanje ter samokontrolo izvajanja načrtov in postopkov. Timsko delo, pisanje poročil in člankov. Koherentno obvladanje temeljnega znanja, pridobljenega pri obveznih predmetih, ter sposobnost povezovanja znanja z različnih področij in njegova uporaba v praksi.	**Knowledge and understanding:** Expertise in several techniques and methods, used for intelligent system modelling. The ability for analysis, synthesis and anticipation of solutions and their consequences for target problems using the scientific methodology. **Application:** The use of the presented methods on target problems from scientific and business environment. The understanding and usage of tools for statistical modelling and data mining. **Reflection:** The recognition and understanding of the meaning of basic mathematical and statistical knowledge, the relation between theory and its application in concrete examples of intelligent modelling and learning. Autonomy, (self) criticalness, (self) reflexivity, aspiration for quality. **Transferable skills:** The transfer of the learned principles to planning of large systems where the principles of intelligent solutions help to improve the usability and the system performance. The ability to receive, select and evaluate new information and a proper interpretation in a context. A self-control and ability to manage limited time when preparing, planning and implementing plans and processes. Team work, writing of reports and articles, public presentations. Coherent mastering of basic knowledge, gained through mandatory courses, and the ability to combine the knowledge from different fields and to apply it in practice.
Metode poučevanja in učenja:	**Learning and teaching methods:**

Predavanja, vaje z ustnimi nastopi in predstavitvami, seminarski način dela pri domačih nalogah. Študenti bodo v manjših skupinah samostojno reševali realen problem. Skupine bodo svoje naloge in rešitve opisale v pisnem poročilu in predstavile ostalim v obliki kratke predstavitve, ki je ocenjena skupaj s poročilom.	Lectures, assignments with written and oral demonstrations and presentations, seminar works and homework. Students from small project teams and autonomously solve assignments based on real-life problems. The teams describe their solutions in written reports and prepare short oral presentations. Written reports and oral presentations are graded.

Načini ocenjevanja:	Delež (v %) / Weight (in %)	**Assessment:**
Način: pisni in ustni izpit, naloge, projekt. **Sprotno preverjanje:** domače naloge, kolokviji in projektno delo. **Končno preverjanje:** pisni in ustni izpit. Ocene: 6-10 pozitivno, 1-5 negativno	**50%** **50%**	Type: written and oral exam, coursework, project. **Continuing:** homework, project work. **Final:** written and oral exam. Grading: 6-10 pass, 1-5 fail.

Reference nosilca / Lecturer's references:

Pet najpomembnejših del/ Five most important works:

KONONENKO Igor:

1. KONONENKO, Igor, KUKAR, Matjaž. Machine learning and data mining: introduction to principles and algorithms. Chichester: Horwood Publishing, 2007.
2. ŠTRUMBELJ, Erik, KONONENKO, Igor. An efficient explanation of individual classifications using game theory. J. mach. learn. res., Jan. 2010, vol. 11, no. [1], str. 1-18.
3. ROBNIK ŠIKONJA, Marko, KONONENKO, Igor. Theoretical and empirical analysis of ReliefF and RReliefF. Mach. learn., 2003, vol. 53, str. 23-69.
4. KONONENKO, Igor, BRATKO, Ivan. Information-based evaluation criterion for classifier's performance. Mach. learn., 1991, vol. 6, no. 1, str. 67-80.
5. KONONENKO, Igor. Machine learning for medical diagnosis: history, state of the art and perspective. Artif. intell. med., 2001, vol. 23, no. 1, str. 89-109.

Celotna bibliografija prof. dr. Kononenka je dostopna na SICRISu: http://sicris.izum.si/search/rsr.aspx?lang=slv&id=5066.

ROBNIK-ŠIKONJA Marko:

1. ROBNIK ŠIKONJA, Marko. Data generators for learning systems based on RBF networks. *IEEE transactions on neural networks and learning systems*, May 2016, vol. 27, no. 5, pp. 926-938.
2. PIČULIN, Matej, ROBNIK ŠIKONJA, Marko. Handling numeric attributes with ant colony based classifier for medical decision making. Expert systems with applications, Nov. 2014, vol. 41, no. 16, pp. 7524-7535.
3. ROBNIK ŠIKONJA, Marko, VANHOOF, Koen. Evaluation of ordinal attributes at value level. *Data mining and knowledge discovery*, 2007, vol. 14, no. 2, pp. 225-243.
4. ROBNIK ŠIKONJA, Marko, KONONENKO, Igor. Theoretical and empirical analysis of ReliefF and RReliefF. *Machine learning*, 2003, 53:23-69.

5. ROBNIK ŠIKONJA, Marko, KONONENKO, Igor. Explaining classifications for individual instances. *IEEE Transactions on Knowledge and Data Engineering,* 2008, 20(5):589-600.

Celotna bibliografija je dostopna na SICRISu
http://sicris.izum.si/search/rsr.aspx?lang=slv&id=8741.
Complete bibliography is available in SICRIS:
http://sicris.izum.si/search/rsr.aspx?lang=eng&id=8741.

UČNI NAČRT PREDMETA / COURSE SYLLABUS	
Predmet:	**Multimedijski sistemi**
Course title:	**Multimedia Systems**

Študijski program in stopnja Study programme and level	Študijska smer Study field	Letnik Academic year	Semester Semester
Univerzitetni študijski program prve stopnje Računalništvo in informatika **Univerzitetni študijski program prve stopnje Računalništvo in matematika**	**Modul: Medijske tehnologije**	**3**	**zimski**
University study programme Computer and Information Science, 1st cycle **University study programme Computer Science and Mathematics , 1st cycle**	**Module: Media technologies**	**3**	**fall**

Vrsta predmeta / Course type	**izbirni predmet /elective course**
Univerzitetna koda predmeta / University course code:	**63270**

Predavanja Lectures	Seminar Seminar	Vaje Tutorial	Klinične vaje Laboratory work	Druge oblike študija Field work	Samost. delo Individ. work	ECTS
45	**10**	**20**	**/**	**/**	**105**	**6**

Nosilec predmeta / Lecturer:	doc. dr. Matej Kristan

Jeziki / Languages:	**Predavanja / Lectures:**	slovenščina Slovene
	Vaje / Tutorial:	slovenščina Slovene

Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:	**Prerequisites:**

Vsebina:

Predavanja:

1. Pregled področja Multimedijskih sistemov in izzivi
2. Manipulacija slikovnih gradiv
3. Manipulacija video podatkov in standardi zapisa video podatkov
4. Pridobivanje informacij s tekstom
5. Arhitektura sistema za pridobivanje multimedijskih informacij
6. Evaluacija multimedijskih sistemov za pridobivanje informacij
7. Metode za avtomatsko opisovanje vsebine slik
8. Razgradnja slikovne informacije
9. Razgradnja video informacije
10. Interaktivni mediji in obogatena resničnost v multimedijskem sistemu
11. Standardi za brezizgubno stiskanje multimedijskih vsebin
12. Standardi za izgubno stiskanje multimedijskih vsebin

Vaje:

Vaje bodo potekale v obliki projektno-orientiranih nalog v primerno opremljenih študentskih laboratorijih. Študentje v okviru projektov samostojno implementirajo algoritme, ki jih obravnavamo na predavanjih in jih preizkušajo na različnih naborih podatkov zajetih z različnimi senzorskimi sistemi. Sprotno in obvezno delo na projektih omogoča poglobljeno in kritično razumevanje obravnavane tematike, spodbuja pa tudi samostojno mišljenje in kreativnost.

Content (Syllabus outline):

Lectures:

1. Introduction to multimedia, overview of the field and challenges
2. Manipulation of image data
3. Video standards and manipulation of video data
4. Text-based information retrieval
5. Architecture of multimedia information retrieval
6. Evaluation of multimedia systems for information retrieval
7. Automatic image content description
8. Segmentation of image content
9. Segmentation of video content
10. Interactive media and augmented reality in multimedia systems
11. Lossless compression standards in multimedia
12. Lossy compression standards in multimedia

Exercises:

Exercises will take a form of project-oriented exercises in properly equipped student laboratories. Students will implement various algorithms, that will be covered in lectures, and test them on different datasets using a variety of sensor systems. Exercises will support an in-depth understanding of the theory. They will also encourage independent thinking and creativity.

Temeljni literatura in viri / Readings:

Obvezna:

- A. Del Bimbo: Visual Information Retrieval, Morgan Kaufmann 1999, ISBN 1-55860-624-6.
- C. D. Manning, P. Raghavan, H. Schütze, Introduction to Information Retrieval, Cambridge University Press. 2008

Dopolnilna:

Mark S. Li Ze-Nian and Drew, Fundamentals of Multimedia, Prentice-Hall of India (2005)
Članki iz revij, kot npr. IEEE Multimedia. (dostopno na spletu)

Cilji in kompetence:

Multimedijski sistemi so nepogrešljiv del sodobnih informacijskih tehnologij. Študenti naj bi v okviru tega predmeta pridobili znanja in veščine potrebne za uporabo, načrtovanje in razvoj multimedijskih sistemov. Obravnavani bodo problemi učinkovitih predstavitev in obdelave več predstavitvenih podatkov, kot so besedilo, grafika, animacije, slike in video.

Polega tega bodo študenti osvojili naslednje kompetence:

- Sposobnost razumevanja in reševanja strokovnih izzivov s področja računalništva in informatike
- Sposobnost strokovne komunikacije v materinem in tujem jeziku.
- Sposobnost neodvisnega reševanja tako manj zahtevnih kakor kompleksnih inženirskih in organizacijskih problemov iz ozkih področji, kakor tudi specifičnih dobro definiranih problemov s področja računalništva in informatike.

Objectives and competences:

Multimedia systems are an indispensable part of modern information technology. In the framework of this course, the students will acquire knowledge and skills needed for use, design and development of multimedia systems. The course will also deal with the problems related to efficient representations and processing multimedia data, such as text, graphics, animations, images, and video.

In addition, the students will obtain the following competences:

- The ability to understand and solve professional challenges in computer and information science.
- The ability of professional communication in the native language as well as a foreign language.
- The ability to independently perform both less demanding and complex engineering and organisational tasks in certain narrow areas and independently solve specific well-defined tasks in computer and information science.

Predvideni študijski rezultati:

Znanje in razumevanje:
Poznavanje računalniških tehnologij in računalniških metodologij za uporabo in razvoj komponent in multimedijskih sistemov.

Uporaba:
Uporaba računalniških tehnologij in računalniških metodologij pri specifičnih

Intended learning outcomes:

Knowledge and understanding:
Understanding of computer technology and computational methodology for use and development of components for multimedia systems.

Application:
Use of computer technology and computational

aplikacijah multimedijskih sistemov. Refleksija: Spoznavanje in razumevanje uglašenosti med teorijo in njeno aplikacijo na konkretnih primerih s področja modeliranja multimedijskih sistemov. Prenosljive spretnosti - niso vezane le na en predmet: Reševanje drugih konceptualno sorodnih problemov (npr. na drugih modalnostih) na osnovi modelov multimedijskih sistemov.	methodology for specific applications of multimedia systems. Reflection: Understanding how the theory can be tuned for different application scenarios in the area of multimedia systems. Transferable skills: Solving other conceptually similar problems (e.g., other modalities) based on the models of multimedia systems.

Metode poučevanja in učenja:	**Learning and teaching methods:**
Predavanja, laboratorijske vaje v računalniški učilnici z aktivnim sodelovanjem. Individualno delo na vajah. Teorija s predavanj se praktično analizira na vajah. Poseben poudarek je na sprotnem študiju in sprotnem delu pri vajah.	Lectures, laboratory exercises in computer classroom with active participation. Individual work on excercises. Theory from the lectures made concrete with hands-on laboratory exercises. Special emphasis will be put on continuous assessment at exercises.

Načini ocenjevanja:	Delež (v %) / Weight (in %)	**Assessment:**
Način (pisni izpit, ustno izpraševanje, vaje):		Type (examination, oral, laboratory exercises):
Sprotno preverjanje (domače naloge in laboratorijske vaje)	**50%**	**Continuing** (homework and laboratory exercises)
Končno preverjanje (pisni in ustni izpit)	**50%**	**Final** (written and oral exam)
Ocene: 6-10 pozitivno, 1-5 negativno (v skladu s Statutom UL)		Grading: 6-10 pass, 1-5 fail.

Reference nosilca / Lecturer's references:

Pet najpomembnejših del:

KRISTAN, Matej, LEONARDIS, Aleš. Online discriminative kernel density estimator with Gaussian kernels. *IEEE transactions on cybernetics*, vol. 44, (3), 2014, str. [355-365], [COBISS.SI-ID 9907284]

ČEHOVIN, Luka, KRISTAN, Matej, LEONARDIS, Aleš. Robust visual tracking using an adaptive coupled-layer visual model. *IEEE trans. pattern anal. mach. intell.*. [Print ed.], 2012, str. [1-14], [COBISS.SI-ID 9431124]

KRISTAN, Matej, LEONARDIS, Aleš, SKOČAJ, Danijel. Multivariate online kernel density estimation with Gaussian kernels. *Pattern recogn.*. [Print ed.], 2011, vol. 44, no. 10/11, str. 2630-2642.

[COBISS.SI-ID 8289876]

KRISTAN, Matej, SKOČAJ, Danijel, LEONARDIS, Aleš. Online kernel density estimation for interactive learning. *Image vis. comput.*. [Print ed.], Jul. 2010, vol. 28, no. 7, str. 1106-1116, ilustr. [COBISS.SI-ID 7326804]

KRISTAN, Matej, KOVAČIČ, Stanislav, LEONARDIS, Aleš, PERŠ, Janez. A two-stage dynamic model for visual tracking. *IEEE trans. syst. man cybern., Part B, Cybern.*. [Print ed.], Dec. 2010, vol. 40, no. 6, str. 1505-1520, ilustr. [COBISS.SI-ID 7709524]

Celotna bibliografija je dostopna na SICRISu: http://sicris.izum.si/search/rsr.aspx?lang=slv&id=32801.

UČNI NAČRT PREDMETA / COURSE SYLLABUS	
Predmet:	**Umetno zaznavanje**
Course title:	**Machine Perception**

Študijski program in stopnja Study programme and level	Študijska smer Study field	Letnik Academic year	Semester Semester
Univerzitetni študijski program prve stopnje Računalništvo in informatika **Univerzitetni študijski program prve stopnje Računalništvo in matematika** **Univerzitetni študijski program prve stopnje Multimedija**	**Modul: Umetna inteligenca**	**3** **2, 3**	**zimski**
University study programme Computer and Information Science, 1st cycle **University study programme Computer Science and Mathematics , 1st cycle** **University study programme Multimedia, 1st cycle**	**Module: Artificial Intelligence**	**3** **2, 3**	**fall**

Vrsta predmeta / Course type	**izbirni predmet /elective course**
Univerzitetna koda predmeta / University course code:	**63267**

Predavanja Lectures	Seminar Seminar	Vaje Tutorial	Klinične vaje Laboratory work	Druge oblike študija Field work	Samost. delo Individ. work	ECTS
45	10	20	/	/	105	6

Nosilec predmeta / Lecturer:	doc. dr. Matej Kristan

Jeziki / Languages:	**Predavanja / Lectures:**	angleščina English
	Vaje / Tutorial:	angleščina English

Pogoji za vključitev v delo oz. za opravljanje **Prerequisites:**

študijskih obveznosti:

Vsebina:

Vsebina predmeta:

1. Pregled področja umetnega zaznavanja, aplikacijski doseg in znanstveni izzivi
2. Procesiranje slik
    a. Nastanek slike v kameri
    b. Binarizacija, morfološke operacije, segmentacija
    c. Barvni prostori in zaznavanje
    d. Linearni in nelinearni filtri
3. Odvodi slike in zaznavanje robov
    a. Zaznavanje robov z odvodi
    b. Robovi za zaznavanje objektov
    c. Zaznavanje parametričnih oblik
4. Prileganje modelov
    a. Normalne enačbe
    b. Homogeni sistemi
    c. Robustne metode
5. Lokalne značilnice
    a. Detektorji kotov
    b. Lokalni opisniki z izbiro merila in afino adaptacijo
6. Stereoskopija in zaznavanje globine
    a. Nekalibrirani in kalibrirani sistemi ter rekonstrukcija
7. Razpoznavanje objektov
    a. Podprostorske metode (PCA,LDA)
    b. Razpoznavanje z lokalnimi značilnicami
8. Detekcija objektov
    a. Zapis vizualnih lastnosti in postopki za detekcijo
9. Zaznavanje gibanja
    a. Lokalno gibanje in metode za sledenje objektov

Content (Syllabus outline):

Lectures:

1. Overview of the field of Machine perception and scientific challenges
2. Image processing
    a. Image formation
    b. Binarization, morfology, segmentation
    c. Colour spaces and colour perception
    d. Linear and nonlinear filters
3. Image derivatives and edge perception
    a. Derivative-based edge perception
    b. Edge-based object perception
    c. Parametric shape perception
4. Model fitting
    a. Normal equations
    b. Homogenous systems
    c. Robust approaches
5. Local features
    a. Corner perception
    b. Local descriptors in scale space and affine adaptation
6. Stereoscopy and depth perception
    a. Calibrated and uncalibrated systems and reconstruction
7. Object recognition
    a. Subspace methods (PCA, LDA)
    b. Local-features-based recognition
8. Object detection
    a. Visual features and detection approaches
9. Motion perception
    a. Local motion perception and object tracking

Vaje:
Vaje bodo potekale v obliki projektno-orientiranih nalog v primerno opremljenih študentskih laboratorijih. Študentje v okviru nalog samostojno implementirajo algoritme in jih preizkušajo na različnih naborih podatkov zajetih z različnimi senzorskimi sistemi. Sprotno in obvezno delo na projektih omogoča poglobljeno in kritično razumevanje obravnavane tematike, spodbuja pa tudi samostojno mišljenje in kreativnost.

Exercises:
Exercises will take a form of project-oriented exercises in properly equipped student laboratories. Students will implement various algorithms and test them on different datasets using a variety of sensor systems. Exercises will support an in-depth understanding of the theory. They will also encourage independent thinking and creativity.

Temeljni literatura in viri / Readings:

Obvezna:

- D. Forsyth and J. Ponce, Computer Vision: A modern approach, Prentice Hall 2011.
- R. Szeliski,Computer Vision: Algorithms and Applications, Springer, 2011

Dopolnilna:

- H. R. Schiffman: Sensation and Perception, An Integrated Approach, John Wilez & Sons 2001.

Izbrani članki iz revij IEEE PAMI, CVIU, IJCV, Pattern Recognition (dostopno na spletu)

Cilji in kompetence:

Študenti bodo v okviru tega predmeta pridobili konkretna znanja in veščine s področja računalniškega vida. Razvili bodo kompetence z nizkonivojskega procesiranja slik, 3D geometrije kamer in sterea, detekcije objektov, razpoznavanja objektov in osnove izračunavanja gibanja v videoposnetkih. Osvojili bodo tudi matematične osnove za reševanje zahtevnih inženirskih problemov, ki so značilni za analizo tako kompleksnih signalov kot so slike in videoposnetki.

Poleg tega bodo študenti osvojili naslednje kompetence:

- Sposobnost razumevanja in reševanja strokovnih izzivov s področja računalništva in informatike
- Sposobnost strokovne komunikacije v materinem in tujem jeziku.

Objectives and competences:

In the framework of this course, the students will acquire concrete knowledge and skills in the area of machine perception. The students will develop competences in low-level image processing, 3D geometry of stereo systems, object detection, object recognition, and motion extraction in video sequences. The students will also practice mathematical basics crucial for solving demanding engineering problems, which are essential for analysis of complex signals such as images and video.

In addition, the students will obtain the following competences:

- The ability to understand and solve professional challenges in computer and information science.
- The ability of professional communication in the native language

• Sposobnost neodvisnega reševanja tako manj zahtevnih kakor kompleksnih inženirskih in organizacijskih problemov iz ozkih področji, kakor tudi specifičnih dobro definiranih problemov s področja računalništva in informatike.	as well as a foreign language. • The ability to independently perform both less demanding and complex engineering and organisational tasks in certain narrow areas and independently solve specific well-defined tasks in computer and information science.

Predvideni študijski rezultati:	**Intended learning outcomes:**
Znanje in razumevanje: Poznavanje računalniških tehnologij in računalniških metodologij za uporabo in razvoj komponent in sistemov računalniškega zaznavanja. Uporaba: Uporaba računalniških tehnologij in računalniških metodologij pri specifičnih aplikacijah avtonomnih inteligentnih kognitivnih sistemov. Refleksija: Spoznavanje in razumevanje uglašenosti med teorijo in njeno aplikacijo na konkretnih primerih s področja modeliranja umetnih inteligentnih spoznavnih/zaznavnih sistemov. Prenosljive spretnosti - niso vezane le na en predmet: Reševanje drugih konceptualno sorodnih problemov (npr. na drugih modalnostih) na osnovi modelov računalniškega in kognitivnega zaznavanja.	Knowledge and understanding: Understanding of computer technology and computational methodology for use and development of components for machine vision systems. Application: Use of computer technology and computational methodology for specific applications of autonomous intelligent cognitive systems. Reflection: Understanding how the theory can be tuned for different application scenarios in the area of intelligent perceptual/cognitive systems. Transferable skills: Solving other conceptually similar problems (e.g., other modalities) based on the models of machine and artificial cognitive perception.

Metode poučevanja in učenja:	**Learning and teaching methods:**

Predavanja, laboratorijske vaje v računalniški učilnici z aktivnim sodelovanjem. Individualno delo na vajah. Teorija s predavanj se praktično analizira na vajah. Poseben poudarek je na sprotnem študiju in sprotnem delu pri vajah.	Lectures, laboratory exercises in computer classroom with active participation. Individual work on exercises. Theory from the lectures made concrete with hands-on laboratory exercises. Special emphasis will be put on continuous assessment at exercises.

Načini ocenjevanja:	Delež (v %) / Weight (in %)	**Assessment:**
Način (pisni izpit, ustno izpraševanje, vaje):		Type (examination, oral, laboratory exercises):
Sprotno preverjanje (domače naloge in laboratorijske vaje)	**50%**	**Continuing** (homework and laboratory exercises)
Končno preverjanje (pisni in ustni izpit)	**50%**	**Final** (written and oral exam)
Ocene: 6-10 pozitivno, 1-5 negativno (v skladu s Statutom UL)		Grading: 6-10 pass, 1-5 fail.

Reference nosilca / Lecturer's references:

Pet najpomembnejših del:

KRISTAN, Matej, LEONARDIS, Aleš. Online discriminative kernel density estimator with Gaussian kernels. *IEEE transactions on cybernetics*, vol. 44, (3), 2014, str. [355-365], [COBISS.SI-ID 9907284]

ČEHOVIN, Luka, KRISTAN, Matej, LEONARDIS, Aleš. Robust visual tracking using an adaptive coupled-layer visual model. *IEEE trans. pattern anal. mach. intell.*. [Print ed.], 2012, str. [1-14], [COBISS.SI-ID 9431124]

KRISTAN, Matej, LEONARDIS, Aleš, SKOČAJ, Danijel. Multivariate online kernel density estimation with Gaussian kernels. *Pattern recogn.*. [Print ed.], 2011, vol. 44, no. 10/11, str. 2630-2642. [COBISS.SI-ID 8289876]

KRISTAN, Matej, SKOČAJ, Danijel, LEONARDIS, Aleš. Online kernel density estimation for interactive learning. *Image vis. comput.*. [Print ed.], Jul. 2010, vol. 28, no. 7, str. 1106-1116, ilustr. [COBISS.SI-ID 7326804]

KRISTAN, Matej, KOVAČIČ, Stanislav, LEONARDIS, Aleš, PERŠ, Janez. A two-stage dynamic model for visual tracking. *IEEE trans. syst. man cybern., Part B, Cybern.*. [Print ed.], Dec. 2010, vol. 40, no. 6, str. 1505-1520, ilustr. [COBISS.SI-ID 7709524]

Celotna bibliografija je dostopna na SICRISu: http://sicris.izum.si/search/rsr.aspx?lang=slv&id=32801.

UČNI NAČRT PREDMETA / COURSE SYLLABUS	
Predmet:	**Tehnologija upravljanja podatkov**
Course title:	**Data Management Technologies**

Študijski program in stopnja Study programme and level	Študijska smer Study field	Letnik Academic year	Semester Semester
Univerzitetni študijski program prve stopnje Računalništvo in informatika **Interdisciplinarni univerzitetni študijski program prve stopnje Računalništvo in matematika** **Interdisciplinarni univerzitetni študijski program prve stopnje Upravna informatika**	**Modul: Obvladovanje informatike**	**3**	**zimski**
University study programme Computer and Information Science, 1st cycle **Interdisciplinary University study programme Computer Science and Mathematics , 1st cycle** **Interdisciplinary university Study Programme in Administrative Informatics 1st Cycle**	**Module: Management of Information Systems**	**3**	**fall**

Vrsta predmeta / Course type	**izbirni predmet / elective course** **obvezni predmet / compulsory course**
Univerzitetna koda predmeta / University course code:	**63226**

Predavanja Lectures	Seminar Seminar	Vaje Tutorial	Klinične vaje Laboratory work	Druge oblike študija Field work	Samost. delo Individ. work	ECTS
45	10	20	/	/	105	6

Nosilec predmeta / Lecturer:	izr. prof. dr. Matjaž Kukar

Jeziki / Languages:	**Predavanja / Lectures:**	slovenščina Slovene
	Vaje / Tutorial:	slovenščina Slovene

Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:

Prerequisites:

Vsebina:

Predavanja obsegajo dva tematska sklopa:

Eksterni vidiki obvladovanja podatkov:

1. Podatkovne baze in podatkovna skladišča
2. Načrtovanje podatkovnih baz
   - Konceptualno, logično in fizično načrtovanje
   - Normalizacija relacij
   - Optimizacija performans
   - Porazdeljene podatkovne baze
3. Načrtovanje podatkovnih skladišč
   - Namen in načrtovanje podatkovnih skladišč
   - Zagotavljanje kvalitete shranjenih podatkov
   - Pristopi k analizi shranjenih podatkov
4. Načrtovanje nerelacijskih podatkovnih baz
   - Nerelacijsko modeliranje podatkov

Interni vidiki obvladovanja podatkov:

1. Zagotavljanje dostopnosti in konsistentnosti podatkov
   - Upravljanje sočasnosti dostopa do podatkovne baze
   - Varovanje in obnavljanje podatkovne baze

Content (Syllabus outline):

Course topics:

External data management:

1. Databases and data warehouses
2. Database design:
   - conceptual, logical and physical design
   - advanced normalization,
   - performance optimization
   - distributed databases
3. Data warehouse design:
   - design methodologies,
   - data quality assurance,
   - data analysis
4. Non-relational database design (NoSQL)
   - Non-relational data modelling

Internal data management:

1. Assuring availability and consistency of stored data:
   - concurrent data access,
   - data archival and recovery
   - distributed and parallel

- Porazdeljeni in vzporedni podatkovni sistemi

2. Optimizacija in evalvacija poizvedb
   - Načrtovanje izvajanja poizvedb
   - Vrednotenje zahtevnosti osnovnih operacij
   - Alternativne strategije izvajanja poizvedb
3. Upravljanje delno strukturiranih in nestrukturiranih podatkov
   - Sodobni nerelacijski podatkovni sistemi
   - Delo s prostorskimi in časovnimi podatki
   - Delo z drugimi delno strukturiranimi ali nestrukturiranimi podatki (tekst, zvok, slika, sekvence, JSON, XML)

Vaje:

1. Seznaniti se s tipičnimi problemi pri obvladovanju podatkov in s pristopi za reševanje le-teh.
2. Spoznati in obvladati orodja za načrtovanje in uporabo podatkovnih baz.
3. Obvladati uporabo produktov teh orodij v praktičnih primerih (v obliki seminarske naloge).

   Pri vajah se študenti seznanijo z orodji za obvladovanje podatkov (predvsem načrtovanje) in jih v okviru svojih domačih nalog samostojno uporabijo v praktičnih primerih. Rezultate domačih nalog predstavijo v obliki seminarjev.

databases

2. Query evaluation and optimization:
   - query execution planning,
   - estimating the costs of basic operations,
   - alternative plan considerations
3. Management of semi-structured and unstructured data types:
   - Modern non-relational database systems
   - spatial and temporal data,
   - other semi-structured data (audio, video, images, sequences, JSON, XML)

Tutorial topics:

1. Recognize typical data management problems and approaches for solving them
2. Get to know various tools for database design and utilization, and use them in practical problems.
3. Using the products of aforementioned tools for a practical database implementation (in terms of a substantial project)

Through the tutorial students get familiar with various data management tools and use them - in course of their projects – as a part of a practical problem solution. The final part of the project is a public presentation of the assigned problem, its solution and results.

Temeljni literatura in viri / Readings:

1. T. M. Connolly, C. E. Begg: Database Systems: A Practical Approach to Design, Implementation and Management, 4th edition, Addison Wesley, 2004.

2. S. Sumathi, S. Esakkirajan: Fundamentals of Relational Database Management Systems, Springer, 2007.

3. R. Ramakrishnan, J. Gehrke: Database Management Systems, 3rd edition, McGraw-Hill, 2002.

4. Seven Databases in Seven Weeks: A Guide to Modern Databases and the NoSQL Movement, Pragmatic Bookshelf, 2012

Cilji in kompetence:	**Objectives and competences:**
Cilj predmeta je študentom računalništva in informatike predstaviti principe in pristope za upravljanje podatkov z dveh vidikov: **zunanjega**, s poudarkom na primernem načrtovanju in pripravi, ter **notranjega**, s poudarkom na tehnologijah znotraj podatkovnih baz. Splošne kompetence: • sposobnost kritičnega mišljenja • razvoj sposobnosti kritičnega, analitičnega in sintetičnega mišljenja • sposobnost definiranja, razumevanja in reševanja strokovnih izzivov na področju računalništva in informatike • Skladnost z varnostnimi, funkcionalnimi, ekonomskimi in okoljskimi vodili. • sposobnost samostojne uporabe pridobljenega znanja pri reševanju tehničnih in znanstvenih izzivov na področju računalništva in informatike; sposobnost nadgradnje pridobljenega znanja Predmetno specifične kompetence: • sposobnost razumevanja in uporabe znanja računalništva in informatike na drugih tehničnih in relevantnih področjih (ekonomija, organizacijske vede ipd.); • praktična znanja in veščine na področju strojne opreme, programske opreme in informacijskih tehnologij, ki so nujna za uspešno delo na področju računalništva in informatike • sposobnost samostojne izvedbe manj zahtevnih in zahtevnih inženirskih in organizacijskih opravil na določenih ozkih področjih in neodvisnega reševanja določenih dobro opredeljenih opravil na področju računalništva in informatike	The main course objective is to present principles and approaches to data management from two points of view: **external**, focusing on proper database/data warehouse design and data preparation, and **internal**, focusing on intrinsic key database technologies. General competences: • ability of critical thinking • developing skills in critical, analytical and synthetic thinking • the ability to define, understand and solve creative professional challenges in computer and information science; • compliance with security, functional, economic and environmental principles • the ability to apply acquired knowledge in independent work for solving technical and scientific problems in computer and information science; the ability to upgrade acquired knowledge Subject specific competences: • The ability to understand and apply computer and information science knowledge to other technical and relevant fields (economics, organisational science, etc) • practical knowledge and skills of computer hardware, software and information technology necessary for successful professional work in computer and information science • the ability to independently perform both less demanding and complex engineering and organisational tasks in certain narrow areas and independently solve specific well-defined tasks in computer and information science

Predvideni študijski rezultati:	**Intended learning outcomes:**
Znanje in razumevanje: Poznavanje problematike upravljanja s podatki, ter razumevanje principov in pristopov za njihovo reševanje. Poznavanje konceptov in področij uporabnosti sodobnih nerelacijskih (NoSQL) podatkovnih sistemov. Uporaba: Uporaba pridobljenih znanj in orodij za obvladovanje podatkov v inženirskem in raziskovalnem delu. Refleksija: Spoznavanje in razumevanje povezav med teoretičnimi principi za obvladovanje podatkov in njihovo uporabo v praksi. Prenosljive spretnosti - niso vezane le na en predmet: Načrtovanje, obvladovanje, hranjenje in analiza različnih vrst podatkov se neposredno ali posredno uporablja na področjih informacijskih sistemov, poslovne inteligence, spletnih storitev in inteligentnih sistemov.	Knowledge and understanding: Recognizing data management problems, and understanding principles and approaches for solving them. Comprehension of basic concepts and usability of non-relational (NoSQL) databases. Application: Using acquired knowledge and tools for data management in engineering and research work. Reflection: Introduction and comprehension of connections between specific theoretical data management technologies, and their practical use. Transferable skills: Database design, data storage, management and analysis are directly or indirectly being used in information systems, business intelligence, web services and intelligent systems.

Metode poučevanja in učenja:	**Learning and teaching methods:**
Predavanja in seminarski način dela pri domačih nalogah. Poseben poudarek je na sprotnem študiju in na skupinskem delu pri domačih nalogah in seminarjih.	Lectures, homework and project work with explicit focus on simultaneous studies (for homeworks) and teamwork (for projects).

Načini ocenjevanja:	Delež (v %) / Weight (in %)	**Assessment:**
Način (pisni izpit, ustno izpraševanje, naloge, projekt):		Type (examination, oral, coursework, project):
Sprotno preverjanje (domače naloge, kolokviji in projektno delo)	**60%**	**Continuing** (homework, midterm exams, project work)
Končno preverjanje (pisni in ustni izpit)	**40%**	**Final** (written and oral exam)
Ocene: 6-10 pozitivno, 1-5 negativno (v skladu s Statutom UL)		Grading: 6-10 pass, 1-5 fail.

Reference nosilca / Lecturer's references:

Pet najpomembnejših del:

1. KONONENKO, Igor, KUKAR, Matjaž. Machine learning and data mining: introduction to principles and algorithms. Chichester: Horwood Publishing, 2007.
2. PETELIN, Boris, KONONENKO, Igor, MALAČIČ, Vlado, KUKAR, Matjaž. Multi-level association rules and directed graphs for spatial data analysis. Expert syst. appl. [Print ed.], 2013, vol. 40, issue 12, 4957-4970.
3. KUKAR, Matjaž, KONONENKO, Igor, GROŠELJ, Ciril. Modern parameterization and explanation techniques in diagnostic decision support system: a case study in diagnostics of coronary artery disease. Artif. intell. med., Jun. 2011, vol. 52, no. 2, 77-90.
4. ŠAJN, Luka, KUKAR, Matjaž. Image processing and machine learning for fully automated probabilistic evaluation of medical images. Computer methods and programs in biomedicine, ISSN 0169-2607. [Print ed.], Dec. 2011, vol. 104, no. 3, 75-86,
5. KUKAR, Matjaž. Quality assessment of individual classifications in machine learning and data mining. Knowledge and information systems, 2006, vol. 9, no. 3.

Celotna bibliografija je dostopna na SICRISu:
http://sicris.izum.si/search/rsr.aspx?lang=slv&id=8453.

UČNI NAČRT PREDMETA / COURSE SYLLABUS	
Predmet:	**Porazdeljeni sistemi**
Course title:	**Distributed Systems**

Študijski program in stopnja Study programme and level	Študijska smer Study field	Letnik Academic year	Semester Semester
Univerzitetni študijski program prve stopnje Računalništvo in informatika **Univerzitetni študijski program prve stopnje Računalništvo in matematika**	**Modul: Računalniški sistemi**	**3**	**zimski**
University study programme Computer and Information Science, 1st cycle **University study programme Computer Science and Mathematics , 1st cycle**	**Module: Computer systems**	**3**	**fall**

Vrsta predmeta / Course type **izbirni predmet /elective course**

Univerzitetna koda predmeta / University course code: **63261**

Predavanja Lectures	Seminar Seminar	Vaje Tutorial	Klinične vaje Laboratory work	Druge oblike študija Field work	Samost. delo Individ. work	ECTS
45	10	20	/	/	105	6

Nosilec predmeta / Lecturer: izr. prof. dr. Uroš Lotrič

Jeziki / Languages:	
Predavanja / Lectures:	slovenščina Slovene
Vaje / Tutorial:	slovenščina Slovene

Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:

Prerequisites:

Vsebina:

1. Uvod: cilji paralelizacije, komunikacija in koordinacija, programerske napake
2. Dekompozicija problema: podatkovni in funkcijski paralelizem, cevovod, razteglјivost
3. Komunikacija in koordinacija: večprocesorski sistemi (deljeni pomnilnik, sovisnost predpomnilnika, medsebojno izključevanje, prepreke, pogojne spremenljivke), večračunalniški sistemi (izmenjevanje sporočil, točka-točka in skupinsko, latenca in pasovna širina)
4. Paralelni algoritmi, analiza in programiranje: koncepti in primeri uporabe (nerodno paralelni algoritmi, deli in vladaj, razprši in združi, gospodar-suženj), analiza (pohitritev in Amdahlov zakon, razteglјivost)
5. Paralelne arhitekture: Flynnovo označevanje, večprocesorski sistemi (SIMD, UMA, NUMA), večračunalniški sistemi (gruča, grid, oblak), grafične procesne enote in moderni koprocesorji in heterogeni sistemi, povezovanje (vodila, mreže)
6. Zmogljivost paralelnih sistemov: uravnavanje obremenitve, razporejanje opravil, stroški komunikacije, vpliv predpomnilnika, prostorska in časovna lokalnost, energijska učinkovitost
7. Teoretični modeli paralelnega računanja: modeli paralelnega računanja (PRAM, BSP), modeli izmenjevanja sporočil (CSP), modeliranje odvisnosti v algoritmu,

Content (Syllabus outline):

1. Fundamentals: goals, communication, coordination, programming errors
2. Parallel decomposition: data and functional paralelism, pipeline, scalability
3. Communication and coordination: shared-memory systems (shared memory, cache coherence, mutual exclusion, barriers, conditional variables, semaphores), distributed-memory systems (message passing, point-to-point versus multicast, latency and throughput)
4. Parallel algorithms, analysis and programming: concepts and examples (embarisingly parallel algorithms, divide and conquer, map reduce, master slave), analyis (speedup and Amdahl's law, scalability)
5. Parallel architectures: Flynn's taxonomy, shared-memory systems (SIMD, UMA, NUMA), distributed-memory systems (cluster, grid, cloud), graphic processing units, modern coprocessors and heterogeneous systems, topologies (buses and interconnects)
6. Parallel performance: load balancing, scheduling and contention, communication overhead, cache effects, spatial and temporal datal locality, energy efficiency
7. Theoretical models of parallel computing: formal models of parallel computation (PRAM, BSP), formal models of message passing (CSP), formal models of computational

modeli zagotavljanja skladnosti v sistemih z deljenim pomnilnikom 8. Porazdeljeni sistemi: napake na mreži in vozliščih, razpoložljivost, kompromisi pri načrtovanju sistemov in servisnih storitev, primeri porazdeljenih algoritmov (volitve, odkrivanje)	dependencies, models of shared memory consistency 8. Distributed systems: network- and node-based faults, availability, distributed system and service design tradeoffs, examples of distributed algorithms (election, discovery)

Temeljni literatura in viri / Readings:

1. P.S. Pacheco. An Introduction to Parallel Programming, Morgan Kaufman, 2011.
2. M. J. Quinn. Parallel Programing in C with MPI and OpenMP. Mc Graw Hill, 2003.
3. B.R. Gaster et. al. Heterogeneous computing with OpenCL. Morgan Kaufmann, 2013.
4. G. Couloris et al. Distributed Systems: Concepts and Design. Pearson, 2012.

Cilji in kompetence:	**Objectives and competences:**
Pridobiti osnovno teoretično in praktično znanje s področij vzporednih in porazdeljenih sistemov, paralelnega programiranja in procesiranja. Razumeti računalniška omrežja, medprocesorsko komunikacijo in značilnosti snovanja paralelnih algoritmov. Naučiti se programiranja sistemov s knjižnicami pThreads, OpenMP, OpenCL in MPI. Razumeti Grid in koncept računalništva v oblaku. Seznaniti se s trendi razvoja.	To get the basic theoretical and practival knowledge from the areas of parallel and distributed systems, parallel programming and processing. To understand computer networks, inter-process communication and features of parallel algorithm design. To learn programming with pThreads, OpenMP, CUDA, and MPI. To understand Grid and concept of cloud computing. To realize future trends.
Predvideni študijski rezultati:	**Intended learning outcomes:**

Znanje in razumevanje: Študenti se pri predmetu spoznajo z osnovnimi pojmi vzporednih in porazdeljenih sistemov, arhitekturo, posebnostmi komunikacije in koordinacije med elementi. Velik poudarek je na spoznavanju in programiranju paralelnih algoritmov, dekompoziciji problema na podlagi uveljavljenih formalnih modelov, teoretični analizi in merjenju zmogljivosti. Uporaba: Znanja, pridobljena pri tem predmetu, spadajo med specialna računalniška znanja. Sposobnost samostojnega in praktičnega načrtovanja in programiranja vzporednih in porazdeljenih računalniških, sposobnost evalvacije vzporednih in porazdeljenih sistemov. Refleksija: Spoznavanje in razumevanje uglašenosti med teorijo in njeno aplikacijo na konkretnih primerih s področja načrtovanja in programiranja vzporednih in porazdeljenih sistemov. Prenosljive spretnosti: Spretnosti uporabe domače in tuje literature in drugih tehniških virov, zbiranja in interpretiranja podatkov, identifikacija in reševanje problemov pri programiranju vzporednih sistemov, kritična analiza in ocena uporabnosti konkretnega vzporednega oz. porazdeljenega sistema ali algoritma.	Knowledge and understanding: The course focuses on the basic concepts of parallel and distributed systems, their architecture, communication, and coordination among elements. Important part of the course is in theorethical analysis and programming of important parallel agorithms, including parallel decomposition, theoretical analysis based on formal theoretical models, and perofrmance evaluation. Application: Student with skills gained in this course will be capable of designing, programming, and evaluating parallel and or distributed systems. Reflection: Awareness and understanding of connection between the theory and its application on parallel and distributed systems. Transferable skills: Capability of reading and understanding domestic and foreign technical literature, gathering and interpreting data, identifying and solving problems, critical analysis and evaluation of the usefulness of parallelization of distributed system and/or algorithms.

Metode poučevanja in učenja:	**Learning and teaching methods:**
Predavanja, seminarji, laboratorijske vaje, projektno delo na laboratorijskih vajah, individualne domače naloge.	Lectures, laboratories, homework

Načini ocenjevanja: Delež (v %) / **Assessment:**

	Weight (in %)	
Način (ustno izpraševanje, domače naloge, projektno delo): **Domače naloge** **Projekt** **Ustni izpit** Ocene: 6-10 pozitivno, 1-5 negativno (v skladu s Statutom UL)	 **33 %** **33 %** **34 %**	Type (examination, oral, homework): **Homework** **Project** **Oral exam** Grading: 6-10 pass, 1-5 fail.

Reference nosilca / Lecturer's references:

Pet najpomembnejših del:

1. LOTRIČ, Uroš, DOBNIKAR, Andrej. Parallel implementations of recurrent neural network learning. *Lect. notes comput. sci.*, 2009, vol. 5495, 99-108
2. SILVA, Catarina, LOTRIČ, Uroš, RIBEIRO, Bernardete, DOBNIKAR, Andrej. Distributed text classification with an ensemble kernel-based learning approach. IEEE trans. syst. man cybern., Part C Appl. rev., May 2010, vol. 40, 287-297
3. LOTRIČ, Uroš, BULIĆ, Patricio. Applicability of approximate multipliers in hardware neural networks. Neurocomputing, 2012, vol. 96, 57-65
4. SLUGA, Davor, CURK, Tomaž, ZUPAN, Blaž, LOTRIČ, Uroš. Acceleration of information-theoretic data analysis with graphics processing units. Prz. Elektrotech., 2012, 136-139
5. CANKAR, Matija, ARTAČ, Matej, ŠTERK, Marjan, LOTRIČ, Uroš, SLIVNIK, Boštjan. Co-allocation with collective requests in grid systems. Journal for universal computer science, 2013, vol. 96, 282-300

Celotna bibliografija izr. prof. dr. Lotriča je dostopna na SICRISu: http://sicris.izum.si/search/rsr.aspx?lang=slv&id=9241.

UČNI NAČRT PREDMETA / COURSE SYLLABUS	
Predmet:	**Programiranje 1**
Course title:	**Programming 1**

Študijski program in stopnja Study programme and level	Študijska smer Study field	Letnik Academic year	Semester Semester
Univerzitetni študijski program prve stopnje Računalništvo in informatika **Univerzitetni študijski program prve stopnje Računalništvo in in matematika** **Univerzitetni študijski program prve stopnje Multimedija**	**ni smeri**	**1**	**zimski**
University study programme Computer and Information Science, 1st cycle **University study programme Computer Science and Mathematics , 1st cycle** **University study programme Multimedia, 1st cycle**	**none**	**1**	**fall**

Vrsta predmeta / Course type	**obvezni predmet / compulsory course**
Univerzitetna koda predmeta / University course code:	**63277**

Predavanja Lectures	Seminar Seminar	Vaje Tutorial	Klinične vaje Laboratory work	Druge oblike študija Field work	Samost. delo Individ. work	ECTS
45	/	30	/	/	105	6

Nosilec predmeta / Lecturer:	prof. dr. Viljan Mahnič

Jeziki / Languages:	**Predavanja / Lectures:**	slovenščina Slovene
	Vaje / Tutorial:	slovenščina Slovene

Pogoji za vključitev v delo oz. za opravljanje **Prerequisites:**

študijskih obveznosti:

Vsebina:	**Content (Syllabus outline):**
predavanja: 1. Pregled programskih jezikov s poudarkom na sodobnih programskih jezikih 3. generacije 2. Primer preprostega programa, postopek priprave programa, prevajanje in izvajanje 3. Osnovni podatkovni tipi • Predstavitev celih in realnih števil, znakov ter logičnih vrednosti • Deklaracije konstant in spremenljivk 4. Stavki • Prireditveni stavek, pisanje izrazov, operatorji in njihova prioriteta • Izbirni stavki • Ponavljalni stavki 5. Metode • Vloga in vrste metod • Formalni in dejanski parametri • Rekurzija 6. Razredi in objekti • Spremenljivke in metode objekta • Konstruktorji, večkratno definiranje konstruktorjev • Dostopna določila • Vnaprej deklarirani razredi 7. Tabele • Enodimenzionalne in večdimenzionalne tabele • Tabele objektov 8. Nizi 9. Dedovanje • Redefinicija metod • Konstruktorji v podrazredih • Dinamično povezovanje	**lectures:** 1. Overview of programming languages with emphasis on 3rd generation 2. Writing, compiling and executing a simple computer program 3. Basic data types • Integer and real numbers, characters and logical values • Constants and variables declaration 4. Programming statements • The assignment statement, expressions, operators, operator precedence • Conditional statements • Loops 5. Methods • The role and classification of methods • Formal and actual parameters • Recursion 6. Classes and objects • Instance variables and methods • Constructors, overloading constructors • Access modifiers • Using predefined classes 7. Arrays • One-dimensional and multidimensional arrays • Arrays of objects 8. Strings 9. Inheritance • Overriding superclass methods • Using superclass constructors in

podprogramov
- Abstraktni razredi in abstraktne metode
- Razred Object
- Vmesnik (interface)

10. Grafične knjižnice, komponente grafičnega uporabniškega vmesnika
11. Dogodkovno vodeno programiranje

vaje:
Na vajah študenti rešujejo praktične probleme, s katerimi utrjujejo snov, ki so jo obravnavali na predavanjih. Poudarek je na samostojnem delu ob pomoči asistentov.

domače naloge:
Študenti dobijo seznam nalog (programov), ki jih morajo izdelati doma in zagovarjati na vajah v vnaprej predpisanih rokih. S tem jih vzpodbujamo k sprotnemu študiju in samostojnemu delu. Študent, ki nima pozitivno ocenjenih domačih nalog, ne more pristopiti k izpitu.

subclasses
- Dynamic method binding
- Abstract classes and abstract methods
- The Object class
- Creating and using interfaces

10. Graphics and GUI widget toolkits, components of GUI
11. Event driven programming

lab practice:
Students solve practical problems to reinforce the understanding of topics covered during lectures. Individual work under the guidance of teaching assistants is emphasized.

homework:
Students are given a list of programs that must be developed outside contact hours and submitted for evaluation within prescribed deadlines, thus preventing them from procrastinating and encouraging self-reliance. Completion of these assignments is a prerequisite for entering the exam.

Temeljni literatura in viri / Readings:

1. V. Mahnič, L. Fürst, I. Rožanc: Java skozi primere, Bi-TIM, 2008.
2. J. Farrell: Java Programming, Seventh Edition, Course Technology, Cengage Learning, 2014.

Dodatna literatura:

1. I. Horton: Beginning Java, Java 7 Edition, John Wiley & Sons, Inc., 2011
2. Uroš Mesojedec, Borut Fabjan: Java 2: Temelji programiranja, Pasadena, 2004.

Cilji in kompetence:

Cilj predmeta je študentom predstaviti osnovne koncepte objektno usmerjenega programiranja v enem izmed splošno namenskih programskih jezikov 3. generacije in jih usposobiti za samostojen razvoj enostavnih računalniških programov.

Predvidene kompetence:
- razvoj sposobnosti za kritično, analitično in sintetično razmišljanje,
- sposobnost razumevanja in reševanja strokovnih izzivov na področju računalništva in informatike,

Objectives and competences:

The main objective is to teach students basic concepts of object-oriented programming in a general-purpose 3rd generation programming language, thus making them able to develop computer programs of low complexity.

The competences students gain are:
- developing skills in critical, analytical and synthetic thinking,
- the ability to understand and solve professional challenges in computer and information science.
- the ability to apply acquired knowledge in

• sposobnost uporabe pridobljenega znanja pri samostojnem delu za reševanje tehničnih in znanstvenih problemov na področju računalništva in informatike; sposobnost nadgradnje pridobljenega znanja, • temeljna znanja na področju računalništva in informatike, ki vključujejo temeljna teoretična znanja, praktična znanja in znanja, ki so bistvena za področje računalništva in informatike, • temeljna znanja na področju računalništva in informatike, ki so pomembna za nadaljevanje študija na drugi stopnji.	independent work for solving technical and scientific problems in computer and information science; the ability to upgrade acquired knowledge. • basic skills in computer and information science, which includes basic theoretical skills, practical knowledge and skills essential for the field of computer and information science. • basic skills in computer and information science, allowing the continuation of studies in the second study cycle.

Predvideni študijski rezultati:	**Intended learning outcomes:**
Znanje in razumevanje: • postopka priprave in izvajanja programa, • osnovnih programskih konstruktov in podatkovnih struktur, • konceptov objektno usmerjenega programiranja, • osnovnih algoritmov za reševanje tipičnih programerskih problemov, • dogodkovno vodenega programiranja in osnovnih komponent uporabniškega vmesnika. Uporaba: Uporaba naučenih konceptov pri samostojnem razvoju enostavnejših računalniških programov. Refleksija: Spoznavanje in razumevanje vloge programerja pri reševanju problemov različnih uporabnikov. Prenosljive spretnosti - niso vezane le na en predmet: Spretnost pri uporabi domače in tuje literature ter uporabniške dokumentacije. Pridobivanje sposobnosti za samostojno reševanje problemov.	Knowledge and understanding of: • the process of writing, compiling, and running a computer program • basic programming constructs and data structures • object-oriented programming concepts • basic algorithms for typical program problems solving • event-driven programming and basic components of GUI Application: Application of concepts learned in development of simple computer programs. Reflection: Understanding of the role of a programmer in solving problems of different end-users. Transferable skills: The ability of using Slovenian and foreign literature and user manuals. Capability for self-reliant problem solving.

Metode poučevanja in učenja:	**Learning and teaching methods:**

• *Predavanja* z aktivno udeležbo študentov (razlaga, diskusija, vprašanja, primeri, reševanje problemov); • *Laboratorijske vaje* (refleksija izkušenj, praktično reševanje več tipičnih problemov na računalniku, predstavitev in zagovor programskih rešitev, diskusija, sporočanje povratne informacije); • *Domače naloge* (samostojna izdelava računalniških programov) • Individualne *konsultacije* (diskusija, dodatna razlaga, obravnava specifičnih vprašanj)	• *Lectures* with active participation of students (explanation, discussion, questions, examples, problem solving); • *Lab practice* (reflection of experience, practical problem solving, presentation of solutions, discussion, communication of feedback information) • *Homework* (individual development of simple computer programs) • Individual consultation hours (discussion, additional explanation, specific problems solving)

Načini ocenjevanja:	Delež (v %) / Weight (in %)	**Assessment:**
Način (pisni izpit, ustno izpraševanje, naloge, projekt): **Sprotno preverjanje** (3 seminarske naloge, , kratki testi v obliki kvizov) **Končno preverjanje** (izpit) Ocene: 6-10 pozitivno, 1-5 negativno (v skladu s Statutom UL)	 **50%** **50%**	Type (examination, oral, coursework, project): **Continuing** (three homework programming projects, short tests) **Final** (exam) Grading: 6-10 pass, 1-5 fail.

Reference nosilca / Lecturer's references:

Pet najpomembnejših del:

1. MAHNIČ, Viljan. A capstone course on agile software development using Scrum. *IEEE trans. ed.*, Feb. 2012, vol. 55, no. 1, str. 99-106
2. MAHNIČ, Viljan, HOVELJA, Tomaž. On using planning poker for estimating user stories. *J. syst. softw.*. Sep. 2012, vol. 85, no. 9, str. 2086-2095.
3. MAHNIČ Viljan. Teaching Scrum through team-project work: students' perceptions and teacher's observations. *International journal of engineering education*, 2010, vol. 26, no. 1, str. 96-110.
4. FÜRST, Luka, MAHNIČ, Viljan. Introductory programming course: motivating students with prior knowledge. *World transactions on engineering and technology education*, ISSN 1446-2257, 2013, vol. 11, no. 4, str. 400-405. http://wiete.com.au/journals/WTE&TE/Pages/Vol.11,%20No.4%20(2013)/08-Fuerst-L.pdf.
5. MAHNIČ, Viljan, FÜRST, Luka, ROŽANC, Igor. *Java skozi primere*. Šenčur: Bi-tim, 2008. XIV, 478 str., ponovni ponatis 2012.

Celotna bibliografija je dostopna na SICRISu: http://sicris.izum.si/search/rsr.aspx?lang=slv&id=4767.

UČNI NAČRT PREDMETA / COURSE SYLLABUS	
Predmet:	**Tehnologija programske opreme**
Course title:	**Software Engineering**

Študijski program in stopnja Study programme and level	Študijska smer Study field	Letnik Academic year	Semester Semester
Univerzitetni študijski program prve stopnje Računalništvo in informatika **Univerzitetni študijski program prve stopnje Računalništvo in matematika**	**ni smeri**	**3**	**poletni**
University study programme Computer and Information Science, 1st cycle **University study programme Computer Science and Mathematics , 1st cycle**	**none**	**3**	**spring**

Vrsta predmeta / Course type	**obvezni predmet / compulsory course**
Univerzitetna koda predmeta / University course code:	**63256**

Predavanja Lectures	Seminar Seminar	Vaje Tutorial	Klinične vaje Laboratory work	Druge oblike študija Field work	Samost. delo Individ. work	ECTS
45	10	20	/	/	105	6

Nosilec predmeta / Lecturer:	prof. dr. Viljan Mahnič

Jeziki / Languages:	**Predavanja / Lectures:**	slovenščina Slovene
	Vaje / Tutorial:	slovenščina Slovene

Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:	**Prerequisites:**

Vsebina:

predavanja:

Temeljne vsebine:

1. Osnovni koncepti
   a. Kaj je tehnologija programske opreme
   b. Faze v razvoju programske opreme
   c. Modeli razvojnega procesa (npr. slapovni, inkrementalni, agilni)
2. Orodja in okolja za razvoj programske opreme
   a. Upravljanje konfiguracije in nadzor različic
   b. Avtomatizirana gradnja in zvezna integracija
   c. Orodja za pomoč pri analizi in načrtovanju (orodja CASE)
3. Opredelitev zahtev
   a. Ugotavljanje zahtev
   b. Dokumentiranje zahtev
   c. Nefunkcionalne zahteve
   d. Ovrednotenje in uporaba specifikacije zahtev
4. Modeliranje
   a. Klasične tehnike (npr. diagrami entite-razmerja, diagrami podatkovnih tokov, diagrami prehajanja stanj)
   b. Jezik UML
5. Načrtovanje programske opreme
   a. Principi načrtovanja (abstrakcija, modularnost, delitev odgovornosti, skrivanje detajlov, sklopljenost in povezanost, ponovna uporaba)
   b. Klasične metode načrtovanja (funkcionalna dekompozicija, strukturirane metode)
   c. Objektno usmerjena analiza in

Content (Syllabus outline):

lectures:

Core topics:

1. Basic concepts
   a. What is Software Engineering
   b. Phases in the development of software
   c. Software process models (e.g., waterfall, incremental, agile)
2. Software engineering tools and environments
   a. Configuration management and version control
   b. Automated builds and continuous integration
   c. Requirements analysis and design modeling tools (CASE tools)
3. Requirements engineering
   a. Requirements elicitation
   b. Requirements documentation
   c. Non-functional requirements
   d. Evaluation and use of requirements specifications
4. Modeling
   a. Classic modeling techniques (e.g., entity-relationship diagrams, data flow diagrams, finite state machines)
   b. The Unified Modeling Language
5. Software design
   a. Software design principles (abstraction, modularity, separation of concerns, information hiding, coupling and cohesion, reuse)
   b. Classical design methods (functional decomposition, data flow design)
   c. Object-oriented analysis and design (Rational Unified Process)

načrtovanje (RUP)
   d. Načrtovalski vzorci
6. Programiranje
   a. Dobre prakse (defenzivno programiranje, varno programiranje, uporaba mehanizmov za lovljenje izjem, prestrukturiranje kode)
   b. Standardi kodiranja
   c. Strategije za integracijo
7. Testiranje programske opreme
   a. Testiranje in življenjski cikel
   b. Strukturirani pregledi
   c. Testiranje enot, integracijsko testiranje, testiranje funkcionalnosti, sistemsko testiranje
   d. Testiranje po metodi črne in bele škatle
   e. Regresijsko testiranje in avtomatizacija testiranja
   f. Testno voden razvoj
8. Vzdrževanje in nadgradnje
   a. Glavni vzroki problemov pri vzdrževanju
   b. Značilnosti programske opreme, ki je primerna za vzdrževanje
   c. Obratno inženirstvo in prestrukturiranje
   d. Ponovna uporaba programske opreme

Izbirne vsebine:
9. Modeli za izboljšanje kakovosti razvojnega procesa
   a. CMMI (Capability Maturity Model Integration) for Development
   b. PSP (Presonal Software Process)
   c. TSP (Team Software Porcess)
10. Agilni in vitki razvoj programske opreme
   a. Scrum
   b. Extreme Programming
   c. Kanban
   d. Uravnoteženje agilnosti in discipline

vaje:
Skupinsko delo na projektih, ki so čim bolj podobni realnim. Projekte lahko predlagajo študenti sami, potrditi pa jih morata nosilec predmeta in asistent. Lahko pa problem definira nosilec predmeta v sodelovanju z ustreznim naročnikom. Velikost skupin je

   d. Design patterns

6. Software construction
   a. Coding practices (defensive coding practices, secure coding practices, use of exception handling mechanisms, refactoring)
   b. Coding standards
   c. Integration strategies
7. Software testing
   a. Testing and the software life cycle
   b. Inspections and walkthroughs
   c. Unit, integration, validation, and system testing
   d. Black-box and white-box testing techniques
   e. Regression testing and test automation
   f. Test-driven development

8. Software maintenance and evolution
   a. Major causes of maintenance problems
   b. Characteristics of maintainable software
   c. Reverse engineering and refactoring
   d. Software reuse

Elective topics:
9. Process improvement models
   a. CMMI (Capability Maturity Model Integration) for Development
   b. PSP (Personal Software Process)
   c. TSP (Team Software Process)

10. Agile and lean software development
   a. Scrum
   b. Extreme Programming
   c. Kanban
   d. Balancing agility and discipline

lab practice:
Team-work on almost real projects. Projects can be proposed by students themselves and approved by instructors or can be defined by teacher in co-operation with real customers. Group sizes are restricted to four and students are given the opportunity to decide who they

omejena na štiri študente, študenti pa lahko sami izbirajo, s kom bodo delali. Vsaka skupina mora določiti vodjo projekta in ostale vloge, za katere meni, da so potrebne za realizacijo projekta. Študente spodbujamo, da delajo na projektu tudi izven ur, ki so po urniku predvidene za izvedbo predmeta. Za spremljanje dela na projektih definiramo mejnike (kontrolne točke), na katerih študenti pokažejo, kaj so že naredili, in dobijo nasvete za nadaljnje delo.	should work with. Each group is asked to nominate a Project Manager and identify specific roles which they feel will be important in managing the group. Students are encouraged to work on the project outside the officially scheduled hours. There are several progress meetings (milestones) with the tutor before the final presentation takes place.

Temeljni literatura in viri / Readings:

1. H. van Vliet: Software Engineering, Third Edition, John Wiley & Sons, 2008.
2. I. Jacobson, G. Booch, J. Rumbaugh: The unified software development process, Addison-Wesley, 1999.

Dodatno:

3. M. Seidl, M. Scholz, C. Huemer, G. Kappel: UML @ Classroom, An Introduction to Object-Oriented Modeling, Springer, 2015.
4. CMMI® for Development (CMMI-DEV), Version 1.3 CMU/SEI-2010-TR-033, Software Engineering Institute, Carnegie Mellon University, 2010.
5. K. Schwaber: Agile Project Management with Scrum, Microsoft Press, 2004.

Cilji in kompetence:	**Objectives and competences:**
Cilj predmeta je predstaviti pregled aktivnosti v življenjskem ciklu razvoj programske opreme, ki so potrebne ne glede na to, kateri model razvojnega procesa se uporablja. Da bi obvladali te aktivnosti, študentje kombinirajo teoretična znanja s praktičnim delom na (skoraj) realnem projektu. Predvidene kompetence: • sposobnost opredelitve, razumevanja in reševanja kreativnih strokovnih izzivov na področju računalništva in informatike; • sposobnost uporabe pridobljenega znanja pri samostojnem delu za reševanje tehničnih in znanstvenih problemov na področju računalništva in informatike; sposobnost nadgradnje pridobljenega znanja, • sposobnost skupinskega dela v profesionalnem delovnem okolju; vodenje manjše strokovne skupine; • sposobnost administrativnega vodenja procesov, povezanih z raziskovanjem,	The aim of the course is to provide an overview of activities in the software development life cycle that must be preformed regardless of the process model used. In order to master these activities, the students combine theoretical knowledge with practical work on a quasi-real software project. The competences the students gain are: • the ability to define, understand and solve creative professional challenges in computer and information science; • the ability to apply acquired knowledge in independent work for solving technical and scientific problems in computer and information science; the ability to upgrade acquired knowledge. • the ability of teamwork within the professional environment; management of a small professional team; • the ability for administrative management of processes related to research, industry, education and other fields;

industrijo, izobraževanjem in drugimi področji; • sposobnost razumevanja in uporabe znanja računalništva in informatike na drugih tehničnih in relevantnih področjih (ekonomija, organizacijske vede ipd.); • praktično znanje in spretnosti, potrebne za uspešno strokovno delo na področju računalništva in informatike; • samostojno reševanje zahtevnih razvojnih, inženirskih in organizacijskih nalog kot tudi povprečno zahtevnih raziskovalnih nalog na področju računalništva in informatike.	• the ability to understand and apply computer and information science knowledge to other technical and relevant fields (economics, organisational science, etc); • practical knowledge and skills of computer hardware, software and information technology necessary for successful professional work in computer and information science; • the ability to tackle demanding developmental, engineering, and organisational tasks as well as moderately demanding research tasks in their fields of study.
Predvideni študijski rezultati:	**Intended learning outcomes:**
Znanje in razumevanje: Poznavanje in razumevanje: • vseh aktivnosti v življenjskem ciklu razvoja programske opreme, • različnih pristopov k razvoju programske opreme, • najpomembnejših razvojnih metodologij, • diagramskih tehnik za modeliranje sistema, ki ga razvijamo, • kriterijev, ki vplivajo na izbor in prilagoditev metodologije. Uporaba: Uporaba naučenih metodologij, orodij in diagramskih tehnik pri delu na konkretnem projektu s področja razvoja programske opreme. Refleksija: Razumevanje okoliščin, ki vplivajo na potek razvoja programskih sistemov in izbor najprimernejše rešitev v konkretnih primerih. Prenosljive spretnosti - niso vezane le na en predmet: Sposobnosti za skupinsko delo, vodenje, načrtovanje in organizacijo, pripravo predstavitev in medosebno komuniciranje, iskanje informacij, pisno in ustno poročanje.	Knowledge and understanding: Knowledge and understanding of: • activities in the software development life cycle, • different approaches to software development, • the most important development methodologies, • diagramming techniques for system modelling, • criteria that affect the choice and adaptation of development methodology. Application: Application of software development methods, tools and diagramming techniques in a context of an (almost) real software development project. Reflection: Understanding circumstances that affect the development of software and the choice of the most appropriate solution. Transferable skills: Professional skills like teamwork, management/leadership, planning and organizing, presentation and communication, information search, written and oral reporting.

Metode poučevanja in učenja:	**Learning and teaching methods:**
• *Predavanja* z aktivno udeležbo študentov (razlaga, diskusija, vprašanja, primeri, reševanje problemov). • *Laboratorijske vaje* (skupinsko delo na večjem projektu razvoja programske opreme, ki služi kot študija primera za ilustracijo potrebnih aktivnosti). • *Konsultacije* (diskusija, dodatna razlaga, obravnava specifičnih vprašanj).	• *Lectures* with active participation on the part of students (explanation, discussion, questions, examples, problem solving). • *Lab practice* (teamwork on an quasi-real software development project that serves as a case study for illustration of required activities). • *Consultations* (discussion, additional explanation, answers to specific questions)

Načini ocenjevanja:	Delež (v %) / Weight (in %)	**Assessment:**
Način (pisni izpit, ustno izpraševanje, naloge, projekt):		Type (examination, oral, coursework, project):
Sprotno preverjanje: seminarske naloge, delo na projektu	**50%**	**Continuing assessment:** seminal and project work
Končno preverjanje: pisni izpit	**50%**	**Final assessment:** written exam
Ocene: 6-10 pozitivno, 1-5 negativno (v skladu s Statutom UL)		Grading: 6-10 pass, 1-5 fail.

Reference nosilca / Lecturer's references:

Pet najpomembnejših del:

1. MAHNIČ, Viljan. A capstone course on agile software development using Scrum. *IEEE trans. ed.*, Feb. 2012, vol. 55, no. 1, str. 99-106.
2. MAHNIČ, Viljan, HOVELJA, Tomaž. On using planning poker for estimating user stories. *J. syst. softw.*. Sep. 2012, vol. 85, no. 9, str. 2086-2095.
3. MAHNIČ, Viljan, ŽABKAR, Nataša. Measuring progress of Scrum-based software projects. *Electronics and Electrical Engineering*. 2012, vol. 18, no. 8, str. 73-76.
4. MAHNIČ Viljan. Teaching Scrum through team-project work: students' perceptions and teacher's observations. *International journal of engineering education*, 2010, vol. 26, no. 1, str. 96-110.
5. MAHNIČ, Viljan, HOVELJA, Tomaž. Teaching user stories within the scope of a software engineering capstone course: analysis of students' opinions. *International journal of engineering education*, 2014, vol. 30, no. 4, str. 901–915.

Celotna bibliografija je dostopna na SICRISu:
http://sicris.izum.si/search/rsr.aspx?lang=slv&id=4767.

UČNI NAČRT PREDMETA / COURSE SYLLABUS	
Predmet:	**Računalniška grafika in tehnologija iger**
Course title:	**Computer Graphics and Game Technology**

Študijski program in stopnja Study programme and level	Študijska smer Study field	Letnik Academic year	Semester Semester
Univerzitetni študijski program prve stopnje Računalništvo in informatika Univerzitetni študijski program prve stopnje Računalništvo in matematika	Modul: Medijske tehnologije	3	zimski
University study programme Computer and Information Science, 1st cycle University study programme Computer Science and Mathematics , 1st cycle	Module: Media technologies	3	fall

Vrsta predmeta / Course type	izbirni predmet /elective course
Univerzitetna koda predmeta / University course code:	63269

Predavanja Lectures	Seminar Seminar	Vaje Tutorial	Klinične vaje Laboratory work	Druge oblike študija Field work	Samost. delo Individ. work	ECTS
45	10	20	/	/	105	6

Nosilec predmeta / Lecturer:	doc. dr. Matija Marolt

Jeziki / Languages:	**Predavanja / Lectures:**	slovenščina Slovene
	Vaje / Tutorial:	slovenščina Slovene

Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:	**Prerequisites:**

Vsebina:

Predavanja:

1. Uvod.
2. Geometrija, afine transformacije, koordinatni sistemi. Homogene koordinate.
3. Predstavitve predmetov: poligoni, deljene ploskve, parametrične krivulje. Hierarhije.
4. Upodabljanje: barve.
5. Lokalno osvetljevanje in senčenje.
6. Teksture.
7. Grafični cevovod: izločanje in rezanje, rasterizacija, z-buffer.
8. Senčilniki
9. Detekcija trkov. Metode razdelitve prostora
10. Načrtovanje iger.
11. Globalno upodabljanje: sledenje žarka, sevalna metoda, kartiranje fotonov.

Vaje:

Laboratorijski projekt izdelave interaktivne igre. Na vajah podan uvod v OpenGL in Unity in samostojno delo na projektih z zaključno predstavitvijo študentov.

Content (Syllabus outline):

Lectures:

1. Introduction.
2. Geometry, affine transformations, coordinate systems, homogeneous coordinates.
3. Representations: polygons, subdivision surfaces, parametric curves. Hierarchies.
4. Rendering: colors.
5. Local illumination and shading.
6. Texture mapping.
7. Graphics pipeline: culling and clipping, rasterisation, z-buffer.
8. Shaders
9. Collision detection. Space partitioning methods.
10. Game design.
11. Global illumination: raytracing, radiosity, photon mapping.

Laboratory:

Students will implement an interactive game. Exercises will include an introductionary course on OpenGL and Unity and individual project work with final public presentation of results.

Temeljni literatura in viri / Readings:

1. Nikola Guid: Računalniška grafika. Univerza v Mariboru, FERI.
2. D. Hearn, M.P. Baker: Computer Graphics with OpenGL, Pearson Prentice Hall, NJ USA.
3. D.H. Eberly: 3D Game Engine Design, Morgan Kaufman Publishers, CA USA.

Cilji in kompetence:

Cilj predmeta je študentom predstaviti programsko in algoritmično ozadje računalniške grafike in iger. Študenti bodo pridobili naslednje kompetence:
- razumevanje in reševanje izzivov na področju računalništva in informatike;
- uporabo znanja za samostojno delo pri reševanju tehničnih in znanstvenih problemov na področju računalništva in informatike; sposobnost nadgradnje znanj;
- sposobnost samostojnega izvajanja manj in bolj zahtevnih inženirskih in organizacijskih nalog na ožjih področjih in samostojno reševanje dobro definiranih nalog na področju računalništva in informatike;
- sposobnost samostojnega razvoja 3D interaktivnih grafičnih aplikacij in iger.

Objectives and competences:

The objective is to present students the programming and algorithmic background of computer graphics and games. When completing the course, students will be able to gain the following competences:
- the ability to understand and solve professional challenges in computer and information science.
- the ability to apply acquired knowledge in independent work for solving technical and scientific problems in computer and information science; the ability to upgrade acquired knowledge.
- the ability to independently perform both less demanding and complex engineering and organisational tasks in certain narrow areas and independently solve specific well-defined tasks in computer and information science
- the ability to independently develop interactive 3D applications and games.

Predvideni študijski rezultati:

Znanje in razumevanje:
Poznavanje ozadja računalniške grafike in računalniških iger.
Uporaba:
Razvoj interaktivnih 3D vizualizacij in računalniških iger.
Refleksija:
Spoznavanje in razumevanje uglašenosti med teorijo in njeno aplikacijo na konkretnih primerih s področja računalniške grafike in iger.
Prenosljive spretnosti - niso vezane le na en predmet:
Razvoj grafičnih vizualizacij na različnih strokovnih področjih.

Intended learning outcomes:

Knowledge and understanding:
Knowledge of background of computer graphics and games.
Application:
Development of interactive 3D visualizations and computer games.
Reflection:
Knowing and understanding of the balance between the theory and practice on concrete examples from the field of computer graphics and games.
Transferable skills:
Developing graphical visualization in various fields.

Metode poučevanja in učenja:	**Learning and teaching methods:**
Predavanja s praktičnimi demonstracijami, izvajanje laboratorijskega projekta pod mentorstvom asistenta.	Lectures with practical demostrations, laboratory work under the supervision of assistants.

Načini ocenjevanja:	Delež (v %) / Weight (in %)	**Assessment:**
Način (pisni izpit, ustno izpraševanje, naloge, projekt): **Sprotno preverjanje** (domače naloge, kolokviji in projektno delo) **Končno preverjanje** (pisni in ustni izpit) Ocene: 6-10 pozitivno, 1-5 negativno (v skladu s Statutom UL)	 **50%** **50%**	Type (examination, oral, coursework, project): **Continuing** (homework, midterm exams, project work) **Final** (written and oral exam) Grading: 6-10 pass, 1-5 fail.

Reference nosilca / Lecturer's references:

Pet najpomembnejših del:

1. LESAR, Žiga, BOHAK, Ciril, MAROLT, Matija. Evaluation of angiogram visualization methods for fast and reliable aneurysm diagnosis. Medical imaging 2015 : image perception, observer performance, and technology assessment : 25-26 February 2015, Orlando, Florida, United States.
2. BOHAK, Ciril, SODJA, Anže, MAROLT, Matija, MITROVIĆ, Uroš, PERNUŠ, Franjo. Fast segmentation, conversion and rendering of volumetric data using GPU. IWSSIP 2014 : proceedings, (International Conference on Systems, Signals, and Image Processing (Print), ISSN 2157-8672), 2014, str. 239-242.
3. MAROLT, Matija. A connectionist approach to automatic transcription of polyphonic piano music. IEEE trans. multimedia. [Print ed.], str. 439-449, ilustr. [COBISS.SI-ID 4203860]
4. MAROLT, Matija. A mid-level representation for melody-based retrieval in audio collections. IEEE trans. multimedia. [Print ed.], Dec. 2008, vol. 10, no. 8, str. 1617-1625, ilustr. [COBISS.SI-ID 6908756]
5. Matija Marolt, "Automatic transcription of bell chiming recordings", IEEE transactions on audio, speech, and language processing, vol. 20, no. 3, str. 844-853, Mar. 2012.

Celotna bibliografija je dostopna na SICRISu: http://sicris.izum.si/search/rsr.aspx?lang=slv&id=8948.

UČNI NAČRT PREDMETA / COURSE SYLLABUS	
Predmet:	**Modeliranje računalniških omrežij**
Course title:	**Computer Networks Modelling**

Študijski program in stopnja Study programme and level	Študijska smer Study field	Letnik Academic year	Semester Semester
Univerzitetni študijski program prve stopnje Računalništvo in informatika **Interdisciplinarni univerzitetni študijski program prve stopnje Računalništvo in matematika**	**Modul: Računalniška omrežja**	**3**	**zimski**
University study programme Computer and Information Science, 1st cycle **Interdisciplinary university study programme Computer Science and Mathematics , 1st cycle**	**Module: Computer networks**	**3**	**fall**

Vrsta predmeta / Course type	**izbirni predmet / elective course**
Univerzitetna koda predmeta / University course code:	**63257**

Predavanja Lectures	Seminar Seminar	Vaje Tutorial	Klinične vaje Laboratory work	Druge oblike študija Field work	Samost. delo Individ. work	ECTS
45	10	20	/	/	105	6

Nosilec predmeta / Lecturer:	prof. dr. Miha Mraz

Jeziki / Languages:	**Predavanja / Lectures:**	slovenščina Slovene
	Vaje / Tutorial:	slovenščina Slovene

Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:	**Prerequisites:**

Vsebina:

Predavanja:

1. Teoretične osnove
    1. Zahteve, strežniki, čakalne vrste, Kendallova notacija
    2. Modeliranje z vidika časa in zaloge možnih stanj
    3. Intenzivnost prihajajočih zahtev in strežbe
    4. Strežne enote (diskretne, eksponentne, Erlangove, …),
    5. Strežne mreže
    6. Opredelitev simulacijskih parametrov (breme, metrike, potrebni resursi, itd.)
    7. Analiza in interpretacija simulacijskih rezultatov
    8. Petrijeve mreže, barvne Petrijeve mreže
    9. Ocenjevalne metrike, latenca

2. Uporaba teorije v praksi
    1. Modeliranje in simulacije omrežij
    2. Modeliranje in simulacije protokolov
    3. Modeliranje in simulacije višje nivojskih protokolov in storitev
    4. Orodja za modeliranje in simulacijo računalniških omrežij (OpNet, NS2, OMNeT++, TETCOS, GTNetS, itd.)

Vaje:

Namen vaj pri navedenem predmetu je predvsem v predstavitvi uporabe zgoraj navedenih teoretičnih osnov na reševanju praktičnih problemov s področja računalniških omrežij. V ta namen se bodo uporabljala na vajah ustrezna programska orodja (npr. OpNet, NS2, OMNeT++,

Content (Syllabus outline):

Lectures:

1. Theoretical basics
    1. Requests, servers, queues, Kendall's notation
    2. Modelling regarding time and modelling regarding the possible states of the system
    3. Request arrival rate in request serving rate
    4. Serving units (discrete, exponential, Erlang's, …),
    5. Serving networks
    6. Definition of simulation parameters (work-load, metrics, required resources, etc.)
    7. Analysis and interpretation of simulation results
    8. Petri nets, Coloured Petri nets
    9. Performance metrics, latency

2. Practical use of theory presented
    1. Modelling and simulation of networks
    2. Modelling and simulation of protocols
    3. Modelling and simulation of higher layer protocols and services
    4. Tools for network modelling and simulation (OpNet, NS2, OMNeT++, TETCOS, GTNetS, etc.)

Laboratory courses:

Methods and approaches presented during the lectures will be demonstrated on practical computer network examples during the laboratory courses. Different software tools will be used such as OpNet, NS2, OMNeT++, TETCOS, GTNetS, etc.

TETCOS, GTNetS, itd.).	

Temeljni literatura in viri / Readings:

1. N. C. Hock: Queueing Modelling Fundamentals, J.Wiley & Sons, New York, 1996.
2. M. E. Woodward: Communication and computer networks: modelling with discrete-time queues, Pentech Press, London 1993.
3. M. Mraz, M. Moškon: Modeliranje računalniških omrežij. 1. izd. Ljubljana: Založba FE in FRI, 2012. ISBN 978-961-6209-80-9. https://ucilnica.fri.uni-lj.si/course/view.php?id=209. [COBISS.SI-ID 265042944]

Cilji in kompetence:	**Objectives and competences:**
Cilj predmeta je študentom računalništva in informatike predstaviti osnovne metode izgradnje modelov in izvajanja simulacij z zornega kota računalniških omrežij. S teoretičnega vidika temelji predmet na splošni teoriji strežbe, ki študente seznanja s problematiko zahtev, strežnikov (resursov), čakalnih vrst, ozkih grl, itd. S praktičnega vidika bo študentom predstavljen prenos teoretičnih znanj na reševanje praktičnih problemov, do katerih prihaja na področju računalniških omrežij. Ostale kompetence: - Razvoj spretnosti v analitičnem in sinteznem razmišljanju - Praktično obvladovanje sestavnih delov računalniških sistemov za uspešno profesionalno delo - Zmožnost razumevanja in reševanja profesionalnih problemov - Zmožnost uporabe in nadgradnje znanja pri samostojnem delu	Objective of the course is to present the basics in modelling and simulation of computer networks to the students of computer and information science. The course is based on the theory of service which acknowledges the students with the terms such as demands, serving units (resources), queues, bottlenecks etc. Students will learn the practical values of theoretical knowledge on the problems that arise in the field of computer networks. Other competences: - Developing skills in critical, analytical and synthetic thinking. - Practical knowledge and skills of computer hardware, software and information technology necessary for successful professional work in computer and information science. - The ability to understand and solve professional challenges in computer and information science. - The ability to apply acquired knowledge in independent work for solving technical and scientific problems in computer and information science; the ability to upgrade acquired knowledge.

Predvideni študijski rezultati:	**Intended learning outcomes:**
Znanje in razumevanje: Poznavanje teoretičnih in metodoloških znanj s področja modeliranja in simulacij. Razumevanje pomena področja. Poznavanje uporabe teoretičnih in metodoloških znanj skozi prizmo računalniških omrežij. Uporaba: Uporaba metodoloških znanj pri načrtovanju in vzdrževanju raznovrstnih računalniških omrežij in njihovih storitev, od katerih smo vse bolj odvisni. Refleksija: Razumevanje povezave med teoretičnimi znanji in metodologijami ter konkretnimi problemi do katerih prihaja v računalniških omrežjih. Prenosljive spretnosti - niso vezane le na en predmet: Večina predstavljenih metodologij odpira *sistemski* zorni kot bodočega diplomanta na računalniška omrežja. Slednji spodbuja predvsem vidike, kot so zbiranje in interpretiranje podatkov, identifikacija in reševanje problemov, kritična analiza in sinteza.	Knowledge and understanding: Having the theoretical and methodological knowledge from the field modelling and simulations. Understanding the importance of the field. Application: Application of methodological knowledge in design and support of various computer networks and their services. Reflection: Understanding the relations among theoretical knowledge and methodologies and practical problems from the field of computer networks. Transferable skills – are not bound only to this course: Students gain a new *system* perspective on the field of computer networks. This perspective opens new viewpoints such as data gathering and interpretation, problem identification and solving, critical analysis and synthesis.

Metode poučevanja in učenja:	**Learning and teaching methods:**
Predavanja bodo potekala ustno, vaje v obliki projektnega dela na konkretnih aplikativnih zgledih.	Lectures and oral presentations of the subject. Seminal work on real-life examples and problems.

Načini ocenjevanja:	Delež (v %) / Weight (in %)	**Assessment:**
Način (pisni izpit, ustno izpraševanje, naloge, projekt):		Type (examination, oral, coursework, project):
Sprotno preverjanje (domače naloge, kolokviji in projektno delo)	**50%**	**Continuing** (homework, midterm exams, project work)
Končno preverjanje (pisni in ustni izpit)	**50%**	**Final** (written and oral exam)

Ocene: 6-10 pozitivno, 1-5 negativno (v skladu s Statutom UL)		Grading: 6-10 pass, 1-5 fail.

Reference nosilca / Lecturer's references:

Pet najpomembnejših del:

1. VASYLCHENKOVA, Anastasiia, MRAZ, Miha, ZIMIC, Nikolaj, MOŠKON, Miha. Classical mechanics approach applied to analysis of genetic oscillators. *IEEE/ACM transactions on computational biology and bioinformatics*, ISSN 1545-5963. [Print ed.], 2016, vol. , no. , str. 1-8, ilustr., doi: 10.1109/TCBB.2016.2550456. [COBISS.SI-ID 1536851139], [JCR, SNIP]

2. BIZJAK, Manca, MRAZ, Miha, ZIMIC, Nikolaj, MOŠKON, Miha. Computational framework for modeling multiple noncooperative transcription factor binding and its application to the analysis of nuclear factor kappa B oscillatory response. *Journal of computational biology*, ISSN 1066-5277. [Print ed.], str. 1-11, ilustr., doi: 10.1089/cmb.2016.0065. [COBISS.SI-ID 1536999619], [JCR, SNIP]

3. BORDON, Jure, MOŠKON, Miha, ZIMIC, Nikolaj, MRAZ, Miha. Fuzzy logic as a computational tool for quantitative modelling of biological systems with uncertain kinetic data. *IEEE/ACM transactions on computational biology and bioinformatics*, ISSN 1545-5963. [Print ed.], 2015, vol. 12, no. 5, str. 1199-1205, ilustr., doi: 10.1109/TCBB.2015.2424424. [COBISS.SI-ID 1536282563], [JCR, SNIP, WoS]

4. MOŠKON, Miha, MRAZ, Miha. Systematic approach to computational design of gene regulatory networks with information processing capabilities. *IEEE/ACM transactions on computational biology and bioinformatics*, ISSN 1545-5963. [Print ed.], 2014, vol. 11, no. 2, str. 431-440, ilustr., doi: 10.1109/TCBB.2013.2295792. [COBISS.SI-ID 10323028], [JCR, SNIP, WoS]]

5. STRAŽAR, Martin, MRAZ, Miha, ZIMIC, Nikolaj, MOŠKON, Miha. An adaptive genetic algorithm for parameter estimation of biological oscillator models to achieve target quantitative system response. *Natural computing*, ISSN 1567-7818, Mar. 2014, vol. 13, no. 1, str. 119-127, ilustr., [COBISS.SI-ID 9950804], [JCR, SNIP, WoS]

Celotna bibliografija je dostopna na SICRISu:
http://sicris.izum.si/search/rsr.aspx?lang=slv&id=8066.

UČNI NAČRT PREDMETA / COURSE SYLLABUS	
Predmet:	**Zanesljivost in zmogljivost računalniških sistemov**
Course title:	**Computer Systems Reliability and Performance**

Študijski program in stopnja Study programme and level	Študijska smer Study field	Letnik Academic year	Semester Semester
Univerzitetni študijski program prve stopnje Računalništvo in informatika **Interdisciplinarni univerzitetni študijski program prve stopnje Računalništvo in matematika** **Interdisciplinarni univerzitetni študijski program prve stopnje Multimedija**	**Modul: Računalniški sistemi**	**3** **2, 3**	**poletni**
University study programme Computer and Information Science, 1st cycle **Interdisciplinary university study programme Computer Science and Mathematics , 1st cycle** **Interdisciplinary university study programme Multimedia, 1st cycle**	**Module: Computer systems**	**3** **2, 3**	**spring**

Vrsta predmeta / Course type	**izbirni predmet /elective course**
Univerzitetna koda predmeta / University course code:	**63262**

Predavanja Lectures	Seminar Seminar	Vaje Tutorial	Klinične vaje Laboratory work	Druge oblike študija Field work	Samost. delo Individ. work	ECTS
45	20	10	/	/	105	6

Nosilec predmeta / Lecturer:	prof. dr. Miha Mraz

Jeziki / Languages:	**Predavanja / Lectures:**	slovenščina Slovene
	Vaje / Tutorial:	slovenščina

Slovene

Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:

Prerequisites:

Vsebina:

Predavanja:

1. Zanesljivost rač. sistemov
    1. Osnovni pojmi (napaka, odpoved, redundanca, MTBF, MTTR, MTTF, degradirano delovanje, nedelujoče stanje sistema, itd.)
    2. Matematično teoretične osnove zanesljivosti
    3. Modeliranje zanesljivosti
    4. Zanesljivost elektronskih komponent – pregled standardov
    5. Zanesljivost programske opreme
    6. Osnove sistemske zanesljivosti
    7. Diagnostika v računalniških sistemih
    8. Pregled konkretnih metod za določevanje zanesljivosti (FMEA, FTA, itd.)
    9. Pregled programskih orodij za določevanje zanesljivosti

2. Zmogljivost rač. sistemov
    1. Metrike za ocenjevanje zmogljivosti
    2. Bremena v računalniških sistemih
    3. Metode za ocenjevanje zmogljivosti (analitični, simulacijski ali meritveni pristop)
    4. Monitorji
    5. Koncepti določanja zmogljivosti: meritve, simulacije, analitični pristop
    6. Postopki za pohitritev programske opreme
    7. Pomnilniške hierarhije

Content (Syllabus outline):

Lectures:

1. Reliability of computer systems
    1. Basic terms (error, failure, redundancy, MTBF, MTTR, MTTF, performance degradation, system failure, etc.)
    2. Mathematical theory in reliability estimation
    3. Modelling the reliability
    4. Reliability assessment of electronic components – overview of the standards available
    5. Software reliability
    6. Basics of system reliability
    7. Computer diagnostics
    8. Overview of selected methods for reliability assessment (FMEA, FTA, etc.)
    9. Overview of software tools for reliability assessment

2. Performance of computer systems
    1. Metrics for performance evaluation
    2. Work-loads in computer systems
    3. Methods for performance evaluation (analytical, simulational and measurement approach)
    4. Computer system performance monitoring
    5. Performance evaluation concepts: measurements, simulations, analytical approach
    6. Methods for improving the system performance

8. Zmogljivost računalniških omrežij **Vaje:** Namen vaj pri navedenem predmetu je predvsem v predstavitvi uporabe zgoraj navedenih metod in pristopov na praktičnih primerih iz realnega sveta. V ta namen se bodo uporabljala na vajah ustrezna programska orodja (npr. Relex, Reliability Workbench itd.).	7. Memory hierarchies 8. Capabilities of computer systems **Laboratory courses:** Methods and approaches presented during the lectures will be demonstrated on practical real-world examples during the laboratory courses. Different software tools will be used for the demonstrations, such as Relex, Reliability Workbench etc.

Temeljni literatura in viri / Readings:

1. M. L Shooman: Reliability of computer systems and networks, J. Wiley & Sons, New York 2002.
2. N. Zimic, M. Mraz: Temelji zmogljivosti računalniških sistemov, Fakulteta za rač. in informatiko, Ljubljana, 2006.

Cilji in kompetence:	**Objectives and competences:**
Cilj predmeta je študentom računalništva in informatike predstaviti osnovne metode in pristope na področjih računalniške zanesljivosti in zmogljivosti. Obe sta ključni za uspešnost delovanja kakršnegakoli računalniškega sistema. Predmet naj bi študentom podal tako teoretične osnove in metode obeh področij, kot tudi skušal čim boljše predstaviti uporabo teoretičnih osnov in metod na konkretnih problemih načrtovanja in vzdrževanja računalniških sistemov. Ostale kompetence: - Razvoj spretnosti v analitičnem in sinteznem razmišljanju. - Sposobnost razumevanja in reševanja profesionalnih problemov - Zmožnost profesionalne komunikacije v materinem in tujem jeziku. - Zmožnost uporabe in nadgradnje znanja pri samostojnem delu - Zmožnost timskega dela v profesionalnem okolju; upravljanje manjših delovnih enot	Objective of the course is to present the basic methods and approaches from the field of reliability and performance of computer systems assessment to the students of computer and information science. Reliability and performance of computer system are bital for its effectivity. Students will comprehend theoretical knowledge from both disciplines and will also learn their practical values from the examples of real-life problems. Other competences: - Developing skills in critical, analytical and synthetic thinking. - The ability to understand and solve professional challenges in computer and information science. - The ability of professional communication in the native language as well as a foreign language. - The ability to apply acquired knowledge in independent work for solving technical and scientific problems in computer and information science; the ability to upgrade acquired knowledge. - The ability of teamwork within the professional environment; management

	of a small professional team.

Predvideni študijski rezultati:	**Intended learning outcomes:**
Znanje in razumevanje: Poznavanje teoretičnih in metodoloških znanj področij zanesljivosti in zmogljivosti. Razumevanje pomena obeh področij. Poznavanje uporabe metodoloških znanj v praksi. Uporaba: Uporaba metodoloških znanj pri načrtovanju in vzdrževanju raznovrstnih računalniških sistemov, ki nas vse bolj obkrožajo. Refleksija: Razumevanje povezave med teoretičnimi znanji in metodologijami ter konkretnimi problemi zmogljivosti in zanesljivosti v računalniških sistemih. Prenosljive spretnosti - niso vezane le na en predmet: Večina predstavljenih metodologij odpira *sistemski* zorni kot načrtovalca ali upravitelja na rač. sistem (aplikacijo). Slednji spodbuja predvsem vidike, kot so kritična analiza, sinteza, delov v timih, socialne spretnosti.	Knowledge and understanding: Having the theoretical and methodological knowledge from the field of computer reliability and performance. Understanding the importance of both disciplines. Knowing the practical values of both disciplines. Application: Application of methodological knowledge in design and support of various computer systems. Reflection: Understanding the relations among theoretical knowledge and methodologies and practical problems from the field of reliability and performance of computer systems. Transferable skills – are not bound only to this course: Students gain a new perspective as designers or supports of a computer system (application). This perspective opens new viewpoints such as critical analysis, synthesis, team work and social skills.

Metode poučevanja in učenja:	**Learning and teaching methods:**
Predavanja bodo potekala ustno, vaje v obliki projektnega dela na konkretnih aplikativnih zgledih.	Lectures and oral presentations of the subject. Seminal work on real-life examples and problems.

Načini ocenjevanja:	Delež (v %) / Weight (in %)	**Assessment:**

Način (pisni izpit, ustno izpraševanje, naloge, projekt): **Sprotno preverjanje** (domače naloge, kolokviji in projektno delo) **Končno preverjanje** (pisni in ustni izpit) Ocene: 6-10 pozitivno, 1-5 negativno (v skladu s Statutom UL)	 **50%** **50%**	Type (examination, oral, coursework, project): **Continuing** (homework, midterm exams, project work) **Final** (written and oral exam) Grading: 6-10 pass, 1-5 fail.

Reference nosilca / Lecturer's references:

Pet najpomembnejših del:

1. VASYLCHENKOVA, Anastasiia, MRAZ, Miha, ZIMIC, Nikolaj, MOŠKON, Miha. Classical mechanics approach applied to analysis of genetic oscillators. *IEEE/ACM transactions on computational biology and bioinformatics*, ISSN 1545-5963. [Print ed.], 2016, vol. , no. , str. 1-8, ilustr., doi: 10.1109/TCBB.2016.2550456. [COBISS.SI-ID 1536851139], [JCR, SNIP]

2. BIZJAK, Manca, MRAZ, Miha, ZIMIC, Nikolaj, MOŠKON, Miha. Computational framework for modeling multiple noncooperative transcription factor binding and its application to the analysis of nuclear factor kappa B oscillatory response. *Journal of computational biology*, ISSN 1066-5277. [Print ed.], str. 1-11, ilustr., doi: 10.1089/cmb.2016.0065. [COBISS.SI-ID 1536999619], [JCR, SNIP]

3. BORDON, Jure, MOŠKON, Miha, ZIMIC, Nikolaj, MRAZ, Miha. Fuzzy logic as a computational tool for quantitative modelling of biological systems with uncertain kinetic data. *IEEE/ACM transactions on computational biology and bioinformatics*, ISSN 1545-5963. [Print ed.], 2015, vol. 12, no. 5, str. 1199-1205, ilustr., doi: 10.1109/TCBB.2015.2424424. [COBISS.SI-ID 1536282563], [JCR, SNIP, WoS]

4. MOŠKON, Miha, MRAZ, Miha. Systematic approach to computational design of gene regulatory networks with information processing capabilities. *IEEE/ACM transactions on computational biology and bioinformatics*, ISSN 1545-5963. [Print ed.], 2014, vol. 11, no. 2, str. 431-440, ilustr., doi: 10.1109/TCBB.2013.2295792. [COBISS.SI-ID 10323028], [JCR, SNIP, WoS]]

5. STRAŽAR, Martin, MRAZ, Miha, ZIMIC, Nikolaj, MOŠKON, Miha. An adaptive genetic algorithm for parameter estimation of biological oscillator models to achieve target quantitative system response. *Natural computing*, ISSN 1567-7818, Mar. 2014, vol. 13, no. 1, str. 119-127, ilustr., [COBISS.SI-ID 9950804], [JCR, SNIP, WoS]

Celotna bibliografija je dostopna na SICRISu: http://sicris.izum.si/search/rsr.aspx?lang=slv&id=8066.

UČNI NAČRT PREDMETA / COURSE SYLLABUS	
Predmet:	**Algoritmi in podatkovne strukture 2**
Course title:	**Algorithms and Data Structures 2**

Študijski program in stopnja Study programme and level	Študijska smer Study field	Letnik Academic year	Semester Semester
Univerzitetni študijski program prve stopnje Računalništvo in informatika **Univerzitetni študijski program prve stopnje Računalništvo in matematika**	**ni smeri**	**2**	**poletni**
University study programme Computer and Information Science, 1st cycle **University study programme Computer Science and Mathematics , 1st cycle**	**none**	**2**	**spring**

Vrsta predmeta / Course type	**obvezni predmet / compulsory course**
Univerzitetna koda predmeta / University course code:	**63280**

Predavanja Lectures	Seminar Seminar	Vaje Tutorial	Klinične vaje Laboratory work	Druge oblike študija Field work	Samost. delo Individ. work	ECTS
45	/	30	/	/	105	6

Nosilec predmeta / Lecturer:	prof. dr. Borut Robič

Jeziki / Languages:	**Predavanja / Lectures:**	slovenščina Slovene
	Vaje / Tutorial:	slovenščina Slovene

Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:	**Prerequisites:**

Vsebina:

Predavanja:

1. Uvod: splošno o metodah razvoja algoritmov, o analizi algoritmov, o računski zahtevnosti algoritmov in problemov
2. Deli in vladaj: opis metode, primeri problemov in algoritmov (glejte primere v točki 12 spodaj)
3. Požrešna metoda: opis metode, primeri
4. Postopno izboljševanje: opis, primeri
5. Dinamično programiranje: opis, primeri
6. Sestopanje: opis metode, primeri
7. Razveji in omeji: opis metode, primeri
8. Linearno programiranje: opis metode, simpleksni algoritem, primeri
9. Izbrane višje podatkovne strukture
10. NP-težki računski problemi: spodnja meja časovne zahtevnosti, intuitivno o razredih P, NP in NP-težkih problemih
11. Metode reševanja NP-težkih problemov: hevristični algoritmi, aproksimacijski algoritmi, verjetnostni algoritmi, parametrizirani algoritmi, eksaktni eksponentni algoritmi, primeri
12. *Primeri problemov in algoritmov*: napredno urejanje & Heapsort, Quicksort; problem izbiranja & linearni algoritmi; matrično množenje & Strassenov alg.; diskretna Fourierova transormacija & FFT alg., iskanje v nizih & Knuth-Morris-Prattov algoritem; osnovni in zahtevnejši problemi in algoritmi na grafih (iskanje v grafu; topološko urejanje; maksimalni pretok & Ford-Fulkersonov alg.; najkrajše poti & Bellman-Fordov ter Floyd-

Content (Syllabus outline):

Lectures:

1. Intro: about methods of algorithm design, analysis of algorithms, and computational complexity of algorithms and problems
2. Divide-and-Conquer: description of the method, examples of problems and algorithms (see examples 12 below)
3. Greedy method: description, examples
4. Iterative improvement: descr., examples
5. Dynamic programming: descr., examples
6. Backtracking: description, examples
7. Branch&Bound: description, examples
8. Linear programming: descr., Simplex algorithm, examples
9. Selected advanced data structures
10. NP-hard computational problems: lower bounds on time complexity, informally about P, NP and NP-hard problems;
11. Methods of solving NP-hard problems: heuristic algorithms, approximation algorithms, randomized algorithms, parameterized algorithms, exact exponential algorithms, examples
12. *Example problems and algorithms*: advanced sorting & Heapsort, Quicksort; selection problem & linear algorithms; matrix multiplication & Strassen alg.; Discrete Fourier Transformation & FFT alg; string matching & Knuth-Morris-Pratt; elementary and other graph problems and algorithms (searching a graph; topological sort; maximum flow & Ford-Fulkerson alg.; shortest paths & algorithms of Bellman-Ford, and Floyd-Warshall); selected problems from

Warshallov alg.) ; izbrani problemi iz računske geometrije. **Vaje:** Na vajah bodo študentje utrjevali snov, podano na predavanjih. Snov bodo uporabili za reševanje praktičnih problemov, pri čemer bo poudarek na samostojnem delu ob pomoči asistentov. Implementirali bodo več manjših programov (kot domače naloge) in obsežnejše programe (kot seminarske naloge), ki jih bodo zagovarjali na vajah. **Domače in seminarske naloge:** Namen domačih in seminarskih nalog je dati študentom priložnost za reševanje raznih računskih problemov s samostojnim razvojem algoritmov in njihovim programiranjem (in jih spodbuditi k sprotnemu študiju).	computational geometry. **Tutorial:** Students will use the topics given during the lectures to independently solve practical problems (with the assistance of the TAs if needed). They will implement several smaller programs (home works) as well as larger programs (seminars), and present them at the tutorial. **Home works and seminars:** These are necessary for a student to independently practice the design and implementation of algorithms .

Temeljni literatura in viri / Readings:

1. B. Robič: *Algoritmi* (to appear, instead of 2. below)
2. B. Vilfan: *Osnovni algoritmi***,** Založba FE in FRI, 2002

Dodatna literatura:

3. T. Cormen et al. *Introduction to Algorithms***,** McGraw-Hill, 3rd ed., 2009
4. B. Robič: *Aproksimacijski algoritmi*, Založba FE in FRI, 2. izdaja, 2009

Cilji in kompetence:	**Objectives and competences:**
Cilj predmeta je pridobiti poglobljeno znanje s področij načrtovanja algoritmov, analize algoritmov, uporabe podatkovnih struktur, izbranih problemov in algoritmov ter ob vsem tem utrjevati in poglabljati znanje programiranja.	To gain deeper knowledge of algorithm design methods, analysis of algorithms, use of data structures , selected problems and algorithms, and at the same time, to improve and deepen programming skills.

Predvideni študijski rezultati:	**Intended learning outcomes:**
Znanje in razumevanje: Sposobnost samostojnega načrtovanja algoritmov in ustreznih podatkovnih struktur pri reševanju računskih problemov, sposobnost analiziranja zahtevnosti problemov in kakovosti rešitev, sposobnost samostojnega razvoja programov. Uporaba: Uporaba naučenih principov pri načrtovanju algoritmov in njihovem programiranju. Refleksija:	Knowledge and understanding: The ability to independently design algorithms and data structures for solving particular computational problems; the ability to independently analyze computational complexity of algorithms (and sometimes problems as well); the ability to independently develop and implement computer programs. Application: use of the principles and methods in algorithm design and implementation

Razumevanje osnovnih principov načrtovanja algoritmov in razumevanje njihove vloge pri reševanju računskih problemov. Prenosljive spretnosti - niso vezane le na en predmet: Zmožnost načrtovanja učinkovite oz. primerne algoritmične rešitve različnih problemov, zmožnost uporabe naučenih principov pri programiranju rešitve (ne glede na izbrani programski jezik).	Reflection: understanding of the basic principles of algorithm design and their role in efficient solving of computational problems Transferable skills: there are many and useful in other subjects. For example, the ability to plan, design, and implement algorithmic solutions to various problems (regardless of the programming language used)

Metode poučevanja in učenja:	**Learning and teaching methods:**
Predavanja, domače naloge, seminarski način dela pri vajah. Poudarek je na sprotnem študiju in samostojnem delu pri vajah, seminarskih in domačih nalogah.	Lectures, tutorial, home works, seminars.

Načini ocenjevanja:	Delež (v %) / Weight (in %)	**Assessment:**
Način: pisni izpit, ustno izpraševanje, naloge, projekt		Type: exam, oral, coursework, project
Sprotno preverjanje: domače naloge, projektno delo	**50%**	**Continuing:** homework, project work
Končno preverjanje: pisni in ustni izpit	**50%**	**Final:** written and oral exam
Ocene: 6-10 pozitivno, 1-5 negativno (v skladu s Statutom UL)		Grading: 6-10 pass, 1-5 fail.

Reference nosilca / Lecturer's references:

Pet najpomembnejših del:

ČIBEJ, U., SLIVNIK, B., ROBIČ, B. The complexity of static data replication in data grids. *Parallel comput.*. 31(8/9):[900]-912, 2005.

SULISTIO, A., ČIBEJ, U., VENUGOPAL, S., ROBIČ, B., BUYYA, R.. A toolkit for modelling and simulating data Grids : an extension to GridSim. *Concurr. comput.*. 20(13):1591-1609, 2008.

TROBEC, R., ŠTERK, M., ROBIČ, B. Computational complexity and parallelization of the meshless local Petrov-Galerkin methods. *Comput. struct.*. 87(1/2):81-90, 2009.

MIHELIČ, J., ROBIČ, B. Flexible-attribute problems. *Comput. Optimiz. appl.* 47(3):553-566, 2010.

MIHELIČ, J., MAHJOUB, A., RAPINE, C., ROBIČ, B. Two-stage flexible-choice problems under

uncertainty. *Eur. J. Oper. Res.*. 201(2):399-403, 2010

Celotna bibliografija je dostopna na SICRISu:
http://sicris.izum.si/search/rsr.aspx?lang=slv&id=5202.

UČNI NAČRT PREDMETA / COURSE SYLLABUS	
Predmet:	**Izračunljivost in računska zahtevnost**
Course title:	**Computability and Computational Complexity**

Študijski program in stopnja Study programme and level	Študijska smer Study field	Letnik Academic year	Semester Semester
Univerzitetni študijski program računalništva in informatike, 1. stopnja **Univerzitetni študijski program prve stopnje Računalništvo in matematika**	**ni smeri**	**2**	**zimski**
University study programme Computer and Information Science, 1st cycle **University study programme Computer Science and Mathematics , 1st cycle**	**none**	**2**	**fall**

Vrsta predmeta / Course type	**obvezni predmet / compulsory course**
Univerzitetna koda predmeta / University course code:	**63283**

Predavanja Lectures	Seminar Seminar	Vaje Tutorial	Klinične vaje Laboratory work	Druge oblike študija Field work	Samost. delo Individ. work	ECTS
45	**/**	**30**	**/**	**/**	**105**	**6**

Nosilec predmeta / Lecturer:	prof. dr. Borut Robič

Jeziki / Languages:	**Predavanja / Lectures:**	slovenščina
	Vaje / Tutorial:	slovenščina

Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:	**Prerequisits:**

Vsebina:

Predavanja:

1. *Uvod*: Algoritem intuitivno.
2. *Zgodovina*: Kriza v osnovah matematike 20. stoletja. Reševanje iz krize. Formalni sistemi. Hilbertov program. Godlova izreka.
3. *Uvod v izračunljivost*: Kaj je algoritem in računanje? Računski modeli. Church-Turingova teza. Turingov stroj in različice. Nedeterminizem.
4. Univerzalni TS. Model RAM in splošno namenski računalniki. Izrek o rekurziji, rekurzivno definiranje in računanje.
5. *Neizračunljivost.* Jezik in množica. Odločitveni problemi. Neizračunljivi problemi obstajajo. Metode za dokazovanje neizračunljivosti (diagonalizacija, prevedbe, Riceov izrek) Primeri neizr. problemov in praktične posledice na raznih področjih.(Osnovno o relat. izračunljivosti in hiearhijah.)
6. *Avtomati, gramatike, jeziki:* Končni avtomat, regularna gramatika, izraz in jezik. Skladovni avtomat, kontekstno neodvisna gramatika in jezik. Linearno omejeni avtomat, kontekstno odvisna gramatika in jezik. Primeri in uporaba.
7. *Uvod v računsko zahtevnost:* Časovna, prostorska, in druge zahtevnosti. Lahki in težki problemi. Razreda P, NP, EXP in drugi. NP-polnost/težkost in njeno dokazovanje. Primeri in uporaba.
8. *Obvladovanje težkih problemov:* Osnovno o verjetnostnem,

Content (Syllabus outline):

Lectures:

1. *Introduction*: Algorithm intuitively.
2. *History:* Foundational crisis in 20th century mathematics. Solving the crisis. Formal systems. Hilbert's program. Godel's theorems.
3. *Introduction to computability:* What is algorithm and computation? Models of comp. Church-Turing thesis. Turing machine and versions. Nondeterminism.
4. Universal TM. RAM model and general purpose computers. Recursion theorem, recursive definitions and execution.
5. *Incomputability*. Sets vs. languages. Decision problems. Incomputable problems exist. Methods of proving incomputability (diagonalization, reductions, Rice's theorem). Examples of incomputable problems and consequences in various fields. (Basics of relative computability and hierarchies.)
6. *Automata, grammars, languages:* Finite automata, regular grammars, expressions and languages. Pushdown automata, context-free grammars and languages. Linear bounded automata, context-sensitive grammars and languages. Examples and application.
7. *Introduction to computational complexity:* Time, space, and other complexities. Easy and hard problems. Classes P, NP, EXP and other complexity classes. NP-completeness/hardness and methods of proving it. Examples and

aproksimativnem in paralelnem računanju. Osnovno o interaktivnem dokazovanju. Primeri v praksi.

9. *Novejši pristopi:* Osnovno o kvantnem računanju.

Vaje: Na vajah bodo študentje utrjevali snov, podano na predavanjih. Snov bodo uporabili za reševanje praktičnih problemov, pri čemer bo poudarek na samostojnem delu ob pomoči asistentov. Implementirali bodo več manjših programov (kot domače naloge) in obsežnejše programe (kot seminarske naloge), ki jih bodo zagovarjali na vajah.

Domače in seminarske naloge:
Namen domačih nalog je ponuditi študentom priložnost za samostojno reševanje zahtevnejših nalog s področja izračunljivost in računske zahtevnosti, ki poleg domiselnosti zahtevajo nekoliko temeljitejši teoretični premislek. Oboje presega možnosti pri vajah in navaja k samostojnemu delu.

applications.

8. *Coping with hard problems:* Basics of randomized, approximation, and parallel computing. Basics of interactive proving. Examples and application.
9. *Recent approaches:* Basics of quantum computing.

Home works and seminars:

Temeljni literatura in viri / Readings:

1. B. Robič: *The Foundations of Computability Theory,* Springer, 2014 (to appear)
2. S.Arora, B.Barak *Computational Complexity: A modern approach***,** Cambridge Univ Press (2009)

Dodatna literatura:

3. M. Sipser: *Introduction to the Theory of Computation*, Course Technology (2006)
4. B. Robič: *Aproksimacijski algoritmi*, Založba FE in FRI, 2. izd. (2009)

Cilji in kompetence:

Cilj predmeta je dvojen: 1) študenta opremiti s sodobnim znanjem s področja teoretičnega računalništva in 2) študenta usposobiti, da bo lahko to znanje uspešno uporabljal pri reševanju problemov v praksi

Objectives and competences:

Major part of the course is devoted to computability and computational complexity theory emphasizing on application on various disciplines of computer science. In part the course covers the historical development of the field as well as its recent achievements, again focusing on practical problem solving.

Predvideni študijski rezultati:

Znanje in razumevanje:
Sodobno razumevanja pojmov algoritem, računanje, izračunljivost, računska zahtevnost in obvladljivost ter povezav med njimi.
Sposobnost samostojnega analiziranja

Intended learning outcomes:

Knowledge and understanding:
Student will posess knowledge and skills in computability and computational complexity theory.
Application:

računske zahtevnosti problemov in možnosti za učinkovit izračun (kakovostnih) rešitev. *Uporaba*: Uporaba naučenih pojmov, principov in tehnik pri reševanju konkretnih računskih problemov v praksi. *Refleksija:* Razumevanje postopkov za analizo zahtevnosti računskih problemov in poznavanje strategij in metod za njihovo reševanje. *Prenosljive spretnosti* - niso vezane le na en predmet.	Computability and computational complexity theory is fundamental to efficient problem solving, algorithm design and analysis, and design of complex software. *Reflection*: Learning deep and intricate facts of the computability and computation complexity theory and their use in various disciplines in computer science. *Transferable skills:* We will treat the topics with as much of mathematical rigor as necessary for clear and develop a birds-eye look at the theory by explaining the motivation and intuition behind the various notions and facts of this theory .

Metode poučevanja in učenja:	**Learning and teaching methods:**
Predavanja, domače naloge, seminarski način dela pri vajah. Poudarek je na sprotnem študiju in samostojnem delu pri vajah, seminarskih in domačih nalogah.	Lectures and exercise groups, homework assignemnts. Frequent homework assignemts shall not be time consuming. Some of the homework assignments will be more demanding – projects – which may be distibuted to students divided in groups.

Načini ocenjevanja:	Delež (v %) / Weight (in %)	**Assessment:**
Način (pisni izpit, ustno izpraševanje, naloge, projekt): Oceno sestavljata dva dela: prvi (50%) je za sprotno delo, drugi (50%) pa za ustni in pisni izpit. Obveznosti predmeta so uspešno opravljene le, če sta oba dela pozitivna. V sprotno delo sodijo vaje in seminarske naloge.	50% 50%	Type: exam, oral, coursework, project Continuing: homework, project work Final: written and oral exam Grading: 6-10 pass, 1-5 fail.

Reference nosilca / Lecturer's references:

Pet najpomembnejših del:

ROBIČ, B. *The Foundations of Computability Theory*, Springer, 2014 (to appear)

BEZENŠEK, M., ROBIČ, B. A survey of parallel and distributed algorithms for the Steiner tree problem. *Int. J. Par. Program.* 42:287-319, 2013

MIHELIČ, J., MAHJOUB, A., RAPINE, C., ROBIČ, B. Two-stage flexible-choice problems under

uncertainty. *Eur. J. Oper. Res.*. 201(2):399-403, 2010

MIHELIČ, J., ROBIČ, B. Flexible-attribute problems. *Comput. Optimiz. Appl.* 47(3):553-566, 2010

TROBEC, R., ŠTERK, M., ROBIČ, B. Computational complexity and parallelization of the meshless local Petrov-Galerkin methods. *Comput. Struct.*. 87(1/2):81-90, 2009.

Celotna bibliografija je dostopna na SICRISu:
http://sicris.izum.si/search/rsr.aspx?lang=slv&id=5202.

UČNI NAČRT PREDMETA / COURSE SYLLABUS	
Predmet:	**Operacijski sistemi**
Course title:	**Operating Systems**

Študijski program in stopnja Study programme and level	Študijska smer Study field	Letnik Academic year	Semester Semester
Univerzitetni študijski program prve stopnje Računalništvo in informatika **Univerzitetni študijski program prve stopnje Računalništvo in matematika**	**ni smeri**	**2**	**poletni**
University study programme Computer and Information Science, 1st cycle **University study programme Computer Science and Mathematics , 1st cycle**	**none**	**2**	**spring**

Vrsta predmeta / Course type	**obvezni predmet / compulsory course**
Univerzitetna koda predmeta / University course code:	**63217**

Predavanja Lectures	Seminar Seminar	Vaje Tutorial	Klinične vaje Laboratory work	Druge oblike študija Field work	Samost. delo Individ. work	ECTS
45	/	30	/	/	105	6

Nosilec predmeta / Lecturer:	prof. dr. Borut Robič

Jeziki / Languages:	**Predavanja / Lectures:**	slovenščina Slovene
	Vaje / Tutorial:	slovenščina Slovene

Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:	**Prerequisites:**

Vsebina:

Predavanja:

1. Uvod: zgodovina OS, komponente OS, osnovno o organizaciji rač. sistema
2. Strukture v OS: komponente in servisi OS, sistemski klici, sistemski programi, navidezni stroji, razvoj OS
3. Procesi: proces, operacije na procesih, razvrščanje
4. Niti: nit, modeli večnitnosti, primeri operacijskih sistemov
5. Razvrščanje: kriteriji kakovosti, algoritmi, razvrščanje niti, primeri OS
6. Komunikacija: vrste medprocesne komunikacije, strežnik-odjemalec, P2P
7. Sinhronizacija: problem kritičnih odsekov, rešitve, semaforji, klasični sinhronizacijski problemi, monitorji,...
8. Smrtni objem: preprečevanje, ogibanje, zaznavanje, reševanje iz s.o,...
9. Glavni in navidezni pomnilnik: menjavanje, dodeljevanje, odstranjevanje, segmentacija,...
10. Datotečni sistem: datoteka, dostop, mape, souporaba, zaščita, implementacija d.s.,...
11. Pomožni pomnilnik: disk, razvrščanje na disku, upravljanje s prostorom,...
12. Vhodno-izhodni sistem: strojna oprema, vmesnik upor.-V/I, V/I in jedro
13. Zaščita in varnost: cilji, načela, matrika dostopa, pretnje, kriptografija, požarni zid,...
14. OS in porazdeljeni sistemi: problemi zaradi porazdeljenosti, rešitve,trendi
15. OS in namenski sistemi: sistem v realnem času, OS in multimedija, trendi
16. Izbrani primeri sodobnih OS (bodo obravnavani tudi pri točkah zgoraj).

Content (Syllabus outline):

Predavanja:

1. Introduction: history of OS, components of OS, computer-system structures
2. Operating-system structures: OS components and services, system calls, system programs, virtual machines, OS design
3. Processes: process, operations on processes, scheduling
4. Threads: thread, multithreading models, example operating systems
5. Scheduling: scheduling criteria and algorithms, thread scheduling, example OS
6. Communication: models of interprocess communication, client-server, P2P
7. Synchronization: critical-section problem, solutions, semaphore, classical synch. problems, monitors, ...
8. Deadlocks: deadlock prevention, avoidance, and detection, recovery from deadlocks,...
9. Main and virtual memory: swapping, allocation, paging, segmentation,...
10. File-systems: file, access, ditrectory, sharing, protection, file-system implementation,...
11. Mass-storage: discs, disc scheduling, free-space management,...
12. I/O system: I/O hardware, application I/O interface, I/O and kernel
13. Protection and security: goals, principles, access matrix, threats, cryptography, fire-wall ...
14. OS and distributed systems: problems, solutions, trends
15. OS and in special-purpose systems: real-time systems, OS and multimedia, trends
16. Selected examples of OS (will be explained above).

Vaje:
Na vajah bodo študentje utrjevali snov, ki je bila podana na predavanjih. Snov bodo uporabili za reševanje praktičnih problemov s področja OS, pri čemer bo poudarek na samostojnem delu ob pomoči asistentov. Implementirali bodo več manjših programov (tudi kot domače naloge) pa tudi obsežnejše programe (kot seminarske naloge). Naloge bodo definirane tako, da se bodo nadgrajevale in dopolnjevale v preprost, a delujoč OS. Študentje bodo naloge zagovarjali na vajah.

domače in seminarske naloge:
Namen domačih in seminarskih nalog je študentom omogočiti, da v praksi zasnujejo zelo preprost, a delujoč OS ali njegove dele in se tudi tako spoznajo s problematiko operacijskih sistemov.

Tutorial:
Students will use the topics given during the lectures to independently solve practical problems (with the assistance of the TAs if needed). They will implement several smaller programs (home works) as well as larger programs (seminars) that can be parts of a simple OS. Students will present their results at the tutorial.

Home works and seminars:
These are necessary for a student to understand how an operating system works and independently practice the design and implementation of a simple operating system.

Temeljni literatura in viri / Readings:

1. A. Silberschatz et al.: Operating systems concepts, Wiley, 2007.
2. B. Robič: Operacijski sistemi (v pripravi).

Dodatna literatura
1. A. Tanenbaum, A. Woodhull: Operating systems: design and implementation, Prentice-Hall, 2006.

Cilji in kompetence:
Cilj predmeta je podati kakovostno znanje s področja sodobnih operacijskih sistemov: obrazložiti vlogo OS v različnih vrstah računalniških sistemov (povezanost s strojno in programsko opremo ter uporabnikom); pojasniti naloge, zgradbo, delovanje, implementacijo in sodelovanje sestavnih delov OS; in seznaniti poslušalca s trendi in razvojnimi alternativami OS.

Objectives and competences:
To gain good knowledge of operating systems; to understand the role of OS in various computer systems; to understand the trends in the development of OS

Predvideni študijski rezultati:
Znanje in razumevanje:
Poznavanje komponent sodobnega operacijskega sistema, njihove vloge, delovanja in posebnosti. Uporaba:
Uporaba naučenih principov pri uporabi katerega koli operacijskega sistema in pri načrtovanju sistemske programske opreme.

Intended learning outcomes:
Knowledge and understanding:
Knowledge of the components of a modern OS, their role in computer systems, their internal working and properties

Application:
The knowledge is useful in the design of any

Usposobljenost za načrtovanje računalniških sistemov. Refleksija: Razumevanje osnovnih principov delovanja sodobnih operacijskih sistemov in razumevanje njihove vloge v sodobnem računalniškem sistemu. Prenosljive spretnosti - niso vezane le na en predmet: Lažje načrtovanje in razvoj sistemske programske opreme (npr, zbirnikov, nalagalnikov, povezovalnikov, gonilnikov). Lažja prilagoditev na nov OS.	operating system and any other system software as well Reflection: Understanding how the OS works and how together with hardware makes a computer system useful. Transferable skills: these are many and useful in other subjects. For example, the ability to plan, design, and implement system programs and especially large programs.

Metode poučevanja in učenja:	**Learning and teaching methods:**
Predavanja, domače naloge, seminarski način dela pri vajah. Poudarek je na sprotnem študiju in samostojnem delu pri domačih nalogah, vajah in seminarskih nalogah.	Lectures, tutorial, home works, seminars.

Načini ocenjevanja:	Delež (v %) / Weight (in %)	**Assessment:**
Način (pisni izpit, ustno izpraševanje, naloge, projekt):		Type (exam, oral, coursework, project):
Sprotno preverjanje (domače naloge, kolokviji in projektno delo)	**50%**	**Continuing** (homework, project work)
Končno preverjanje (pisni in ustni izpit)	**50%**	**Final** (written and oral exam)
Ocene: 6-10 pozitivno, 1-5 negativno (v skladu s Statutom UL)		Grading: 6-10 pass, 1-5 fail.

Reference nosilca / Lecturer's references:

Pet najpomembnejših del:

ČIBEJ, U., SLIVNIK, B., ROBIČ, B. The complexity of static data replication in data grids. *Parallel comput.*. 31(8/9):[900]-912, 2005.

SULISTIO, A., ČIBEJ, U., VENUGOPAL, S., ROBIČ, B., BUYYA, R.. A toolkit for modelling and simulating data Grids: an extension to GridSim. *Concurr. comput.*. 20(13):1591-1609, 2008.

TROBEC, R., ŠTERK, M., ROBIČ, B. Computational complexity and parallelization of the meshless local Petrov-Galerkin methods. *Comput. struct.*. 87(1/2):81-90, 2009.

MIHELIČ, J., ROBIČ, B. Flexible-attribute problems. *Comput. Optimiz. appl.* 47(3):553-566, 2010.

MIHELIČ, J., MAHJOUB, A., RAPINE, C., ROBIČ, B. Two-stage flexible-choice problems under uncertainty. *Eur. J. Oper. Res.*. 201(2):399-403, 2010

Celotna bibliografija je dostopna na SICRISu:
http://sicris.izum.si/search/rsr.aspx?lang=slv&id=5202.

UČNI NAČRT PREDMETA / COURSE SYLLABUS	
Predmet:	**Računska zahtevnost in hevristično programiranje**
Course title:	**Computation Complexity and Heuristic Programming**

Študijski program in stopnja Study programme and level	Študijska smer Study field	Letnik Academic year	Semester Semester
Univerzitetni študijski program prve stopnje Računalništvo in informatika Univerzitetni študijski program prve stopnje Računalništvo in matematika	Modul: Algoritmi in sistemski programi	3	zimski
University study programme Computer and Information Science, 1st cycle University study programme Computer Science and Mathematics , 1st cycle	Module: Algorithms and System Utilities	3	fall

Vrsta predmeta / Course type	izbirni predmet /elective course
Univerzitetna koda predmeta / University course code:	63263

Predavanja Lectures	Seminar Seminar	Vaje Tutorial	Klinične vaje Laboratory work	Druge oblike študija Field work	Samost. delo Individ. work	ECTS
45	10	20	/	/	105	6

Nosilec predmeta / Lecturer:	izr. prof. dr. Marko Robnik Šikonja

Jeziki / Languages:	**Predavanja / Lectures:**	slovenščina Slovene
	Vaje / Tutorial:	slovenščina Slovene

Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:	**Prerequisites:**
Poznavanje osnovnih algoritmov in podatkovnih struktur.	Knowledge of basic algorithms and data structures.

Vsebina:

Vsebina predmeta:

1. Analiza rekurzivnih algoritmov: substitucijska metoda, rešitev za algoritme deli in vladaj, metoda Akra-Bazzi.
2. Verjetnostna analiza: definicija, analiza stohastičnih algoritmov.
3. Randomizacija algoritmov.
4. Amortizirana analiza kompleksnosti algoritmov.
5. Reševanje linearnih rekurzivnih enačb.
6. Razreda P in NP: definicija, NP-polnost, standardni NP-polni problemi.
7. Prevedljivost in reševanje NP-polnih problemov.
8. Aproksimacijski algoritmi.
9. Kombinatorična optimizacija, lokalno preiskovanje, simulirano ohlajanje.
10. Linearno programiranje za reševanje problemov.
11. Metahevristike in stohastično preiskovanje: vodeno lokalno preiskovanje, preiskovanje s spremenljivo soseščino, tabu preiskovanje.
12. Populacijske metode: genetski algoritmi, optimizacija z rojem delcev, diferencialna evolucija, umetni imunski sistemi.

Content (Syllabus outline):

Lecture topics:

1. Analysis of recursive algorithms: substitution method, solution for divide and conquer approach, Akra-Bazzi method.
2. Probabilistic analysis: definition, analysis of stochastic algorithms.
3. Randomization of algorithms.
4. Amortized analysis of algorithm complexity.
5. Sloving linear recurrences.
6. Classes P and NP: definitions, NP-completeness, standard NP-complete problems.
7. Reducibility and solving NP-complete problems.
8. Approximation algorithms.
9. Combinatorial optimization, local search.
10. Linear programming for problem solving.
11. Metaheuristics and stochastic search: guided local search, variable neighbourhood search, and tabu search.
12. Population methods: genetic algorithms, particle swarm optimization, differential evolution, artificial immune systems.

Temeljni literatura in viri / Readings:

1. T.H. Cormen, C.E. Leiserson, R.L. Rivest, C. Stein: *Introduction to Algorithms, 3rd edition*. MIT Press, 2009
2. R. Sedgewick, P. Flajolet: *An Introduction to the Analysis of Algorithms.* Addison-Wesley, 1995
3. M. Gendreau, J.-Y. Potvin: *Handbook of Metaheuristics, 2nd Edition*. Springer, 2010.

Dodatna literatura je na razpolago v obliki znanstvenih člankov.
Additional literature is available in the form of scientific papers.

Cilji in kompetence:

Cilj predmeta je študente seznaniti z analizo algoritmov, računsko zahtevnostjo in učinkovitim reševanjem zahtevnih problemov, ki potrebujejo posebne pristope in optimizacijske tehnike.

Splošne kompetence:

- sposobnost kritičnega razmišljanja,
- sposobnost definiranja, razumevanja in reševanja ustvarjalnih profesionalnih izzivov,
- sposobnost prenosa znanja in pisne komunikacije v domačem in tujem jeziku.

Predmetno-specifične kompetence:

- uporaba metod za analizo rekurzivnih algoritmov: substitucijska metoda, drevesna metoda.
- metode za analizo algoritmov deli in vladaj: mojstrova metoda in metoda Akra-Bazzi
- verjetnostna analiza algoritmov,
- uporaba amortizirane analize algoritmov,
- prevedba nekaterih NP-polnih problemov,
- poznavanje ideje aproksimacijskih tehnik,
- poznavanje hevrističnih pristopov in meta-hevristik za reševanje težkih problemov,
- uporaba populacijskih optimizacijskih metod in principov evolucijskega računanja.

Objectives and competences:

The goal of the course is the students to become acquainted with the analysis of algorithms, computational complexity and techniques for efficient solving of difficult problems, requiring optimization techniques and approximations.

General competences:

- ability of critical thinking,
- the ability to define, understand and solve creative professional challenges in computer and information science,
- the ability of knowledge transfer and writing skills in the native language as well as a foreign language.

Subject-specific competences:

- use of methods for analysis of recursive algorithms; substitution method, recursive-tree method,
- use of methods for analysis of divide-and-conquer algorithms: master theorem and Akra-Bazzi method,
- probabilistic analysis of algorithms,
- use of amortized analysis of algorithms,
- reduction of some NP-complete problems,
- use of heuristic methods and metaheuristics, for solving complex problems,
- use of population techniques and principles of evolutionary computation in optimization.

Predvideni študijski rezultati:	Intended learning outcomes:
Znanje in razumevanje: Poznavanje različnih tehnik in metod, ki se uporabljajo pri analizi kompleksnosti algoritmov in pri reševanju zahtevnih optimizacijskih in kombinatoričnih problemov. Sposobnost za analizo, sintezo in predvidevanje rešitev konkretnih problemov z uporabo znanstvenih metod. **Uporaba:** Uporaba predstavljenih metod na konkretnih problemih iz tehničnega in poslovnega okolja. Poznavanje in uporaba orodij za reševanje in analizo tovrstnih problemov. Študenti morajo biti za dani problem sposobni presoje, katero od predstavljenih tehnik uporabiti, ter sestaviti prototip rešitve. **Refleksija:** Spoznavanje in razumevanje pomena temeljnega matematičnega in statističnega znanja, uglašenosti med teorijo in njeno aplikacijo na konkretnih primerih analize algoritmov in s področja hevrističnega programiranja. Avtonomija, (samo) kritičnost, (samo) refleksija, težnja po kakovosti. **Prenosljive spretnosti - niso vezane le na en predmet:** Sposobnost pridobivanja, selekcije in ocenjevanja novih informacij in zmožnost ustrezne interpretacije v kontekstu. Sposobnost za upravljanje s časom, za samo pripravo in načrtovanje ter samokontrolo izvajanja načrtov in postopkov. Timsko delo, pisanje poročil, javne predstavitve rezultatov. Koherentno obvladanje temeljnega znanja, pridobljenega pri obveznih predmetih, ter sposobnost povezovanja znanja z različnih področij in njegova uporaba v praksi.	**Knowledge and understanding:** Knowledge of several techniques and methods, used for analysis of algorithms and for solving complex optimization and combinatorial problems. The ability for analysis, synthesis and anticipation of solutions and their consequences for target problems using the scientific methodology. **Application:** The use of the presented methods on target problems from scientific and business environment. The understanding and usage of tools for analysis and solving such problems. The students are able to decide which of the presented techniques should be used for a given problem, and to develop a prototype solution. **Reflection:** The recognition and understanding of the importance of basic mathematical and statistical knowledge, the relation between theory and its application in concrete examples of analysis of algorithms and heuristic programming. Autonomy, (self) criticalness, (self) reflexivity, aspiration for quality. **Transferable skills:** The ability to receive, select and evaluate new information and a proper interpretation in a context. A self-control and ability to manage limited time when preparing, planning and implementing plans and processes. Team work, writing of reports, public presentations of the results. Coherent mastering of basic knowledge, gained through mandatory courses, and the ability to combine the knowledge from different fields and apply it in practice.

Metode poučevanja in učenja:	**Learning and teaching methods:**
Predavanja, naloge s pisnimi poročili in z ustnimi nastopi in predstavitvami, seminarski način dela in domače naloge, ki stimulirajo sproten študij. Študenti bodo v manjših skupinah samostojno reševali in analizirali zahtevne optimizacijske probleme. Skupine bodo svoje naloge, analize in rešitve opisale v pisnem poročilu in predstavile ostalim v obliki kratke predstavitve, ki se ocenjuje skupaj s poročilom.	Lectures, assignments with written and oral demonstrations and presentations, seminar works and home works, which stimulate continuous learning. The emphasis is on the continuous study and on autonomous work on assignments and seminars. Students form small project teams and autonomously solve assignments based on real-life problems. The teams describe their solutions in written reports and prepare short oral presentations. Written reports and oral presentations are graded.

Načini ocenjevanja:	Delež (v %) / Weight (in %)	**Assessment:**
Način: pisni in ustni izpit, domače naloge, predstavitev projekta, projekt.		Type: oral and written examination, coursework, project presentation, project.
Sprotno preverjanje: domače naloge, projektno delo.	**50%**	**Continuing:** homework, project work.
Končno preverjanje: pisni in ustni izpit.	**50%**	**Final:** written and oral exam.
Ocene: 6-10 pozitivno, 1-5 negativno (v skladu s Statutom UL)		Grading: 6-10 pass, 1-5 fail.

Reference nosilca / Lecturer's references:

Pet najpomembnejših del/ Five most important works:

1. ROBNIK ŠIKONJA, Marko. Data generators for learning systems based on RBF networks. *IEEE transactions on neural networks and learning systems*, May 2016, vol. 27, no. 5, pp. 926-938.
2. ROBNIK ŠIKONJA, Marko, VANHOOF, Koen. Evaluation of ordinal attributes at value level. *Data mining and knowledge discovery*, 2007, vol. 14, no. 2, str. 225-243.
3. ROBNIK ŠIKONJA, Marko, KONONENKO, Igor. Theoretical and empirical analysis of ReliefF and RReliefF. *Machine learning*, 2003, 53:23-69.
4. ROBNIK ŠIKONJA, Marko, KONONENKO, Igor. Explaining classifications for individual instances. *IEEE Transactions on Knowledge and Data Engineering,* 2008, 20(5):589-600.
5. ROBNIK ŠIKONJA, Marko, KONONENKO, Igor, ŠTRUMBELJ, Erik: Quality of Classification Explanations with PRBF. *Neurocomputing*, 96:37-46, 2012

Celotna bibliografija je dostopna na SICRISu
http://sicris.izum.si/search/rsr.aspx?lang=slv&id=8741.
Complete bibliography is available in SICRIS:
http://sicris.izum.si/search/rsr.aspx?lang=eng&id=8741.

UČNI NAČRT PREDMETA / COURSE SYLLABUS	
Predmet:	**Planiranje in upravljanje informatike**
Course title:	**Informatics Planning and Management**

Študijski program in stopnja Study programme and level	Študijska smer Study field	Letnik Academic year	Semester Semester
Univerzitetni študijski program prve stopnje Računalništvo in informatika **Interdisciplinarni univerzitetni študijski program prve stopnje Računalništvo in in matematika** **Interdisciplinarni univerzitetni študijski program prve stopnje Upravna informatika**	**Modul: Obvladovanje informatike**	**3**	**poletni**
University study programme Computer and Information Science, 1st cycle **University study programme Computer Science and Mathematics , 1st cycle** **Interdisciplinary university study programme in Administrative Informatics 1st Cycle**	**Module: Management of Information Systems**	**3**	**spring**

Vrsta predmeta / Course type	**izbirni predmet / elective course** **obvezni predmet / compulsory course**
Univerzitetna koda predmeta / University course code:	**63253**

Predavanja Lectures	Seminar Seminar	Vaje Tutorial	Klinične vaje Laboratory work	Druge oblike študija Field work	Samost. delo Individ. work	ECTS
45	/	30	/	/	105	6

Nosilec predmeta / Lecturer:	doc. dr. Rok Rupnik

Jeziki / Languages:	**Predavanja / Lectures:** slovenščina Slovene

Vaje / Tutorial:	slovenščina Slovene

Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:	**Prerequisites:**

Vsebina:	**Content (Syllabus outline):**

Temeljna vsebinska področja predmeta zajemajo naslednje:
• opredelitev in pregled obvladovanja informatike skozi čas:
  • opredelitev in časovni pregled strateškega planiranja, poslovno-informacijskih arhitektur, standardov, metodologij in ogrodij;
• strateško planiranje informatike:
  • poslovna strategija, strateški elementi, analiza stanja, tehnološka vizija, načrt informacijske tehnologije, prioritete projektov, operativni plan;
• metodologije strateškega planiranja informatike:
  • pregled metodologij strateškega planiranja, EMRIS (Enotna metodologija razvoja informacijskih sistemov);
• poslovno-informacijske arhitekture:
  • arhitekturne ravni – poslovna, aplikativna, tehnološka, usklajenost poslovne in informacijske domene, storitveno usmerjena arhitektura (SOA), konceptualni model arhitekture (ISO 1471);
• arhitekturne metode in ogrodja:
	Basic course content areas include the following:
	• definition and review of IT governance through time:
	  • definition and time review of strategic IS/IT planning, enterprise architecture, standards, methodologies and frameworks;
	• strategic IS/IT planning:
	  • business strategy, strategic elements, analysis of the existing situation, technological vision, information technology plan, projects priorities, operation plan;
	• strategic IS/IT planning methodologies:
	  • review of strategic IS/IT planning methodologies, EMRIS (Unified information systems development methodology);
	• enterprise architectures:
	  • architecture layers - business, application and technology, business –IT alignment, service-oriented architecture (SOA), conceptual architecture model (ISO 1471);
	• architecture methods and frameworks:
	  • Zachman, Togaf, Archimate;
	• business and IT management

- Zachman, Togaf, Archimate;
- instrumenti upravljanja poslovnih sistemov in instrumenti upravljanja informatike:
  - EFQM, BSC, standardi ISO (9000, 17799, 27000);
- organizacija informatike:
  - organizacija informatike v poslovnem sistemu, vrste organizacijskih shem organizacijske enote za informatiko.
- procesi informatike:
  - plansko organizacijski, izvedbeni, podporni in nadzorni.
- vrednotenje uspešnosti informatike in ravni zrelosti (CMMI),
- ogrodja in najboljše prakse upravljanja informatike:
  - COBIT, ITIL, upravljanje varnosti, zagotavljanje neprekinjenosti poslovanja.

instruments:
- EFQM, BSC, ISO standards (9000, 17799, 27000);
- organizing the IT function:
  - organizing the IT function in an enterprise, different organizational charts for IT function.
- IT processes:
  - plan and organize, implementation, support and control.
- Evaluation of IT success and levels of maturity (CMMI)
- Frameworks and best practices for IT governance:
  - COBIT, ITIL, security management, business continuity.

Temeljni literatura in viri / Readings:

- Strategic Planning, George A. Steiner, Free Press, 2008
- Executive's Guide to IT Governance: Improving Systems Processes with Service Management, COBIT, and ITIL, Wiley, 2013
- IT Governance: Policies & Procedures, Michael Wallace, Larry Webber, Wolters Kluwer Law & Business, 2013

Cilji in kompetence:

Cilj predmeta je študentom predstaviti osnovne pojme, pristope, metode in instrumente upravljanja informatike v poslovnih sistemih. Gre za področje strateškega planiranja, poslovno-informacijskih arhitektur ter drugih mehanizmov celostnega obvladovanja informatike.

Objectives and competences:

The aim of the course is to present students key concepts, methods and instruments for IT governance in enterprises. Content areas include strategic IS/IT planning, enterprise architectures and other mechanisms for holistic IT governance.

Predvideni študijski rezultati:

Znanje in razumevanje:
Poznavanje pristopov, metod, arhitektur ter instrumentov upravljanja informatike.
Razumevanje strateškega planiranja in izbranih metod upravljanja informatike.

Intended learning outcomes:

Knowledge and understanding:
Knowledge of approaches, methods, architectures and IT governance instruments.
Understanding of strategic IS/IT planning and selected methods of IT governance.

Uporaba: Uporaba mehanizmov upravljanja informatike pri delu informatika. Refleksija: Razumevanje skladnosti med teorijo upravljanja informatike in praktičnim ravnanjem na podlagi konkretnih primerov uporabe v poslovnih sistemih ter najboljših praks. Prenosljive spretnosti - niso vezane le na en predmet: Metode upravljanja informatike povezujejo med seboj različne vidike informatike, predstavljajo celostno obvladovanje informatike in so tako uporabne v okviru vseh področij informatike kot dela poslovnega sistema.	Application: Use of IT governance mechanisms at daily work of informatics professionals. Reflection: Understanding the consistency between theory of IT governance and its practical use based on concrete examples of applications in enterprises and best practices. Transferable skills - not tied to just one course: IT governance methods interconnect various informatics related aspects, enable holistic IT governance and are therefore useful in the context of all areas of informatics as a part of an enterprise.

Metode poučevanja in učenja:	**Learning and teaching methods:**
Predavanja in laboratorijske vaje ter seminarji. V okviru laboratorijskih vaj in seminarjev gre za skupinsko delo.	Lectures, laboratory exercises and seminars. Laboratory exercises and seminars are organised as teamwork.

Načini ocenjevanja:	Delež (v %) / Weight (in %)	**Assessment:**
Način (pisni izpit, ustno izpraševanje, naloge, projekt): • **ena seminarska naloga** • **dva kolokvija med semestrom ali ustni izpit** • **sodelovanje na predavanjih** Ocene: 6-10 pozitivno, 1-5 negativno (v skladu s Statutom UL)	**45%** **45%** **10%**	Type (examination, oral, coursework, project): • **one project** • **two examinations during semester or oral examination** • **active participation on lectures** Grading: 6-10 pass, 1-5 fail. (According to the UL Statues)

Reference nosilca / Lecturer's references:

Pet najpomembnejših del:

- HOVELJA, Tomaž, VASILECAS, Olegas, RUPNIK, Rok. A model of influences of environmental stakeholders on strategic information systems planning success in an enterprise. Technological and economic development of economy, ISSN 2029-4913. [Print ed.], 2013, vol. 19, no. 3, str. 465-488
- HOVELJA, Tomaž, VASILECAS, Olegas, RUPNIK, Rok . A novel approach for the evaluation of

investments in preconfigured software products for enterprises that organisationally differ from enterprises in USA and Germany, Ciência e Técnica Vitivinícola Journal (ISSN: 0254-0223), v tisku

- HOVELJA, Tomaž, ROŽANEC, Alenka, RUPNIK, Rok. Measuring the success of the strategic information systems planning in enterprises in Slovenia. Management, ISSN 1331-0194, 2010, vol. 15, no. 2, str. 25-46
- Metodologija strateškega planiranje
- Rok Rupnik (glavni avtor s soavtorji). Enotna metodologija razvoja informacijskih sistemov. [Zv. 2], Strateško planiranje. 2. izd. Ljubljana: Vlada Republike Slovenije, Center Vlade RS za informatiko, 2003. XV, 446 str., ilustr. ISBN 961-6389-08-4
- Glavni avtor strateških planov informatike za vsrto večjih slovenskih podjetij: SŽ, Elektro Celja, Elektro Ljubljana, ELES, Plinovodi, Dravske elektrnarne Maribor.

UČNI NAČRT PREDMETA / COURSE SYLLABUS	
Predmet:	**Razvoj inteligentnih sistemov**
Course title:	**Development of Intelligent Systems**

Študijski program in stopnja Study programme and level	Študijska smer Study field	Letnik Academic year	Semester Semester
Univerzitetni študijski program prve stopnje Računalništvo in informatika **Interdisciplinarni univerzitetni študijski program prve stopnje Računalništvo in matematika**	**Modul: Umetna inteligenca**	**3**	**poletni**
University study programme Computer and Information Science, 1st cycle **Interdisciplinary university study programme Computer Science and Mathematics , 1st cycle**	**Module: Artificial intelligence**	**3**	**spring**

Vrsta predmeta / Course type **izbirni predmet /elective course**

Univerzitetna koda predmeta / University course code: **63268**

Predavanja Lectures	Seminar Seminar	Vaje Tutorial	Klinične vaje Laboratory work	Druge oblike študija Field work	Samost. delo Individ. work	ECTS
45	/	30	/	/	105	6

Nosilec predmeta / Lecturer: izr. prof. dr. Danijel Skočaj

Jeziki / Languages:	**Predavanja / Lectures:**	angleščina English
	Vaje / Tutorial:	angleščina English

Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:

Prerequisites:

Vsebina:

Predmet bo v teoriji in na praktičnih primerih predstavil sledeče vsebine:

1. Tehnologije in orodja za razvoj inteligentnih sistemov: uvod
2. Značilne aplikacije inteligentnih tehnologij
3. Tehnološke platforme in razvojne metodologije
4. Orodja sistemov umetnega zaznavanja, strojnega učenja in sklepanja, s poudarkom na tehnikah njihove integracije
5. Pristopi k integraciji tehnik umetnega zaznavanja, strojnega učenja in načrtovanja akcij v agentni sistem, ki deluje v realnem času
6. Specifične lastnosti senzorsko-robotskih sistemov
7. Osnove mobilne robotike
8. Študijski primeri razvoja kompleksnih inteligentnih sistemov

Na predavanjih bodo študenti spoznavali ključne tehnologije in orodja, s katerimi bodo tekom semestra na vajah in v okviru projektov oz. seminarskih nalog reševali praktične probleme. Pri tem bodo kombinirali znanja, ki so jih pridobili pri predmetih Inteligentni sistemi in Umetno zaznavanje istega modula. Poudarek bo na razvoju praktičnih, delujočih rešitev v simulacijskih okoljih in predvsem na razvoju praktičnih rešitev, ki bodo v realnem času delovale na primernih robotskih platformah. Pri tem bodo študenti spoznali odprtokodna in prostodostopna okolja in orodja za razvoj inteligentnih sistemov.

Content (Syllabus outline):

During the course the following topics will be presented:

1. Technologies and tools for the development of intelligent systems: an introduction
2. Typical applications of intelligent technologies
3. Technological platforms and development methodologies
4. Tools for machine perception, machine learning and reasoning, with the emphasis on the techniques for integration of these tools
5. Approaches to the integration of machine perception, learning, and planning into an artificial real-time agent system
6. Specific properties of robotic systems
7. Basics of mobile robotics
8. Case studies of the development of complex intelligent systems

The lectures will familiarize the students with key technologies and tools. The students will use these on practical problems within the scope of laboratory classes and projects. They will combine the knowledge and skills obtained in Artificial Intelligence and Machine Perception classes from the same course module. The emphasis of this course will be on the development of practical and functional implementations in both in simulation environments and especially in real-time systems operating on robot platforms. The implementations will be developed in open-

	source frameworks and tools for development of intelligent systems.

Temeljni literatura in viri / Readings:

- Dokumentacija prostodostopnega Robotskega operacijskega sistema ROS
  Documentation of the open source Robot Operating System ROS
  http://www.ros.org.
- Dokumentacija prostodostopne knjižnice za delo s slikovnimi in 3D podatki PCL
  Documentation of the open source Point Cloud Library PCL
  http://pointclouds.org.
- Dokumentacija prostodostopne knjižnice računalniškaga vida za delo s slikami OpenCV
  Documentation of the open source library for computer vision OpenCV
  http://opencv.org
- S. Thrun, W. Burgard, D. Fox, Probabilistic Robotics (Intelligent Robotics and Autonomous Agents series), The MIT Press, 2005.

Cilji in kompetence:	**Objectives and competences:**
Cilj predmeta je študente naučiti povezati ter v praksi uporabiti znanja s področij umetne inteligence in umetnega zaznavanja v namene samostojnega razvoja inteligentnega sistema. Pri predmetu se bodo naučili pravilno zasnovati inteligentni sistem, izbrati ustrezne metode in orodja, implementirati nove komponente ter te z že obstoječimi integrirati v delujoč robotski sistem. Študentje bodo razvijali sposobnosti kritičnega in analitičnega razmišljanja. Osvojili bodo tudi veščine iskanja po ustreznih podatkovnih virih, najdeno informacijo pa bodo znali tudi kritično ovrednotiti. Osvojili bodo tudi sposobnost apliciranja osvojenega znanja za reševanje tehničnih problemov in sposobnost samostojnega opravljanja inženirskih nalog na področju inteligentne robotike, kjer bodo sposobni samostojnega reševanja specifičnih dobro opredeljenih nalog. Ker bo večino dela potekala v skupinah, bodo študentje osvojili tudi veščine skupinskega dela.	The course aims at teaching the students to develop an intelligent system by integrating techniques from artificial intelligence and machine perception. Students will learn how to design an intelligent system, how to select which tools and methods to use, and how to implement new components and integrate them into a functional robot system. The students will develop skills in critical and analytical thinking. They will also acquire the ability to search knowledge sources and to search for resources and critically evaluate information. They will acquire the ability to apply the acquired knowledge in independent work for solving technical problems and to independently perform engineering tasks in the field of intelligent robotics. They will be able to solve specific well-defined tasks from this area. Since most of the work will be performed in teams, the students will also acquire the ability of team work.

Predvideni študijski rezultati:	**Intended learning outcomes:**
Znanje in razumevanje: Poznavanje metod in orodij umetnega zaznavanja in umetne inteligence, njihove soodvisnosti ter načinov za njihovo integracijo v delujoče sisteme. Uporaba: Uporaba metod in orodij umetnega zaznavanja in umetne inteligence, načrtovanje integriranih inteligentnih sistemov ter implementacija teh sistemov za reševanje praktičnih problemov. Refleksija: Razumevanje primernosti teoretičnih metod za reševanje praktičnih primerov ter njihovih omejitev, sposobnost analitičnega razmišljanja, sposobnost analize in reševanja praktičnih problemov z razvojem inteligentnih sistemov. Prenosljive spretnosti: Kombiniranje znanj pridobljenih pri predmetih s področja umetnega zaznavanja in inteligence, multidisciplinarni pristopi, spretnosti iskanja in uporaba literature, uporaba primerne (predvsem odprtokodne) programske opreme, identifikacija in reševanje kompleksnih problemov.	Knowledge and understanding: Knowledge on methods and tools from machine perception and artificial intelligence and their integration within real-world functional systems. Application: The application of techniques from machine perception and artificial intelligence, design and implementation of integrated intelligent systems for solving practical problems. Reflection: Understanding the suitability of theoretical methods for solving practical problems, as well as understanding their requirements and limitations. The ability of analyzing and solving problems by developing intelligent systems. Transferable skills: Combining the knowledge and skills the students learned during the courses on Artificial Intelligence and Machine perception, multidisciplinary approach, skills for searching and using the literature, application of suitable (primarily open source) software and hardware, identification and solving of complex problems.

Metode poučevanja in učenja:	**Learning and teaching methods:**
Predavanja s podporo avdio-vizualne opreme, laboratorijske vaje v računalniški učilnici z ustrezno strojno in programsko opremo, vključno s primernimi senzorsko-robotskimi platformami. Delo posamezno in v skupinah. Velik poudarek na praktičnem razvojnem delu in reševanju problemov ter implementaciji na robotskih sistemih.	Lectures with the appropriate audio-visual equipment in a classroom with suitable hardware and software, including appropriate robot platforms. Individual and group work. Emphasis on hands-on approaches and problem solving including implementation of the developed solutions on robotic systems.

Načini ocenjevanja:	Delež (v %) / Weight (in %)	**Assessment:**
Način (pisni izpit, ustno izpraševanje, naloge, projekt):		Type (examination, oral, coursework, project):
Sprotno preverjanje (domače naloge in projektno delo)	**50%**	**Continuing** (homework, project work)
Končno preverjanje (izpitna naloga in	**50%**	**Final** (project and oral exam)

ustni izpit) Ocene: 6-10 pozitivno, 1-5 negativno (v skladu s Statutom UL)		Grading: 6-10 pass, 1-5 fail.

Reference nosilca / Lecturer's references:

Pet najpomembnejših del:

Skočaj D, Vrečko A, Mahnič M, Janíček M, Kruijff G-J, Hanheide M, Hawes N, Wyatt J, Keller T, Zhou K, Zillich M, Kristan M (2016) An integrated system for interactive continuous learning of categorical knowledge. Journal of experimental & theoretical artificial intelligence, vol. 28, iss. 5, str. 823-848.

Ridge B, Leonardis A, Ude A, Deniša M, Skočaj D (2015) Self-supervised online learning of basic object push affordances. International journal of advanced robotic systems, vol. 12, str. 24-1-24-18.

Uršič P, Tabernik D, Boben M, Skočaj D, Leonardis A, Kristan M (2013) Room categorization based on a hierarchical representation of space. International journal of advanced robotic systems, vol. 10, str. 1-13.

JL Wyatt, Aydemir A, Brenner M, Hanheide M, Hawes N, Jensfelt P, Kristan M, Kruijff G-J M, Lison P, Pronobis A, Sjöö K, Vrečko A, Zender H, Zillich M, Skočaj D (2010) Self-understanding and self-extension: a systems and representational approach. IEEE Trans Auton Ment Dev 2(4): 282-303.

Skočaj D, Leonardis A, Bischof H (2007) Weighted and robust learning of subspace representations. Pattern Recogn 40 (5): [1556]-1569.

Celotna bibliografija izr. prof. dr. Skočaja je dostopna na SICRISu: http://sicris.izum.si/search/rsr.aspx?lang=slv&id=10425.

UČNI NAČRT PREDMETA / COURSE SYLLABUS	
Predmet:	**Prevajalniki**
Course title:	**Compilers**

Študijski program in stopnja Study programme and level	Študijska smer Study field	Letnik Academic year	Semester Semester
Univerzitetni študijski program prve stopnje Računalništvo in informatika **Univerzitetni študijski program prve stopnje Računalništvo in matematika**	**Modul: Algoritmi in sistemski programi**	**3**	**poletni**
University study programme Computer and Information Science, 1st cycle **University study programme Computer Science and Mathematics , 1st cycle**	**Module: Algorithms and system programs**	**3**	**spring**

Vrsta predmeta / Course type	**izbirni predmet /elective course**
Univerzitetna koda predmeta / University course code:	**63265**

Predavanja Lectures	Seminar Seminar	Vaje Tutorial	Klinične vaje Laboratory work	Druge oblike študija Field work	Samost. delo Individ. work	ECTS
45	/	30	/	/	105	6

Nosilec predmeta / Lecturer:	doc. dr. Boštjan Slivnik

Jeziki / Languages:	**Predavanja / Lectures:**	slovenščina Slovene
	Vaje / Tutorial:	slovenščina Slovene

Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:	**Prerequisites:**

Vsebina:

1. Uvod:
   razbitje prevajalnika na prednji in zadnji del, zgradba prevajalnika kot cevovoda, izbira prevajanega programskega jezika in ciljnega zbirnika.
2. Leksikalna analiza:
   opis simbolov programskega jezika z regularnimi izrazi in razbitje prevajanega programa na osnovne simbole;
   - domača naloga: izdelava leksikalnega analizatorja na osnovi končnih avtomatov.
3. Sintaksna analiza:
   opis sintakse s kontekstno neodvisno gramatiko, postopek sintaksne analize in reševanje iz napak med sintaksno analizo;
   - domača naloga: izdelava sintaksnega analizatorja na osnovi skladovnega avtomata po algoritmu LR.
4. Abstraktna sintaksa:
   poenostavljena interna predstavitev prevajanega programa;
   - domača naloga: generiranje abstraktnega sintaksnega drevesa prevajanega programa.
5. Semantična analiza:
   analiza podatkovnih tipov, (ne)dosegljivosti kode,…;
   - domača naloga: izdelava semantičnega analizatorja za preverjanje tipov.
6. Klicni zapisi:
   klicni zapisi za aktivacijo (gnezdenih, rekurzivnih) podprogramov, uporaba

Content (Syllabus outline):

1. Introduction:
   Decomposition of a compiler into front end and back end. Compiler as a staged pipeline. Choosing the source program language and the target assembler.
2. Lexical analysis:
   describing programming language symbols with regular expressions, breaking the compiled program into lexical tokens
   Homework: construction of lexical analyzer based on finite automata.
3. Parsing:
   describing syntax with a context-free grammar, parsing procedure and error recovery
   Homework: construction of stack-based LR(k) syntax analyzer
4. Abstract syntax:
   simplified internal representation of the compiled program
   Homework: generating an abstract syntax tree of the compiled program.
5. Semantic analysis:
   type checking, unreachable code detection,…
   Homework: construction of semantic analyzer for type-checking.
6. Activation records:
   description of records for activation of nested or recursive functions, and their implementation with stack or heap.
   Homework: activation records design
7. Intermediate code:
   tree- or instruction-based intermediate code, temporary variables, translation

sklada ali kopice za realizacijo klicnih zapisov;
- domača naloga: načrt klicnih zapisov.

7. Vmesna koda:
   drevesna ali ukazna vmesna koda, uporaba začasnih spremenljivk, nivoji vmesne kode, prevod v vmesno kodo;
   - domača naloga: izdelava generatorja vmesne kode.
8. Osnovni bloki:
   kanonizacija klicev in skokov v vmesni kodi, oblikovanje osnovnih blokov, permutacija osnovnih blokov;
   - domača naloga: izračun osnovnih blokov.
9. Izbira strojnih ukazov:
   prevod vmesne kode v ukaze zbirnika z uporabo začasnih spremenljivk;
   - domača naloga: generator strojne kode brez registrov.
10. Analiza aktivnosti začasnih spremenljivk:
    analiza aktivnosti začasnih spremenljivk na osnovi grafov poteka in podatkovnih enačb;
    - domača naloga: izračun interferenčnega grafa spremenljivk.
11. Izbira registrov:
    barvanje interferenčnega grafa in izračun preliva začasnih spremenljivk v klicni zapis;
    - domača naloga: izračun preslikave začasnih spremenljivk v registre in preliv.
12. Zaključek:
    domača naloga: združitev prvih desetih domačih nalog v delujoč prevajalnik.

to intermediate code.
Homework: construction of intermediate code generator

8. Basic blocks:
   canonization of calls and jumps in intermediate code, grouping of statements into basic blocks, permutation of basic blocks
   Homework: formation of basic blocks
9. Instruction selection:
   translation of intermediate code to target assembler using only temporary variables
   Homework: target code generator (without register allocation)
10. Liveness analysis:
    activity analysis of temporary variables based on flow graphs and dataflow equations.
    Homework: construction of a flow graph.
11. Register allocation:
    coloring of inference graphs, spilling temporary variables into activation records.
    Homework: allocation of registers to temporary variables and spilling.
12. Conclusion:
    Homework: integration of earlier homework into a working compiler.

Temeljni literatura in viri / Readings:

1. Andrew W. Appel, Modern Compiler Implementation in Java, Cambridge University Press, 2002.
2. Boštjan Vilfan, Prevajanje programskih jezikov, 1. del, Fakulteta za elektrotehniko in računalništvo, 1991.
3. Steven Muchnick, Advanced Compiler Design and Implementation, Morgan Kaufmann, 1997.

Cilji in kompetence:

Predstavitev zgradbe, delovanja in izdelave prevajalnika za prevajanje programskih jezikov v zbirnik.

Splošne kompetence:

- Sposobnost razumevanja in reševanja strokovnih izzivov v računalništvu in informatiki
- Sposobnost definiranja, razumevanja in reševanja strokovnih izzivov v računalništvu in informatiki
- Sposobnost uporabe pridobljenega znanja pri samostojnem reševanju tehničnih in znanstvenih problemov v računalništvu in informatiki; sposobnost razširjanja pridobljenega znanja

Predmetno-specifične kompetence:

- Praktično znanje in veščine s področja strojen in programske opreme ter informacijske tehnologije, ki so potrebne za uspešno strokovno delo v računalništvu in informatiki
- Sposobnost samostojnega izvajanja enostavnih in zahtevnih opravil v določenih ožjih področjih in samostojno reševanje specifičnih dobro definiranih opravil v računalništvu in informatiki
- Osnovne veščine v računalništvu in informatiki, ki omogočajo nadaljevanje študija na drugi stopnji

Objectives and competences:

Presentation of compiler architecture and functional parts, as well as construction and implementation of a working compiler from a chosen programming language into assembler.

General competences:

- The ability to understand and solve professional challenges in computer and information science
- The ability to define, understand and solve creative professional challenges in computer and information science;
- The ability to apply acquired knowledge in independent work for solving technical and scientific problems in computer and information science; the ability to upgrade acquired knowledge

Subject-specific competences:

- Practical knowledge and skills of computer hardware, software and information technology necessary for successful professional work in computer and information science
- The ability to independently perform both less demanding and complex engineering and organisational tasks in certain narrow areas and independently solve specific well-defined tasks in computer and information science
- Basic skills in computer and information science, allowing the continuation of studies in the second study cycle

Predvideni študijski rezultati:

Znanje in razumevanje:
Razumevanje delovanja prevajalnika: poznavanje algoritmov za sintaksno in semantično analizo programov ter algoritmov za generiranje vmesne in strojne kode; poznavanje omejitev prevajalnikov.
Poznavanje delovanja prevedenih programov.
Uporaba:
Prevajalnik je osnovno orodje pri razvoju programske opreme, zato se pridobljeno

Intended learning outcomes:

Knowledge and understanding:
Understanding the workings of a modern compiler implies familiarity with algorithms for syntax and semantic program analysis, generation of intermediate and target machine code, as well as awareness of compilers' limitations. By knowing all this, one also knows and understands how compiled programs work.
Application:
Compiler is a fundamental software

znanje avtomatsko uporablja pri vsakem programiranju. Refleksija: Spoznavanje in razumevanje odnosa med programiranjem in izvajanjem programov. Prenosljive spretnosti - niso vezane le na en predmet: Algoritmi za analizo strukturiranih besedil, pisanje učinkovito kodiranih programov.	development tool, and therefore the acquired knowledge is (explicitly or implicitly) useful in all programming tasks. Reflection: Understanding of relations between writing programs and their execution. Transferable skills: Algorithms for analysis of structured texts, writing efficiently coded programs.

Metode poučevanja in učenja:	**Learning and teaching methods:**
Predavanja in domače naloge (seminarski način dela). Poseben poudarek je na sprotnem oddajanju domačih nalog.	Lectures and homework with explicit focus on simultaneous studies (for homeworks).

Načini ocenjevanja:	Delež (v %) / Weight (in %)	**Assessment:**
Način (pisni izpit, ustno izpraševanje, naloge, projekt):		Type (examination, oral, coursework, project):
Sprotno preverjanje (domače naloge)	**50%**	**Continuing** (homeworks)
Končno preverjanje (pisni in ustni izpit)	**50%**	**Final** (written and oral exam)
Ocene: 6-10 pozitivno, 1-5 negativno (v skladu s Statutom UL)		Grading: 6-10 pass, 1-5 fail.

Reference nosilca / Lecturer's references:

Pet najpomembnejših del:

1. SLIVNIK, Boštjan. LL conflict resolution using the embedded left LR parser. Computer Science and Information Systems, 2012, vol. 9, no. 3, str. 1105-1124.
2. POTOČNIK, Matic, ČIBEJ, Uroš, SLIVNIK, Boštjan. Linter - a tool for finding bugs and potential problems in Scala code. V: Proceedings of the 29th Annual ACM Symposium on Applied Computing, Gyeongju, Korea, March 24-28, 2014. Proceedings of the 29th Annual ACM Symposium on Applied Computing, Gyeongju, Korea, March 24-28, 2014. [S. l.]: Association for Computing Machinery, cop. 2014, str. 1615-1616, graf. prikazi. [COBISS.SI-ID 10520660]
3. SLIVNIK, Boštjan. LLLR parsing. V: Proceedings of the 28th annual ACM Symposium on Applied Computing 2013, Coimbra, Portugal, March 18-22. [S. l.]: Association for Computing Machinery, 2013, str. 1698-1699. [COBISS.SI-ID 9735508]
4. SLIVNIK, Boštjan. The embedded left LR parser. V: GANZHA, Maria (ur.), MACIASZEK, Leszek (ur.), PAPRZYCKI, Marcin (ur.). FedCSIS : proceedings of the Federated Conference on Computer Science and Information Systems, September 18-21, 2011, Szczecin, Poland. Los Alamitos: IEEE Computer Society Press, 2011, str. 871-878, graf. prikazi. [COBISS.SI-ID

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5. SLIVNIK, Boštjan, VILFAN, Boštjan. Producing the left parse during bottom-up parsing. Inf. process. lett.. [Print ed.], Dec. 2005, vol. 96, no. 6, str. [220]-224. [COBISS.SI-ID 5075284]
6. SLIVNIK, Boštjan, VILFAN, Boštjan. Improved error recovery in generated LR parsers. Informatica (Ljublj.), 2004, vol. 28, no. 3, str. 257-263, ilustr. [COBISS.SI-ID 4902484]

Celotna bibliografija je dostopna na SICRISu:
http://sicris.izum.si/search/rsr.aspx?lang=slv&id=7849.

UČNI NAČRT PREDMETA / COURSE SYLLABUS	
Predmet:	**Programiranje 2**
Course title:	**Programming 2**

Študijski program in stopnja **Study programme and level**	**Študijska smer** **Study field**	**Letnik** **Academic year**	**Semester** **Semester**
Univerzitetni študijski program prve stopnje Računalništvo in informatika Univerzitetni študijski program prve stopnje Računalništvo in in matematika Univerzitetni študijski program prve stopnje Multimedija	ni smeri	1	poletni
University study programme Computer and Information Science, 1st cycle University study programme Computer Science and Mathematics , 1st cycle University study programme Multimedia, 1st cycle	none	1	summer

Vrsta predmeta / Course type	obvezni predmet / compulsory course
Univerzitetna koda predmeta / University course code:	63278

Predavanja **Lectures**	**Seminar** **Seminar**	**Vaje** **Tutorial**	**Klinične vaje** **Laboratory work**	**Druge oblike študija** **Field work**	**Samost. delo** **Individ. work**	**ECTS**
45	/	30	/	/	105	6

Nosilec predmeta / Lecturer:	doc. dr. Boštjan Slivnik

Jeziki / Languages:	**Predavanja / Lectures:**	slovenščina Slovene
	Vaje / Tutorial:	slovenščina Slovene

Pogoji za vključitev v delo oz. za opravljanje **Prerequisites:**

študijskih obveznosti:

Vsebina:

1. Uvod v programski jezik C.
2. Osnovni podatkovni tipi in osnovne kontrolne strukture.
3. Razvoj programov in razhroščevanje.
4. Kazalci in tabele (1. del).
5. Kazalci in tabele (2. del).
6. Funkcije in prenos argumentov.
7. Dinamično dodeljevanje pomnilnika.
8. Nizi.
9. Vhodno-izhodne operacije.
10. Strukture.
11. Enostavni algoritmi urejanja.
12. Rekurzija in algoritmi sestopanja (1. del).
13. Rekurzija in algoritmi sestopanja (2. del).
14. Predprocesor.

Content (Syllabus outline):

1. Introduction to C programming language.
2. Basic data types and basic control structures.
3. Program design and debugging.
4. Pointers and arrays (part 1).
5. Pointers and arrays (part 2).
6. Functions and parameter passing.
7. Dynamic memory allocation.
8. Strings.
9. Input-output operations.
10. Structures.
11. Simple sorting algorithms.
12. Recursion and backtracking (part 1).
13. Recursion and backtracking (part 2).
14. Preprocessor.

Temeljni literatura in viri / Readings:

1. B. W. Kernighan, D. Ritchie: Programski jezik C, Fakulteta za računalništvo in informatiko, 1994.
2. T. Dobravec: abC, Fakulteta za računalništvo in informatiko, 2010.
3. A. Kavčič, M. Privošnik, C. Bohak, M. Marolt, S. Divjak: Programiranje in algoritmi skozi primere, Založba FE in FRI, 2010

Cilji in kompetence:

Cilj predmeta je razširiti znanje programiranja skozi študij bazičnih in naprednejših tehnik programiranja.

Splošne kompetence:

- Sposobnost kritičnega, analitičnega in sintetičnega razmišljanja
- Sposobnost razumevanja in reševanja

Objectives and competences:

The goal of the course is to widen the programming skills by learning the most basic and advanced programming techniques.

General competences:

- Developing skills in critical, analytical and synthetic thinking
- The ability to understand and solve

strokovnih izzivov v računalništvu in informatiki • Sposobnost uporabe pridobljenega znanja pri samostojnem reševanju tehničnih in znanstvenih problemov v računalništvu in informatiki; sposobnost razširjanja pridobljenega znanja **Predmetno-specifične kompetence:** • Osnovne veščine v računalništvu in informatiki – osnovne teoretične veščine, praktično znanje, bistvene veščine za področje računalništva in informatiki • Osnovne veščine v računalništvu in informatiki, ki omogočajo nadaljevanje študija na drugi stopnji	professional challenges in computer and information science • The ability to apply acquired knowledge in independent work for solving technical and scientific problems in computer and information science; the ability to upgrade acquired knowledge **Subject-specific competences:** • Basic skills in computer and information science, which includes basic theoretical skills, practical knowledge and skills essential for the field of computer and information science • Basic skills in computer and information science, allowing the continuation of studies in the second study cycle
Predvideni študijski rezultati:	**Intended learning outcomes:**
Znanje in razumevanje: Sposobnost samostojnega razvoja programov, poznavanje osnovnih podatkovnih struktur in algoritmov. Uporaba: Pisanje programov za reševanje zmerno težkih programskih nalog. Refleksija: Razumevanje osnovnih principov načrtovanja programov in algoritmov in razumevanje njihove vloge pri razvoju programskih sistemov. Prenosljive spretnosti - niso vezane le na en predmet: Zmožnost načrtovanja rešitve različnih problemov s programi in algoritmi, zmožnost uporabe predstavljenih principov pri programiranju v poljubnem programskem jeziku.	Knowledge and understanding: The ability to independently develop programs, the familiarity with basic data structures and algorithms. Application: Writing simple programs for solving moderate programming problems. Reflection: Understanding the basic principles of designing programs and algorithms and understanding their role in the development of large systems. Transferable skills: The ability to design the solution of different problems using programs and algorithms, the ability to use the presented programming concepts in an arbitrary programming language.
Metode poučevanja in učenja:	**Learning and teaching methods:**

Predavanja, domače naloge, seminarski način dela pri vajah. Poseben poudarek je na sprotnem študiju in domačih nalogah.	Lectures, home works, seminar works during tutorials. The emphasis is on continuous study and homeworks.

Načini ocenjevanja:	Delež (v %) / Weight (in %)	**Assessment:**
Način (pisni izpit, ustno izpraševanje):		Type (examination, written and oral):
Sprotno preverjanje (kolokviji)	**50%**	**Continuing** (midterm exams)
Končno preverjanje (pisni izpit)	**50%**	
		Final (written exam)
Ocene: 6-10 pozitivno, 1-5 negativno (v skladu s Statutom UL)		Grading: 6-10 pass, 1-5 fail.

Reference nosilca / Lecturer's references:

Pet najpomembnejših del:

1. ROŽANC, Igor, SLIVNIK, Boštjan. Using reverse engineering to construct the platform independent model of a web application for student information systems. Computer Science and Information Systems, ISSN 1820-0214, 2013, vol. 10, no. 4, str. 1557-1583, ilustr. http://www.comsis.org/archive.php?show=pprmd276-1212, doi: 10.2298/CSIS121218068R. [COBISS.SI-ID 10226516]
2. CANKAR, Matija, ARTAČ, Matej, ŠTERK, Marjan, LOTRIČ, Uroš, SLIVNIK, Boštjan. Co-allocation with collective requests in grid systems. Journal for universal computer science, ISSN 0948-6968, 2013, vol. 19, no. 3, str. 282-300, ilustr. http://www.jucs.org/jucs_19_3/coallocation_with_collective_requests/jucs_19_03_0282_0300_cankar.pdf. [COBISS.SI-ID 9797972]
3. SLIVNIK, Boštjan. LL conflict resolution using the embedded left LR parser. Computer Science and Information Systems, ISSN 1820-0214, Sep. 2012, vol. 9, no. 3, str. 1105-1124, ilustr. [COBISS.SI-ID 9583700]
4. SLIVNIK, Boštjan, VILFAN, Boštjan. Producing the left parse during bottom-up parsing. Information processing letters, ISSN 0020-0190. [Print ed.], Dec. 2005, vol. 96, no. 6, str. [220]-224. [COBISS.SI-ID 5075284]
5. POTOČNIK, Matic, ČIBEJ, Uroš, SLIVNIK, Boštjan. Linter - a tool for finding bugs and potential problems in Scala code. V: Proceedings of the 29th Annual ACM Symposium on Applied Computing, Gyeongju, Korea, March 24-28, 2014. Proceedings of the 29th Annual ACM Symposium on Applied Computing, Gyeongju, Korea, March 24-28, 2014. [S. l.]: Association for Computing Machinery, cop. 2014, str. 1615-1616, graf. prikazi. [COBISS.SI-ID 10520660]
6. SLIVNIK, Boštjan. LLLR parsing. V: Proceedings of the 28th annual ACM Symposium on Applied Computing 2013, Coimbra, Portugal, March 18-22. [S. l.]: Association for Computing Machinery, 2013, str. 1698-1699. [COBISS.SI-ID 9735508]

UČNI NAČRT PREDMETA / COURSE SYLLABUS	
Predmet:	**Arhitektura računalniških sistemov**
Course title:	**Computer Systems Architecture**

Študijski program in stopnja Study programme and level	Študijska smer Study field	Letnik Academic year	Semester Semester
Univerzitetni študijski program prve stopnje Računalništvo in informatika Univerzitetni študijski program prve stopnje Računalništvo in matematika Univerzitetni študijski program prve stopnje Multimedija	ni smeri	1	poletni
University study programme Computer and Information Science, 1st cycle University study programme Computer Science and Mathematics , 1st cycle University study programme Multimedia, 1st cycle	none	1	spring

Vrsta predmeta / Course type	obvezni predmet / compulsory course
Univerzitetna koda predmeta / University course code:	63212

Predavanja Lectures	Seminar Seminar	Vaje Tutorial	Klinične vaje Laboratory work	Druge oblike študija Field work	Samost. delo Individ. work	ECTS
45	/	30	/	/	105	6

Nosilec predmeta / Lecturer:	prof. dr. Branko Šter

Jeziki / Languages:	**Predavanja / Lectures:**	slovenščina Slovene
	Vaje / Tutorial:	slovenščina Slovene

Pogoji za vključitev v delo oz. za opravljanje **Prerequisites:**

študijskih obveznosti:

Poznavanje osnov digitalnih vezij.	Basics of digital circuits.

Vsebina:	**Content (Syllabus outline):**
Kako so narejeni računalniki in kako delujejo? Zakaj se princip delovanja od prvih računalnikov do danes skoraj ni spremenil? Kaj se dogaja v stroju med reševanjem problemov? To so samo nekatera od vprašanj, na katera odgovarja predmet Arhitektura računalniških sistemov. Pri predmetu bodo študenti v teoriji in na praktičnih primerih spoznali naslednje vsebine: 1. Narava računanja, kompleksnost, omejitve, teoretični modeli računanja. 2. Zgodovinski pregled dosedanjega razvoja strojev za računanje. 3. Von Neumannov arhitekturni model, osnovni principi delovanja. Vhod in izhod, prekinitve, lokalnost pomnilniških dostopov, Amdahlov zakon, strojna in programska oprema. 4. Predstavitev informacije in osnove računalniške aritmetike. 5. Ukazi in strojni jezik: načini naslavljanja, operacije, formati, RISC-CISC 6. Centralna procesna enota: podatkovna enota, aritmetično-logična enota, kontrolna enota. 7. Analiza zgradbe in delovanja CPE na primeru RISC računalnika. 8. Paralelizem na nivoju ukazov: cevovod, cevovodne nevarnosti, odpravljanje cevovodnih nevarnosti, dinamično razvrščanje, špekulativno izvrševanje, večizstavitveni procesorji. Paralelizem na nivoju niti	How are computers designed and how they work? Why has the principle of operation remained almost unchanged from the first computers to today? What is going on in the machine during problem solving? These are only some of the questions that are answered by the Computer Systems Architecture course. During the course the students will in theory and on practical examples study the following topics: 1. Nature of computation, complexity, limitations, theoretical models of computation. 2. Survey of historical development of computing machines. 3. Von Neumann architecture model and basic principles of operation. Input and output, interrupts, locality of memory references, Amdahl's law, hardware and software. 4. Representation of information and basic computer arithmetic. 5. Instructions and machine language: addressing modes, operations, formats, RISC-CISC. 6. Central processing unit: datapath with arithmetic-logic unit, control unit. 7. Analysis of CPU design and operation using a RISC computer as an example. 8. Instruction level parallelism: pipeline, pipeline hazards. Pipeline hazard elimination, dynamic scheduling, register renaming, speculative execution, multiple-issue processors. Thread level parallelism. 9. Main memory: technology, organization,

9. Glavni pomnilnik: tehnologija, organizacija, zaščita 10. Predpomnilniki: princip delovanja, vrste zgrešitev, zgrešitvena kazen, problem skladnosti 11. Navidezni pomnilnik	protection. 10. Cache memories: principles of operation, types of cache misses, miss penalty, coherency problem. 11. Virtual Memory

Temeljni literatura in viri / Readings:

1. D. Kodek: *Arhitektura in organizacija računalniških sistemov*, Bi-Tim, Ljubljana 2008, poglavja 1 do 8.

Dodatna literatura:

1. J. L. Hennessy, D. A. Patterson: *Computer Architecture: A Quantitative Approach*, 4. izdaja, Morgan Kaufmann, San Francisco 2007.
2. D. A. Patterson, J. L. Hennessy: *Computer Organization and Design: The Hardware/Software Interface*, 4. izdaja, Morgan Kaufmann, Burlington 2009.

Cilji in kompetence:	**Objectives and competences:**
Namen predmeta je predstaviti študentom področje arhitekture računalniških sistemov. To področje je osnovnega pomena za vse študente računalništva, ker daje razumevanje o tem, kaj stroj za računanje je. Na koncu predmeta bo vsak študent poznal osnovne elemente računalnika, kako so ti deli med seboj povezani, razlikoval različne nivoje programiranja in razumel osnovno zgradbo strojev za računanje. Kompetence: Razvoj veščin kritičnega, analitičnega in sintetičnega mišljenja. Zmožnost definiranja, razumevanja in reševanja ustvarjalnih profesionalnih izzivov v računalništvu in informatiki. Osnovne veščine v računalništvu in informatiki. Praktično znanje in veščine, potrebne za uspešno profesionalno delo v računalništvu in informatiki.	The aim of the course is to introduce students to the field of computer systems architecture. This is a fundamental field for all computer science students since it gives understanding of what a computing machine is. At the end of this course the students will know the basic elements of a computer, comprehend how this elements link together, distinguish different levels of programming, and understand the basis of computing machines design. Competences: Developing skills in critical, analytical and synthetic thinking. The ability to define, understand and solve creative professional challenges in computer and information science. Basic skills in computer and information science. Practical knowledge and skills necessary for successful professional work in computer and information science.

Predvideni študijski rezultati:	**Intended learning outcomes:**

Znanje in razumevanje: Poznavanje arhitekture računalniških sistemov in osnovnih orodij za razvoj strojev za računanje. Ta vključujejo kvantitativne metode za primerjavo in ocenjevanje različnih računalniških arhitektur. **Uporaba**: Razumeti, kako računalnik deluje in kakšne so njegove omejitve, predstavlja osnovo za razvoj kvalitetne programske opreme. Pomembno pa je tudi pri nakupu računalniške opreme. **Refleksija**: Odpraviti pogosto stanje, kjer se na računalnik gleda kot na črno škatlo, ki izvaja programe na čudežen način. **Prenosljive spretnosti**: Predmet se dopolnjuje s predmeti s področja programiranja, algoritmov in digitalnih vezij.	**Knowledge and understanding**: Understanding of computer systems architecture and basic tools for development of computing machines. These include quantitative methods for comparison and evaluation of different computer architectures. **Application**: Understanding of how computers work and what are their limitations represents the basis for high quality software development. It is also important for computer procurement. **Reflection**: Preventing a common situation where a computer is treated as a black box that executes programs in some mysterious way. **Transferable skills**: The course is complemented with courses teaching programming, algorithms and digital circuits.

Metode poučevanja in učenja:	**Learning and teaching methods:**
Predavanja, laboratorijske vaje in domače naloge.	Lectures, laboratory work and homeworks.

Načini ocenjevanja:	Delež (v %) / Weight (in %)	**Assessment:**
Sprotno delo poteka v obliki laboratorijskih vaj, domačih nalog in kolokvijev.	**1/3**	**Midterm work** consists of laboratory exercises, homeworks and midterm exams.
Končno preverjanje (računski in teoretični izpit) Ocene: 6-10 pozitivno, 1-5 negativno.	**1/3 + 1/3**	**Final exam** (written and theoretical exam) Grading: 6-10 pass, 1-5 fail.

Reference nosilca / Lecturer's references:

Pet najpomembnejših del:

1. Branko Šter: Selective recurrent neural network. *Neural processing letters*, 38(1): 1-15, 2013.
2. Dominik Olszewski, Branko Šter: Asymmetric clustering using the alpha–beta divergence. *Pattern Recognition,* 47(5): 2031-2041, 2013.
3. Rok Gaber, Tina Lebar, Andreja Majerle, Branko Šter, Andrej Dobnikar, Mojca Benčina, Roman Jerala: Designable DNA-binding domains enable construction of logic circuits in mammalian

cells. *Nature Chemical Biology*, 10(3): 203-208, 2014.
4. Andrej Dobnikar, Branko Šter: Structural properties of recurrent neural networks. *Neural processing letters*, 29(2): 75-88, 2009.
5. Jernej Zupanc, Damjana Drobne, Branko Šter: Markov random field model for segmenting large populations of lipid vesicles from micrographs. *Journal of liposome research*, 21(4): 315-323, 2011.

UČNI NAČRT PREDMETA / COURSE SYLLABUS	
Predmet:	**Elektronsko poslovanje**
Course title:	**Electronic Business**

Študijski program in stopnja **Study programme and level**	**Študijska smer** **Study field**	**Letnik** **Academic year**	**Semester** **Semester**
Univerzitetni študijski program prve stopnje Računalništvo in informatika Interdisciplinarni univerzitetni študijski program prve stopnje Računalništvo in matematika Interdisciplinarni univerzitetni študijski program prve stopnje Multimedija Interdisciplinarni univerzitetni študijski program prve stopnje Upravna informatika	Modul: Informacijski sistemi	3	zimski
University study programme Computer and Information Science, 1st cycle Interdisciplinary university study programme Computer Science and Mathematics , 1st cycle Interdisciplinary university study programme Multimedia, 1st cycle Interdisciplinary university study programme in Administrative Informatics 1st cycle	Module: Information systems	3	fall

Vrsta predmeta / Course type	**izbirni predmet / elective course** **obvezni predmet / compulsory course**
Univerzitetna koda predmeta / University course code:	**63249**

Predavanja **Lectures**	**Seminar** **Seminar**	**Vaje** **Tutorial**	**Klinične vaje** **Laboratory work**	**Druge oblike študija** **Field work**	**Samost. delo** **Individ. work**	**ECTS**

45	/	30	/	/	105	6

Nosilec predmeta / Lecturer: prof. dr. Denis Trček

Jeziki / Languages:	**Predavanja / Lectures:**	slovenščina Slovene
	Vaje / Tutorial:	slovenščina Slovene

Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:

Prerequisites:

Vsebina:

Poglavja predmeta obsegajo:

1. Uvod in temeljne definicije.
2. Kratek zgodovinski pregled razvoja e-poslovanja.
3. Sistemski pogled na e-poslovanje skozi analizo generičnih struktur (zunanje in notranje logistične verige in verige dodane vrednosti ter vpliv odločanja na njihovo obnašanje).
4. Tehnološki vidiki: RIP, XML, spletne storitve, komponentne arhitekture, digitalni plačilni sistemi (BitCoin), semantični splet, internet stvari, mobilne aplikacije.
5. Organizacijski vidiki: evolucija poslovnih funkcij, procesov in informacijskih sistemov, novi poslovni modeli, revizijski postopki - COBI.
6. Zakonodajni vidiki s poudarkom na ZEPEP, ZEPEP-A, ter ZEKOM.
7. Specifični vidiki načrtovanja in vpeljave sistemov e-poslovanja: spremembe strateškega načrtovanja IS, uporaba formalnih metod (jezik Z), skladnost s

Content (Syllabus outline):

The course contains the following themes:

1. Introduction and basic definitions.
2. Short historical overview of the e-business field.
3. Systemic view on e-business through its generic structures (internal and external logistic and value added chains, the influence of decision making on their behavior).
4. Technological views: EDI, XML, web services, component architectures, digital payment systems (BitCoin), semantic web technologies, internet of things and mobile applications.
5. Organizational views: evolution of business functions, processes and information systems, new business models, auditing procedures (COBIT).
6. Legislation views with emphasis on ZEPEP, ZEPEP-A, ZEKOM.
7. Specific views related to development and introduction of e-business systems: strategic planning changes, use of formal methods (language Z), and

standardi kot je Common Criteria. 8. Varovanje intelektualne lastnine. 9. Zaključki. 10. Addendum: Mini vložki s praktičnim delom, ki pokrivajo najnovejše trende.	compliance with standards like Common Criteria. 8. Intelectual property issues. 9. Conclusions. 10. Addendum: Mini practical tasks covering the latest selected technological trends.

Temeljni literatura in viri / Readings:

1. D. Trček: *Elektronsko poslovanje*, kopije prosojnic, FRI, Ljubljana, 2016.

Dodatna literatura / Additional literature:

2. R. Kalakota: *E-business*, Addison Wesley, New York, 2002.
3. Dave Chaffey: E-Business and E-Commerce Management, FT Prentice Hall, 2011.
4. Sterman J.: Business Dynamics, Prentice Hall, 2002.

Cilji in kompetence:	**Objectives and competences:**
Cilj predmeta je seznaniti študenta s tehnološkimi, organizacijskimi in zakonskimi (pravnimi) znanji, ki jih prinaša elektronsko poslovanje (ter najnovejšimi trendi na tem področju). Poudarek je na praktični usposobljenosti študenta, saj se študent nauči modelirati poslovni (pod)proces, razvije ustrezno aplikacijo za e-poslovanje v okviru tega (pod)procesa in jo integrira v zaledni informacijski sistem. Kategorizirane kompetence: -Sposobnost definiranja, razumevanja in reševanja kreativnih profesionalnih izzivov na področju računalništva in informatike. -Sposobnost profesionalnega komuniciranja v materinem in tujem jeziku. -Sposobnost biti skladen z varnostnimi, funkcionalnimi in okoljskimi zahtevami. -Sposobnost razumevanja in uporabe znanja računalništva in informatike na drugih relevantnih področjih (organizacija, itd.). -Sposobnost samostojnega reševanja in izvedbe manj zahtevnih oz. manj kompleksnih inženirskih in organizacijskih opravil v računalništvu in informatiki.	The objective of the course is to familiarize students with technological, organizational and legal knowledge that is required in e-business along with the latest trends in this area. The emphasis is on practical skills, i.e., students model a business (sub)process, develop a necessary e-business application and integrate it with the background information system. Categorized competences: - The ability to define, understand and solve creative professional challenges in computer and information science. - The ability of professional communication in the native language as well as in a foreign language. - Compliance with security, functional, economic and environmental principles. - The ability to understand and apply computer and information science knowledge to other technical and relevant fields (organisational science, etc). -The ability to independently perform less demanding and less complex engineering and organisational tasks requiering the application of in computer and information systems domain.

Predvideni študijski rezultati:	**Intended learning outcomes:**
Znanje in razumevanje: Razumevanje konceptov elektronskega poslovanja ter integracija z znanji, dobljenimi pri drugih predmetih s tehničnega in organizacijskega področja. Uporaba: Sposobnost za razvoj, administracijo ali vodenje sistemov e-poslovanja v organizacijah. Refleksija: Razumevanje teoretičnih konceptov, pridobljenih na predavanjih skozi praktično realizacijo na vajah. Prenosljive spretnosti - niso vezane le na en predmet: Sposobnost integracije pridobljenih znanj z drugimi področji (obvladovanje in načrtovanje inf. sistemov, vodenje projektov, razvoj spletnih aplikacij, mobilne platforme), sposobnost samostojne pisne in ustne predstavitve strokovne problematike ter javnega nastopanja, podjetniško razmišljanje.	Knowledge and understanding: Understanding of concepts of e-business and their integration with knowledge and skills obtained through other related courses. Application: Ability to develop, administer and manage e-business systems in organizations. Reflection: Understanding of theoretical concepts and their practical implementation through laboratory work. Transferable skills: Ability to integrate knowledge from various fields (and other courses) like information systems planning, information systems management, web applications development and mobile platforms. Further, stimulation of entrepreneurship's mind-set and ability to communicate, work in teams, and public presentation of work.

Metode poučevanja in učenja:	**Learning and teaching methods:**
Predavanja, vaje s projektnim delom (praktične prototipne implementacije), lastne predstavitve. Udeležba na vajah je obvezna (zahtevan procent udeležbe se določi ob začetku študijskega leta). Nosilec predmeta lahko določi obvezno udeležbo tudi na predavanjih.	Lectures, laboratory work (with practical prototype implementations), students' presentations. Attendance of laboratory work is mandatory (the exact percentage is announced at the beginning of a study year). The lecturer may impose mandatory attendance of lectures.

Načini ocenjevanja:	Delež (v %) / Weight (in %)	**Assessment:**
50 % ocene predstavlja sprotno delo študenta v obliki preverjanj na vajah (domače naloge, kvizi, praktičen projekt), 50 % ocene pa predstavlja izpit, ki je načeloma v pisni obliki, lahko	**50%** **50%**	50% of the final grade is obtained on the basis of on-going laboratory work (home-works, quizzes, practical project implementations and presentations). The other 50% is obtained on the basis

pa tudi v pisni in ustni obliki (pri čemer lahko nosilec namesto ustnega izpita uvede seminar). Za uspešno opravljene obveznosti pri predmetu morata biti pozitivni obe delni oceni. Pristop k pisnemu izpitu je možen le po uspešno opravljenih obveznostih pri vajah (in v primeru dodatnih zahtev, ki se nanašajo na predavanja, po izpolnitvi le-teh). Ocene: 6-10 pozitivno, 1-5 negativno.		of a written exam, or written and oral exam (the lecturer may decide that a seminal work replaces the oral exam). To be eligible for the written exam, a candidate must have successfully completed laboratory work, and fulfilled other obligations related to lecturing that the lecturer may have imposed. For successful completition of the course both grades have to be positive. Grading: 6-10 pass, 1-5 fail.

Reference nosilca / Lecturer's references:

Pet najpomembnejših del / Five relevant publications

TRČEK, Denis, BRODNIK, Andrej. Hard and soft security provisioning for computationally weak pervasive computing systems in e-health. IEEE wireless communications, ISSN 1536-1284. [Print ed.], Aug. 2013, vol. 20, no. 4, 8 str., ilustr. [COBISS.SI-ID 10091092].

TRČEK, Denis. Trust management in the pervasive computing era. IEEE security & privacy, ISSN 1540-7993. [Print ed.], 2011, vol. 9, no. 4, str. 52-55, ilustr. http://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=5968087&tag=1. [COBISS.SI-ID 8554836].

ZUPANČIČ, Eva, TRČEK, Denis. QADE : a novel trust and reputation model for handling false trust values in e-commerce environments with subjectivity consideration. Technological and economic development of economy, ISSN 2029-4913. [Print ed.], 2015, vol. , no. , str. 1-30, ilustr. http://www.tandfonline.com/doi/abs/10.3846/20294913.2015.1022810#.VXE-ArdWG70, doi: 10.3846/20294913.2015.1022810. [COBISS.SI-ID 1536328643].

TRČEK, Denis. Qualitative assessment dynamics: complementing trust methods for decision making. International journal of information technology & decision making. [Online ed.], 2014, vol. 13, no. 1, str. 155-173, doi: 10.1142/S0219622014500072. [COBISS.SI-ID 10341204].

TORJUSEN, Arild B., ABIE, Habtamu, PAINTSIL, Ebenezer, TRČEK, Denis, SKOMEDAL, Åsmund. Towards run-time verification of adaptive security for IoT in eHealth , Proceedings of the ECSA 2014 Workshops & Tool Demos Track : ECSAW '14, (ACM proceedings, ISSN 2168-4081). New York (NY): The Association for Computing Machinery, 2014, str. 1-8, ilustr. http://dl.acm.org/citation.cfm?id=2642807 [COBISS.SI-ID 10728532].

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http://sicris.izum.si/search/rsr.aspx?lang=slv&id=7226.

UČNI NAČRT PREDMETA / COURSE SYLLABUS	
Predmet:	**Brezžična in mobilna omrežja**
Course title:	**Mobile and Wireless Networks**

Študijski program in stopnja Study programme and level	Študijska smer Study field	Letnik Academic year	Semester Semester
Univerzitetni študijski program prve stopnje Računalništvo in informatika **Univerzitetni študijski program prve stopnje Računalništvo in matematika**	**Modul: Računalniška omrežja**	**3**	**poletni**
University study programme Computer and Information Science, 1st cycle **University study programme Computer Science and Mathematics , 1st cycle**	**Module: Computer networks**	**3**	**spring**

Vrsta predmeta / Course type	**izbirni predmet /elective course**
Univerzitetna koda predmeta / University course code:	**63259**

Predavanja Lectures	Seminar Seminar	Vaje Tutorial	Klinične vaje Laboratory work	Druge oblike študija Field work	Samost. delo Individ. work	ECTS
45	10	20	/	/	105	6

Nosilec predmeta / Lecturer:	prof. dr. Nikolaj Zimic

Jeziki / Languages:	**Predavanja / Lectures:**	slovenščina Slovene
	Vaje / Tutorial:	slovenščina Slovene

Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:	**Prerequisites:**

Vsebina:

predavanja:

1. Uvod v brezžična omrežja
2. Fizični nivo
3. Lokalna in osebna omrežja
4. Mestna in prostrana omrežja
5. Brezžični internet
6. Ad Hoc brezžična omrežja
7. Transportni nivo in varnost
8. Kvaliteta storitev
9. Hibridna brezžična omrežja

Content (Syllabus outline):

lectures:

1. Introduction to wireless networks
2. Physical layer review
3. Local and personal wireless networks
4. Metropolitan and wide area wireless networks
5. Wireless internet
6. Ad Hoc wireless networks
7. Transport layer and security protocols
8. Quality of service
9. Hybrid wireless networks

Temeljni literatura in viri / Readings:

1. Sauter, Martin, “Communication systems for the mobile information society“, Chichester : J. Wiley & Sons, cop. 2006, ISBN: 0-470-02676-6
2. C. Siva Ram Murthy and B. S. Manoj, “Ad-Hoc Wireless Networks: Architectures and Protocols,” Prentice-Hall, 2004, ISBN: 0-13-147023-X.
3. Bernhard H. Walke, Stefan Mangold, Lars Berlemann, IEEE 802 Wireless Systems: Protocols, Multi-Hop Mesh/Relaying, Performance and Spectrum Coexistence, John Wiley & Sons, 12. jan. 2007, ISBN-13: 978-0470014394
4. Erik Dahlman, 3G Evolution: HSPA and LTE for Mobile Broadband, Academic Press, 2008, ISBN-13: 978-0123745385

Dodatna literatura:

1. Farid Dowla (Ed), " Handbook of RF and Wireless Technologies," Elsevier, 2003, ISBN: 0750676957.
2. Andreas Molisch, "Wireless Communications," Wiley, 2005, 668 pp., ISBN: 047084888X.
3. Benny Bing (Ed), "Emerging Technologies in Wirless LANs," Cambridge Univ Press, 2008, ISBN: 0521895842.

Cilji in kompetence:

Objectives and competences:

Cilj predmeta je študentom računalništva in informatike predstaviti brezžična in mobilna omrežja. Poudarek je na posebnostih, ki jih prinaša brezžičen prenos podatkov in mobilnost terminalov v računalniška omrežja.	The purpose of the course is to give the students a sound understanding of the architecture and operating principles of mobile and wireless networks. This course provides a general introduction to mobile networking, with an emphasis on the wireless data transmission and mobility of terminals.

Predvideni študijski rezultati:	**Intended learning outcomes:**
Znanje in razumevanje: Razumevanje delovanja brezžičnih omrežij. Poznavanje razlik med različnimi brezžičnimi omrežji ter njihova uporaba. Uporaba: Uporaba brezžičnih in mobilnih omrežij pri raznih pogojih uporabe (industrija, hišna omrežja, osebna omrežja, ...). Refleksija: Spoznavanje in razumevanje uglašenosti med teorijo in njeno aplikacijo na konkretnih primerih s področja brezžičnega prenosa podatkov. Prenosljive spretnosti - niso vezane le na en predmet: Reševanje drugih konceptualno sorodnih problemov (npr. telefonska omrežja 3G in 4G).	Knowledge and understanding: Understanding of the basic wireless networks concepts. Understanding of the various wireless networks differences and its applications. Application: Wireless and mobile networks applications in various working conditions (industrial, house, personal networks ...) Reflection: Comprehension and understanding wireless data transmission theory and its application in real world application from the field. Transferable skills: Solving of the similar problems from field of the computer communications.

Metode poučevanja in učenja:	**Learning and teaching methods:**
Predavanja, laboratorijske vaje.	Lectures, lab practice.

Načini ocenjevanja:	Delež (v %) / Weight (in %)	**Assessment:**
Način (pisni izpit, ustno izpraševanje, naloge, projekt): **Sprotno preverjanje** (domače naloge, kolokviji in projektno delo)	**50%**	Type (examination, oral, coursework, project): **Continuing** (homework, midterm exams, project work)

Končno preverjanje (pisni in ustni izpit) Ocene: 6-10 pozitivno, 1-5 negativno (v skladu s Statutom UL)	**50%**	**Final** (written and oral exam) Grading: 6-10 pass, 1-5 fail.

Reference nosilca / Lecturer's references:

Pet najpomembnejših del:

PEČAR, Primož, RAMŠAK, Anton, ZIMIC, Nikolaj, MRAZ, Miha, LEBAR BAJEC, Iztok. Adiabatic pipelining: a key to ternary computing with quantum dots. *Nanotechnology (Bristol)*, 2008, vol. 19, no. 49, str. 1-12, ilustr.

LEBAR BAJEC, Iztok, ZIMIC, Nikolaj, MRAZ, Miha. The computational beauty of flocking: boids revisited. *Math. comput. model. dyn. syst.*, Aug. 2007, vol. 13, no. 4, str. [331]-347, ilustr

ZIMIC, Nikolaj, MRAZ, Miha. Decomposition of a complex fuzzy controller for the truck-and-trailer reverse parking problem. *Math. comput. model.*. [Print ed.], Mar. 2006, vol. 43, no. 5/6, str. 632-645, ilustr.

LEBAR BAJEC, Iztok, ZIMIC, Nikolaj, MRAZ, Miha. Towards the bottom-up concept: extended quantum-dot cellular automata. *Microelectron. eng.*. [Print ed.], 2006, vol. 83, no. 4/9, str. 1826-1829, ilustr

LEBAR BAJEC, Iztok, ZIMIC, Nikolaj, MRAZ, Miha. The ternary quantum-dot cell and ternary logic. Nanotechnology (Bristol), 2006, vol. 17, no. 8, str. 1937-1942, ilustr

UČNI NAČRT PREDMETA / COURSE SYLLABUS	
Predmet:	**Osnove digitalnih vezij**
Course title:	**Introduction to Digital Circuits**

Študijski program in stopnja Study programme and level	Študijska smer Study field	Letnik Academic year	Semester Semester
Univerzitetni študijski program prve stopnje Računalništvo in informatika **Univerzitetni študijski program prve stopnje Računalništvo in matematika**	**ni smeri**	**1**	**zimski**
University study programme Computer and Information Science, 1st cycle **University study programme Computer Science and Mathematics , 1st cycle**	**none**	**1**	**fall**

Vrsta predmeta / Course type	**obvezni predmet / compulsory course**
Univerzitetna koda predmeta / University course code:	**63204**

Predavanja Lectures	Seminar Seminar	Vaje Tutorial	Klinične vaje Laboratory work	Druge oblike študija Field work	Samost. delo Individ. work	ECTS
45	/	30	/	/	105	6

Nosilec predmeta / Lecturer:	prof. dr. Nikolaj Zimic

Jeziki / Languages:	**Predavanja / Lectures:**	slovenščina Slovene
	Vaje / Tutorial:	slovenščina Slovene

Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:	**Prerequisites:**

Vsebina:

predavanja:

1. Boolova algebra
2. Preklopne funkcije in preklopna vezja
3. Funkcijsko polni sistemi
4. Minimizacija preklopnih funkcij
5. Strukturalna preklopna vezja (kodirnik, dekodirnik, multiplekser, ROM, ...)
6. Aritmetično logična vezja
7. Sekvenčna vezja
8. Načrtovanje avtomatov
9. Realizacija avtomatov
10. Osnove VHDL
11. Programabilna logična vezja

Content (Syllabus outline):

lectures:

1. Boolean algebra
2. Switching functions and circuits
3. Functionally complete logic systems
4. Circuit minimization
5. Structural switching circuits (coder, decoder, multiplexer, ROM, ...)
6. Arithmetical and logical circuits
7. Sequential circuits
8. Automata design
9. Automata realization
10. VHDL basics
11. Programmable logic circuits

Temeljni literatura in viri / Readings:

Osnovna:

- J. Virant, Logične osnove odločanja in pomnjenja v računalniških sistemih, Ljubljana: Fakulteta za računalništvo in informatiko, 1996, ISBN 961-6209-01-9.
- I. Lebar Bajec, Preklopne strukture in sistemi: zbirka rešenih primerov in nalog z rešitvami, Ljubljana: Fakulteta za računalništvo in informatiko, 2002, ISBN 961-6209-31-0.
- K. Skahill, VHDL for Programmable Logic, Addison Wesley, 1996, ISBN 0-201-89586-2.

Dodatna literatura:

- T. Floyd, Digital fundamentals, Prentice Hall, cop. 1997, ISBN 0-13-398488-5.
- F. Wakerly, Digital design, Prentice Hall, cop. 2000, ISBN 0-13-769191-2.
- M. Mano, Digital design, Prentice Hall, (3rd edititon), cop., 2001, ISBN 0-13-062121-8.

Cilji in kompetence:

Objectives and competences:

Študenti v okviru tega predmeta pridobijo osnovna znanja s področja digitalne logike. Spoznajo se z osnovnimi gradniki v računalništvu ter ustrezno logično obravnavo le-teh. Seznanijo se s časom v preklopnih strukturah in sistemih, pomnilnimi celicami in osnovami avtomatov.	The object of this course is mastering and understanding efficient practical solutions and gaining a thorough understanding of digital logic, time in digital domain, memory cell and basic of the automaton.

Predvideni študijski rezultati:	**Intended learning outcomes:**
Znanje in razumevanje: Razumevanje delovanja enostavnih digitalnih vezij. Sposobnost minimizacije logičnih vezij. Razumevanje delovanja sekvenčnih vezij in avtomatov. Uporaba: Uporaba osnovnih orodij za načrtovanje vezij in izdelava enostavnih logičnih sklopov. Refleksija: Spoznavanje in razumevanje uglašenosti med teorijo in njeno aplikacijo na konkretnih primerih s enostavnih logičnih in sekvenčnih vezij. Prenosljive spretnosti - niso vezane le na en predmet: Uporaba binarne logike. Načrtovanje in izgradnja enostavnih digitalnih vezij.	Knowledge and understanding: Understanding basic digital circuit design concepts. Mastering digital circuit minimization. Understanding the basics of the sequence circuit and automaton. Application: Using basic tools for circuit development and realization. Reflection: Comprehension and understanding of the basics of digital circuits design. Transferable skills: Boolean logic concepts. Basic digital circuits design.

Metode poučevanja in učenja:	**Learning and teaching methods:**
Predavanja, laboratorijske vaje.	Lectures, lab practice.

Načini ocenjevanja:	Delež (v %) / Weight (in %)	**Assessment:**
Način (pisni izpit, ustno izpraševanje, naloge, projekt):		Type (examination, oral, coursework, project):
Sprotno preverjanje (domače naloge, kolokviji in projektno delo)	**50%**	**Continuing** (homework, midterm exams, project work)
Končno preverjanje (pisni in ustni izpit)	**50%**	**Final** (written and oral exam)

Ocene: 6-10 pozitivno, 1-5 negativno (v skladu s Statutom UL)		Grading: 6-10 pass, 1-5 fail.

Reference nosilca / Lecturer's references:

Pet najpomembnejših del:

PEČAR, Primož, RAMŠAK, Anton, ZIMIC, Nikolaj, MRAZ, Miha, LEBAR BAJEC, Iztok. Adiabatic pipelining: a key to ternary computing with quantum dots. *Nanotechnology (Bristol)*, 2008, vol. 19, no. 49, str. 1-12, ilustr.

LEBAR BAJEC, Iztok, ZIMIC, Nikolaj, MRAZ, Miha. The computational beauty of flocking: boids revisited. *Math. comput. model. dyn. syst.*, Aug. 2007, vol. 13, no. 4, str. [331]-347, ilustr

ZIMIC, Nikolaj, MRAZ, Miha. Decomposition of a complex fuzzy controller for the truck-and-trailer reverse parking problem. *Math. comput. model.*. [Print ed.], Mar. 2006, vol. 43, no. 5/6, str. 632-645, ilustr.

LEBAR BAJEC, Iztok, ZIMIC, Nikolaj, MRAZ, Miha. Towards the bottom-up concept: extended quantum-dot cellular automata. *Microelectron. eng.*. [Print ed.], 2006, vol. 83, no. 4/9, str. 1826-1829, ilustr

LEBAR BAJEC, Iztok, ZIMIC, Nikolaj, MRAZ, Miha. The ternary quantum-dot cell and ternary logic. *Nanotechnology (Bristol)*, 2006, vol. 17, no. 8, str. 1937-1942, ilustr

UČNI NAČRT PREDMETA / COURSE SYLLABUS	
Predmet:	**Uvod v odkrivanje znanj iz podatkov**
Course title:	**Introduction to Data Mining**

Študijski program in stopnja Study programme and level	Študijska smer Study field	Letnik Academic year	Semester Semester
Univerzitetni študijski program prve stopnje Računalništvo in informatika **Interdisciplinarni univerzitetni študijski program prve stopnje Računalništvo in in matematika** **Interdisciplinarni univerzitetni študijski program prve stopnje Multimedija** **Interdisciplinarni univerzitetni študijski program prve stopnje Upravna informatika**	**Modul: Informacijski sistemi**	**3** **2**	**zimski**
University study programme Computer and Information Science, 1st cycle **Interdisciplinary university study programme Computer Science and Mathematics , 1st cycle** **Interdisciplinary university study programme Multimedia, 1st cycle** **Interdisciplinary university Study Programme in Administrative Informatics 1st Cycle**	**Module: Information systems**	**3** **2**	**fall**

Vrsta predmeta / Course type	**izbirni predmet / elective course**
Univerzitetna koda predmeta / University course code:	**63251**

Predavanja Lectures	Seminar Seminar	Vaje Tutorial	Klinične vaje Laboratory	Druge oblike študija	Samost. delo Individ.	ECTS

			work	Field work	work	
45	20	10	/	/	105	6

Nosilec predmeta / Lecturer:	prof. dr. Blaž Zupan

Jeziki / Languages:	**Predavanja / Lectures:**	slovenščina in angleščina Slovene
	Vaje / Tutorial:	slovenščina in angleščina Slovene

Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:

Prerequisites:

Vsebina:

Predmet bo v teoriji in na praktičnih primerih obravnaval sledeče vsebine:

1. Kaj je poslovna inteligenca? Predstavitev področja skozi pregled značilnih aplikacij. Vloga tehnologij in pristopov poslovne inteligence v informacijskih sistemih in elektronskem poslovanju. Tehnologije znanja.
2. Računalniško podprto odločanje. Predstavitev in zajemanje znanja. Odločitveni modeli. Obravnavanje nepopolnih in negotovih odločitvenih podatkov. Razlaga in analiza odločitev.
3. Metode in tehnike za računalniško podporo odločanje v skupinah.
4. Uvod v tehnike odkrivanja znanj iz večdimenzionalnih podatkov. Vloga podatkovnih skladišč in predobdelave podatkov. Uvod v tehnike strojne gradnje modelov odločanja in napovednih modelov.
5. Vizualizacija podatkov in modelov.
6. Razvrščanje v skupine.

Content (Syllabus outline):

The course will in theory and through practical exercises and hands-on lectures include the following topics:

1. Introduction to business intelligence. Typical applications. Role of information technology. Knowledge-based systems.
2. Computer-assisted decision support. Decision support models. Treatment of uncertain and incomplete data. Explanation and analysis.
3. Methods and techniques for group decision making.
4. Introduction to techniques of data mining and knowledge discovery in data bases, with emphasis on their application in business intelligence. Data preprocessing, modelling. Supervised and unsupervised learning.
5. Data and model visualization.
6. Data clustering.
7. Business intelligence on the world-wide-web. Page ranking. Analysis of social networks.

7. Tehnike poslovne inteligence na spletu. rangiranje spletnih strani. Analiza podatkov iz družabnih mrež. 8. Priporočilni sistemi. 9. Orodja in razvoj sistemov poslovne inteligence. Integracija v informacijskih sistemih. Snovanje uporabniških vmesnikov za pomoč pri odločanju. 10. Psihosociološki in etični vidiki poslovne inteligence.	8. Recommendation systems. 9. Data analysis toolboxes for business intelligence and their integration in information systems. Interface design of decision support systems. 10. Psychosocilogical and ethical issues.

Temeljni literatura in viri / Readings:

- Tan, P.-N., Steinbach, M., and Kumar, V. (2006) Introduction to Data Mining, Pearson Education.
- Segaran, T. (2007) Programming Collective Intelligence, O'Reilly.
- Dokumentacija prosto dostopnih programov za podatkovno analitiko (Orange, na strani http://orange.biolab.si, scikit-learn na strani http://scikit-learn.org in numpy na strani http://www.numpy.org).

Cilji in kompetence:	**Objectives and competences:**
Cilj predmeta je spoznati metodološke osnove inteligentnih sistemov, ki so bili razviti na področju računalništva. Študente bomo naučili v praksi prepoznati njihove možne aplikacije ter tekom predmeta v okviru laboratorijskega dela naučeno znanje uporabiti na praktičnih primerih. Še posebej podrobno si bomo ogledali tehnike razvrščanja v skupine, priporočilnih sistemov, iskanja vzorcev v podatkih, gradnje napovednih modelov iz strukturiranih in tekstovnih zapisov in tehnike gradnje odločitvenih modelov.	The aim of this course is an introduction to business intelligent methods and tools that were developed within computer science. Students will learn how to identify potential applications of business intelligence in practice. During the course, they will apply their methodological and development knowledge on real-life applications. In particular, the course will focus on data clustering, recommendations systems, association rule mining, inference of predictive models from structured and textual data, and on decision support techniques.

Predvideni študijski rezultati:	**Intended learning outcomes:**
Znanje in razumevanje: Poznavanje metod, tehnik in orodij poslovne inteligence. Uporaba: Uporaba tehnik poslovne inteligence v informacijski sistemih in spletnih okoljih. Refleksija: Sposobnost prepoznavanja priložnosti in niš, kjer lahko s tehnikami poslovne inteligence pridobimo konkurenčno prednost. Razumevanje primernosti teoretičnih pristopov s področja	Knowledge and understanding: Familiarity and practical understanding of business intelligence techniques. Application: Utility of business intelligence approaches in information systems and on the web. Reflection: Competence to determine where and when utility of business intelligence can

inteligentnih sistemov za reševanje praktičnih primerov v poslovnem okolju. Prenosljive spretnosti - niso vezane le na en predmet: Veščine skriptnega programiranja. Odkrivanje znanj iz podatkov. Kognitivni aspekti odločanja.	provide competitive gains. Ability to identify the most useful techniques for a given practical problem. Transferable skills: Programming in Python. Data mining. Cognitive aspects of decision-making.

Metode poučevanja in učenja:	**Learning and teaching methods:**
Predavanja s podporo avdio-vizualne opreme, laboratorijske vaje v računalniški učilnici z osnovno računalniško opremo. Delo posamezno in v skupinah. Velik poudarek na praktičnem delu in reševanju problemov.	Lectures using modern audio-visual equipment. Individual and group-based project assignments. Emphasis on practical exercises.

Načini ocenjevanja:	Delež (v %) / Weight (in %)	**Assessment:**
Domače naloge. **Končno preverjanje** (pisni izpit). Ocene: 6-10 pozitivno, 1-5 negativno (v skladu s Statutom UL)	**50%** **50%**	**Homeworks.** **Written exam.** Grading: 6-10 pass, 1-5 fail.

Reference nosilca / Lecturer's references:

Pet najpomembnejših del:

Toplak M, Mocnik R, Polajnar M, Bosnic Z, Carlsson L, Hasselgren C, Demsar J, Boyer S, Zupan B, Stalring J (2014) Assessment of machine learning reliability methods for quantifying the applicability domain of QSAR regression models, J Chem Inf Model, 54(2):431-441.

Zitnik M, Janjic V, Larminie C, Zupan B, Przulj N (2013) Discovering disease-disease associations by fusing systems-level molecular data, Scientific Reports, 13:3202.

Demsar J, Curk T, Erjavec A, Gorup C, Hocevar T, Milutinovic M, Mozina M, Polajnar M, Toplak M, Staric A, Stajdohar M, Umek L, Zagar L, Zbontar J, Zitnik M, Zupan B (2013) Orange: data mining toolbox in Python, Journal of Machine Learning Research, 14:2349-2353.

Zitnik M, Zupan B (2012) NIMFA: A Python Library for Nonnegative Matrix Factorization, Journal of Machine Learning Research, 13:849-853.

Kljajić Borštnar M, Kljajić M, Škraba A, Kofjač D, Rajkovič V (2011) The relevance of facilitation in group decision making supported by a simulation model, System Dynamics Review 27(3):270-293.

Celotna bibliografija prof. dr. Zupana je dostopna na SICRISu: http://sicris.izum.si/search/rsr.aspx?lang=slv&id=7764.

Celotna bibliografija prof. dr. Rajkoviča je dostopna na SICRISu:

http://sicris.izum.si/search/rsr.aspx?lang=slv&id=4169.

UČNI NAČRT PREDMETA / COURSE SYLLABUS (leto / year 2017/18)			
Predmet:	Verjetnostni račun in statistika		
Course title:	Probability and statistics		

Študijski program in stopnja **Study programme and level**	**Študijska smer** **Study field**	**Letnik** **Academic year**	**Semester** **Semester**
Interdisciplinarni univerzitetni študijski program Računalništvo in matematika	ni smeri	3	prvi in drugi
Interdisciplinary first cycle academic study programme Computer Science and Mathematics	none	3	first and second

Vrsta predmeta / Course type	obvezni / compulsory
Univerzitetna koda predmeta / University course code:	27216

Predavanja **Lectures**	**Seminar** **Seminar**	**Vaje** **Tutorial**	**Klinične vaje** **work**	**Druge oblike študija**	**Samost. delo** **Individ. work**	**ECTS**
60		**60**			**180**	**10**

Nosilec predmeta / Lecturer:	prof. dr. Roman Drnovšek, prof. dr. Mihael Perman

Jeziki / Languages:	**Predavanja / Lectures:**	slovenski / Slovene
	Vaje / Tutorial:	slovenski / Slovene

Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:	**Prerequisites:**
Vpis v letnik študija. Opravljena predmeta Analiza 1 in Analiza 2.	Enrolment in the programme. Completed courses Analysis 1 and Analysis 2.

Vsebina:	**Content (Syllabus outline):**

definicija verjetnosti	definition of probability
pogojna verjetnost	conditional probability
slučajne spremenljivke in vektorji	random variables and vectors
diskretne in zvezne porazdelitve	discrete and continuous distributions
matematično upanje	expectation
disperzija, kovarianca in korelacijski koeficient	variance, covariance and correlation coefficient
višji momenti in vrstilne karakteristike	higher moments and order statistics
pogojna porazdelitev in pogojno matematično upanje	conditional distribution and conditional expectation
rodovne funkcije, momentno rodovne funkcije	generating functions, moment-generating functions
zakoni velikih števil	laws of large numbers
centralni limitni izrek	central limit theorem
uvod v statistiko	introduction to statistics
vzorčne statistike in cenilke	sample statistics and estimators
intervali zaupanja	confidence intervals
testiranje statističnih hipotez	testing statistical hypotheses
linearna regresija	linear regression
prilagoditveni testi	goodness of fit tests
neparametrični testi	nonparametric tests

Temeljni literatura in viri / Readings:

Hladnik M.: Verjetnost in statistika, Založba FE in FRI, Ljubljana, 2002, ISBN: 961-6209-34-5, 140 str.

Jamnik R.: Matematična statistika, DZS Ljubljana, 1980, 408 str.

Jamnik R.: Verjetnostni račun in statistika, DMFA Slovenije, Ljubljana, 1986, 156 str.

Grimmett G. R., Stirzaker D. R.: Probability and random processes, Second edition, The Clarendon

Press, Oxford University Press, New York, 1992, 541 str.

Cilji in kompetence:	**Objectives and competences:**
Predstaviti osnove teorije verjetnosti in njeno uporabo v statistiki.	Introduction to probability theory and its applications in statistics.

Predvideni študijski rezultati:	**Intended learning outcomes:**
Razumevanje teoretičnih konceptov v številnih primerih uporabe. Zmožnost razpoznavanja verjetnostnih in statističnih vsebin v drugih vedah (fizika, ekonomija, finance, aktuarstvo, medicina, biologija, industrijska statistika).	Understanding of theoretical concepts in various applications. The ability to recognize probabilistic and statistical concepts in other sciences (physics, economics, finance, actuarial science, medicine, biology, industrial statistics).

Metode poučevanja in učenja:	**Learning and teaching methods:**
Predavanja, vaje, domače naloge.	Lectures, exercises, homeworks.

Načini ocenjevanja:	Delež (v %) / Weight (in %)	**Assessment:**
pisni izpit, teoretični test ali ustni izpit		written examination, theoretical test or oral exam

Reference nosilca / Lecturer's references:

Roman Drnovšek: DRNOVŠEK, Roman. Triangularizing semigroups of positive operators on an atomic normed Riesz

space. Proceedings of the Edinburgh Mathematical Society, ISSN 0013-0915, 2000, let. 43, št. 1, str. 43-55. [COBISS.SI-ID 9480281]

DRNOVŠEK, Roman. Common invariant subspaces for collections of operators. Integral equations and operator theory, ISSN 0378-620X, 2001, vol. 39, no. 3, str. 253-266. [COBISS.SI-ID 10597721]

DRNOVŠEK, Roman. An infinite-dimensional generalization of Zenger's lemma. Journal of mathematical analysis and applications, ISSN 0022-247X. [Print ed.], 2012, vol. 388, iss. 2, str. 1233-1238. [COBISS.SI-ID 16214617]

Mihael Perman:

PERMAN, Mihael, WELLNER, Jon A. On the distribution of Brownian areas. Annals of applied probability, ISSN 1050-5164, 1996, let. 6, št. 4, str. 1091-1111. [COBISS.SI-ID 7101017]

PERMAN, Mihael, SENEGAČNIK, Andrej, TUMA, Matija. Semi-Markov models with an application to power-plant reliability analysis. IEEE transactions on reliability, ISSN 0018-9529, 1997, vol. 46, no. 4, str. 526-532. [COBISS.SI-ID 2567707]

PERMAN, Mihael, PITMAN, Jim, YOR, Marc. Size-biased sampling of Poisson processes and excursions. Probability theory and related fields, ISSN 0178-8051, 1992, 92, no. 1, str. 21-39. [COBISS.SI-ID 12236377]

UČNI NAČRT PREDMETA / COURSE SYLLABUS (leto / year 2017/18)			
Predmet:	Uvod v geometrijsko topologijo		
Course title:	Introduction to geometric topology		

Študijski program in stopnja **Study programme and level**	**Študijska smer** **Study field**	**Letnik** **Academic year**	**Semester** **Semester**
Interdisciplinarni univerzitetni študijski program Računalništvo in matematika	ni smeri	3	drugi
Interdisciplinary first cycle academic study programme Computer Science and Mathematics	none	3	second

Vrsta predmeta / Course type	izbirni / elective
Univerzitetna koda predmeta / University course code:	27219

Predavanja **Lectures**	**Seminar** **Seminar**	**Vaje** **Tutorial**	**Klinične vaje** **work**	**Druge oblike študija**	**Samost. delo** **Individ. work**	**ECTS**
30		**30**			**90**	**5**

Nosilec predmeta / Lecturer:	prof. dr. Dušan Repovš, prof. dr. Sašo Strle

Jeziki / Languages:	**Predavanja / Lectures:**	slovenski / Slovene
	Vaje / Tutorial:	slovenski / Slovene

Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:	**Prerequisites:**
Vpis v letnik študija. Opravljen predmet Splošna topologija.	Enrolment in the programme. Completed course Point-set topology.

Vsebina:	**Content (Syllabus outline):**

Kvocientna topologija, zvezne preslikave na kvocientih, zlepki, projektivni prostori. Brouwerjev izrek o negibni točki, Jordanov izrek, Brouwerjev izrek o invarianci odprtih množic. Simplicialni kompleksi in poliedri, subdivizije, kosoma linearne preslikave, Eulerjeva karakteristika. Topološke mnogoterosti, eno in dvorazsežne mnogoterosti, klasifikacija sklenjenih ploskev.	Quotient topology, continuous maps on quotients, projective spaces. The Brouwer fixed point theorem, the Jordan theorem, the Brouwer invariance of domain theorem. Simplicial complexes and polyhedra, subdivisions, picewise linear maps, the Euler characteristic. Topological manifolds, one and two dimensional manifolds, classification of compact, boundaryless surfaces.

Temeljni literatura in viri / Readings:

J. Dugundji: Topology, Allyn and Bacon, Boston, 1978.

W. S. Massey: Algebraic Topology: An Introduction, Springer, New York-Heidelberg, 1989.

J. R. Munkres: Topology : A First Course, Prentice Hall, Englewood Cliffs, 1975.

Cilji in kompetence:	**Objectives and competences:**
Študent spozna osnovne pojme topologije evklidskih prostorov in geometrijske topologije kot so Jordanov in Brouwerjev izrek, simplicialni kompleksi in poliedri ter mnogoterosti.	Student gets familiar with basic concepts of topology of Euclidian spaces and geometric topology, such as Jordan and Brouwer theorems, simplicial complexes and polihedra and manifolds.

Predvideni študijski rezultati:	**Intended learning outcomes:**
Znanje in razumevanje: Razumevanje pojmov kvocientne topologije, osnovnih vprašanj topologije evklidskih prostorov ter odnosa med lokalno in globalno podobo geometrijskih objektov. Poznavanje osnovnih prijemov za delo z geometričnimi objekti. Uporaba: V področjih matematike, ki delajo z geometričnimi objekti (kompleksna in globalna analiza, dinamični sistemi, numerična	Knowledge and understanding: Understanding of notions such as quotient topology, basic questions of topology of Euclidian spaces and relations between local and global picture of geometric objects. Knowledge of basic concepts of geometric objects. Application: In the fields of mathematics, where geometric objects do appear (complex and global analysis, dynamic systems, numerical

matematika, mehanika, teorija grafov), v računalništvu (grafika, prepoznavanje vzorcev), v fiziki, kemiji in drugih naravoslovnih in tehničnih vedah. Refleksija: Razumevanje teorije na podlagi primerov in uporabe. Prenosljive spretnosti – niso vezane le na en predmet: Formulacija problemov v primernem jeziku, reševanje in analiza doseženega na primerih, prehajanje iz lokalnih na globalne lastnosti.	mathematics, mechanics, graph theory), in computing (graphics, pattern recognition), in physics, chemistry and other natural sciences and engineering. Reflection: Understanding of the theory from the applications. Transferable skills: Formulation of the problem in an appropriate language, the abilitiy to solve and analyze the progress on the cases, the transition from local to global properties.

Metode poučevanja in učenja:	**Learning and teaching methods:**
Predavanja, vaje, domače naloge, seminarske naloge, konzultacije	Lectures, exercises, homework, seminar work, consultations

Načini ocenjevanja:	Delež (v %) / Weight (in %)	**Assessment:**
Način (pisni izpit, ustno izpraševanje, naloge, projekt): izpit iz vaj, izpit iz teorije ocene: 1-5 (negativno), 6-10 (pozitivno) (po Statutu UL)	 50% 50%	Type (examination, oral, coursework, project): written exam oral exam grading: 1-5 (fail), 6-10 (pass) (according to the Statute of UL)

Reference nosilca / Lecturer's references:

Dušan Repovš:

KARIMOV, Umed H., REPOVŠ, Dušan. On generalized 3-manifolds which are not homologically locally connected. Topology and its Applications, ISSN 0166-8641. [Print ed.], 2013, vol. 160, iss. 3,

str. 445-449. [COBISS.SI-ID 16558681]

CÁRDENAS, Manuel, LASHERAS, Francisco F., QUINTERO, Antonio, REPOVŠ, Dušan. On manifolds with nonhomogeneous factors. Central European Journal of Mathematics, ISSN 1895-1074, 2012, vol. 10, no. 3, str. 857-862. [COBISS.SI-ID 16241753]

BANAKH, Taras, REPOVŠ, Dušan. Direct limit topologies in the categories of topological groups and of uniform spaces. Tohoku mathematical journal, ISSN 0040-8735, 2012, vol. 64, no. 1, str. 1-24. [COBISS.SI-ID 16215897]

CENCELJ, Matija, REPOVŠ, Dušan. Topologija, (Zbirka Pitagora). 1. ponatis. Ljubljana: Pedagoška fakulteta, 2011. XVI, 169 str., ilustr. ISBN 978-86-7735-051-2. [COBISS.SI-ID 254230528]

Sašo Strle:

OWENS, Brendan, STRLE, Sašo. A characterization of the Z [sup] n [oplus] Z([delta]) lattice and definite nonunimodular intersection forms. American journal of mathematics, ISSN 0002-9327, 2012, vol. 134, no. 4, str. 891-913. [COBISS.SI-ID 16408153]

GRIGSBY, J. Elisenda, RUBERMAN, Daniel, STRLE, Sašo. Knot concordance and Heegaard Floer homology invariants in branched covers. Geometry & topology, ISSN 1364-0380, 2008, vol. 12, iss. 4, str. 2249-2275. [COBISS.SI-ID 14892121]

OWENS, Brendan, STRLE, Sašo. A characterisation of the n<1>[oplus]<3> form and applications to rational homology spheres. Mathematical research letters, ISSN 1073-2780, 2006, vol. 13, iss. 2, str. 259-271. [COBISS.SI-ID 13873241]

UČNI NAČRT PREDMETA / COURSE SYLLABUS (leto / year 2017/18)			
Predmet:	Teorija kodiranja in kriptografija		
Course title:	Coding theory and cryptography		
Študijski program in stopnja **Study programme and level**	**Študijska smer** **Study field**	**Letnik** **Academic year**	**Semester** **Semester**
Interdisciplinarni univerzitetni študijski program Računalništvo in matematika	ni smeri	3	drugi
Interdisciplinary first cycle academic study programme Computer Science and Mathematics	none	3	second

Vrsta predmeta / Course type	izbirni / elective
Univerzitetna koda predmeta / University course code:	27221

Predavanja **Lectures**	**Seminar** **Seminar**	**Vaje** **Tutorial**	**Klinične vaje** **work**	**Druge oblike študija**	**Samost. delo** **Individ. work**	**ECTS**
30		**30**			**90**	**5**

Nosilec predmeta / Lecturer:	prof. dr. Marko Petkovšek, prof. dr. Primož Potočnik, doc. dr. Arjana Žitnik

Jeziki / Languages:	**Predavanja / Lectures:**	slovenski / Slovene
	Vaje / Tutorial:	slovenski / Slovene

Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:	**Prerequisites:**
Vpis v letnik študija. Opravljena predmeta Linearna algebra in Diskretne strukture 2.	Enrolment in the programme. Completed courses Linear algebra and Discrete structures 2.
Vsebina:	**Content (Syllabus outline):**

Teorija kodiranja. Informacija in entropija. Shannonova teorija. Kodi za popravljanje napak. Zgornje meje za število kodnih besed. Linearni, Hammingovi, ciklični in Reed-Mullerjevi kodi. Kriptografija. Klasična kriptografija. Sistemi z zasebnim ključem. RSA in sistemi z javnim ključem. Digitalni podpisi. Zgoščevalne funkcije. Distribucija in izmenjava ključev. Identificiranje, overjanje in delitev skrivnosti. Generiranje psevdo-naključnih števil. Dokazi z ničelno informacijo.	Coding theory. Information and entropy. Shannon's theory. Error-correcting codes. Bounds on the size of codes. Linear, Hamming, cyclic and Reed-Muller codes. Cryptography. Classical cryptography. Symmetric-key cryptosystems. RSA cryptosystem and public-key cryptography. Digital signatures. Hash functions. Key distribution and key agreement schemes. Identification, authentication, secret sharing schemes. Zero-knowledge proofs.

Temeljni literatura in viri / Readings:

D. R. Stinson: Cryptography : Theory and Practice, 3rd edition, Chapman & Hall/CRC, Boca Raton, 2005.

J. Talbot, D. Welsh: Complexity and Cryptography, Cambridge Univ. Press, Cambridge, 2006.

D. Welsh: Codes and Cryptography, Oxford Univ. Press, Oxford, 1988.

Cilji in kompetence:	**Objectives and competences:**
Študent spozna osnove teorije kodiranja in kriptografije.	Students learn the basics of coding theory and cryptography.

Predvideni študijski rezultati:	**Intended learning outcomes:**
Znanje in razumevanje: Matematični postopki, s katerimi zagotavljamo zanesljivo in varno komunikacijo. Uporaba: Kodiranje in kriptografija se uporabljata pri digitalnih komunikacijah in za zagotavljanje informacijske varnosti. Refleksija: Osnovne tehnike sodobne kriptografije temeljijo na matematičnih pojmih in postopkih, ki zagotavljajo največjo znano	Knowledge and understanding: Mathematical procedures that enable reliable and secure communication. Application: Coding theory and cryptography are used in digital communications and for providing information security. Reflection: Basic techniques of modern cryptography are based on mathematical concepts and

mero varnosti. Prenosljive spretnosti – niso vezane le na en predmet: Študent pridobi sposobnost kritičnega razmišljanja in analize komunikacijskih kanalov in računalniških sistemov s stališča informacijske varnosti.	procedures that provide the maximum level of security known. Transferable skills: The students will acquire skills of critical thinking and analysys of the communication channels and computer systems with respect to information security.

Metode poučevanja in učenja:	**Learning and teaching methods:**
Predavanja, vaje, domače naloge, konzultacije	Lectures, exercises, homework, consultations

Načini ocenjevanja:	Delež (v %) / Weight (in %)	**Assessment:**
Način (pisni izpit, ustno izpraševanje, naloge, projekt): 2 kolokvija namesto izpita iz vaj, izpit iz vaj, izpit iz teorije ocene: 1-5 (negativno), 6-10 (pozitivno) (po Statutu UL)	 50% 50%	Type (examination, oral, coursework, project): 2 midterm exams instead of written exam, written exam oral exam grading: 1-5 (fail), 6-10 (pass) (according to the Statute of UL)

Reference nosilca / Lecturer's references:

Marko Petkovšek:

PETKOVŠEK, Marko, ZAKRAJŠEK, Helena. Enumeration of I-graphs: Burnside does it again. Ars mathematica contemporanea, ISSN 1855-3966. [Tiskana izd.], 2009, vol. 2, no. 2, str. 241-262. [COBISS.SI-ID 15497049]

ABRAMOV, Sergei A., PETKOVŠEK, Marko. On the bottom summation. Programming and computer software, ISSN 0361-7688, 2008, vol. 34, no. 4, str. 187-190. [COBISS.SI-ID 15287385]

PETKOVŠEK, Marko. Symbolic computation with sequences. Programming and computer software, ISSN 0361-7688, 2006, vol. 32, no. 2, str. 65-70. [COBISS.SI-ID 15287129]

Primož Potočnik:

POTOČNIK, Primož, SPIGA, Pablo, VERRET, Gabriel. On the nullspace of arc-transitive graphs over finite fields. Journal of algebraic combinatorics, ISSN 0925-9899, 2012, vol. 36, no. 3, str. 389-401. [COBISS.SI-ID 16162137]

POTOČNIK, Primož. B-groups of order a product of two distinct primes. Mathematica slovaca, ISSN 0139-9918, 2001, vol. 51, no. 1, str. 63-67. [COBISS.SI-ID 10617433]

POTOČNIK, Primož, VERRET, Gabriel. On the vertex-stabiliser in arc-transitive digraphs. Journal of combinatorial theory. Series B, ISSN 0095-8956, 2010, vol. 100, iss. 6, str. 497-509. [COBISS.SI-ID 15680601]

Arjana Žitnik:

JURIŠIĆ, Aleksandar, TERWILLIGER, Paul, ŽITNIK, Arjana. The Q-polynomial idempotents of a distance-regular graph. Journal of combinatorial theory. Series B, ISSN 0095-8956, 2010, vol. 100, iss. 6, str. 683-690. [COBISS.SI-ID 15688537]

KAVČIČ, Urška, MUCK, Tadeja, LOZO, Branka, ŽITNIK, Arjana. Readability of multi-colored 2D codes. Technics tehnologies education management, ISSN 1840-1503, 2011, vol. 6, no. 3, str. 622-630, ilustr. [COBISS.SI-ID 2673008]

CONDER, Marston D. E., PISANSKI, Tomaž, ŽITNIK, Arjana. GI-graphs: a new class of graphs with many symmetries. Journal of algebraic combinatorics, ISSN 0925-9899, 2014, vol. 40, iss. 1, str. 209-231. [COBISS.SI-ID 16969561]

UČNI NAČRT PREDMETA / COURSE SYLLABUS (leto / year 2017/18)			
Predmet:	Teorija iger		
Course title:	Game theory		

Študijski program in stopnja **Study programme and level**	**Študijska smer** **Study field**	**Letnik** **Academic year**	**Semester** **Semester**
Interdisciplinarni univerzitetni študijski program Računalništvo in matematika	ni smeri	3	prvi
Interdisciplinary first cycle academic study programme Computer Science and Mathematics	none	3	first

Vrsta predmeta / Course type	izbirni / elective
Univerzitetna koda predmeta / University course code:	27223

Predavanja **Lectures**	**Seminar** **Seminar**	**Vaje** **Tutorial**	**Klinične vaje** **work**	**Druge oblike študija**	**Samost. delo** **Individ. work**	**ECTS**
45		**45**			**90**	**6**

Nosilec predmeta / Lecturer:	prof. dr. Sergio Cabello Justo, prof. dr. Matjaž Konvalinka

Jeziki / Languages:	**Predavanja / Lectures:**	slovenski / Slovene
	Vaje / Tutorial:	slovenski / Slovene

Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:	**Prerequisites:**
Vpis v letnik študija.	Enrolment in the programme.
Vsebina:	**Content (Syllabus outline):**

• Strateške igre z funkcijami preferenc za več igralcev. Nashevo ravnovesje. Najboljši odgovor. Dominiranost. Modeli duopola. • Strateške igre s funkcijami koristnosti za več igralcev. Mešane strategije in loterije. Mešano Nashevo ravnovesje. Princip indiferentnosti. Dominiranost. Obstoj mešanega Nashevega ravnovesja. • Bimatrične igre. Princip indiferentnosti. Iskanje Nashevega ravnovesja. Posebne bimatrične igre. Varnostni nivo. • Matrične igre. Izrek o minimaksu. Reševanje preko linearnega programiranja in dualnosti. Posebne matrične igre. • Bayesove igre. Bayes-Nashevo ravnovesje. • Ekstenzivne igre. Vgnezdeno popolno Nashevo ravnovesje. Stackelbergov model duopola. • Ekstenzivne igre z nepopolno informacijo. Strategije obnašanja. Kuhnov izrek. • Kooperativne igre. Nasheva sodniška procedura. Kooperativne igre v koalicijski obliki. Imputacije. Jedro. Shapleyjeve vrednosti. • Kombinatorne igre. Igra nim.	• Strategic games with preference functions for several players. Nash equilibrium. Best response. Domination. Models of duopoly. • Strategic games with utility functions for several players. Mixed strategies and lotteries. Mixed Nash equilibrium. Principle of indifference. Domination. Existence of mixed Nash equilibrium. • Bimatrix games. Principle of indifference. Search of Nash equilibrium. Special bimatrix games. Safety level. • Matrix games. Minimax Theorem. Solution through linear programming and duality. Special matrix games. • Bayesian games. Bayesian Nash equilibrium. • Extensive games. Subgame perfect Nash equilibrium. Stackelberg model of duopoly. • Extensive games with imperfect information. Behavioral strategy. Kuhn's theorem. • Cooperative games. Nash bargaining solution. Cooperative games in coalitional form. Imputations. Core. Shapley values • Combinatorial games. Nim.

Temeljni literatura in viri / Readings:

T.S. Ferguson: Game Theory. Elektronska knjiga dostopna na http://www.math.ucla.edu/~tom/Game_Theory/Contents.html

M. J. Osborne: An Introduction to Game Theory, Oxford University Press, 2003.

M. J. Osborne, A. Rubinstein: A Course in Game Theory, 10. natis, MIT Press, 2004.

B. von Stengel: Game Theory Basics. Lecture Notes, 2011.

Cilji in kompetence: **Objectives and competences:**

Študent spozna osnove teorije iger ter njeno uporabo pri modeliranju različnih situacij s poudarkom na primerih s področja ekonomije in financ. Teoretična razlaga je ilustrirana z mnogimi primeri.	The student gets acquainted with basic game theory and its use for modeling different situations, especially in the fields of economics and finance. The theoretic concepts are explained through several examples.

Predvideni študijski rezultati:	**Intended learning outcomes:**
Znanje in razumevanje: Slušatelj pozna osnovne probleme, s katerimi se ukvarja teorija iger, in razume pomen posameznih predpostavk pri posameznih vrstah iger. Uporaba: Modeliranje vsaj potencialno konfliktnih situacij, do katerih prihaja pri interakciji osebkov. Refleksija: Uporabe in pomanjkljivosti opisovanja in raziskovanja pojavov iz vsakdanjega življenja s pomočjo formalnih modelov. Prenosljive spretnosti – niso vezane le na en predmet: Sposobnost natančnega matematičnega opisa, zavedanje njegovih pomanjkljivosti.	Knowledge and understanding: The student knows basic problems in Game Theory and understands the meaning of the assumptions in each type of game. Application: Modeling of conflicting situations arising from the interaction of subjects. Reflection: Use and weaknesses of the description and exploration of phenomena in everyday life with the help of formal models. Transferable skills: Ability of precise mathematical description and awareness of its weaknesses.

Metode poučevanja in učenja:	**Learning and teaching methods:**
Predavanja, vaje, domače naloge, konzultacije	Lectures, exercises, homework, consultations

Načini ocenjevanja:	Delež (v %) / Weight (in %)	**Assessment:**

Način (pisni izpit, ustno izpraševanje, naloge, projekt): 2 kolokvija namesto izpita iz vaj, izpit iz vaj, izpit iz teorije ocene: 1-5 (negativno), 6-10 (pozitivno) (po Statutu UL)	 50% 50%	Type (examination, oral, coursework, project): 2 midterm exams instead of written exam, written exam exam of theory grading: 1-5 (fail), 6-10 (pass) (according to the Statute of UL)

Reference nosilca / Lecturer's references:

CABELLO, Sergio, DÍAZ-BÁÑEZ, José Miguel, LANGERMAN, Stefan, SEARA, Carlos, VENTURA, Inma. Facility location problems in the plane based on reverse nearest neighbor queries. European journal of operational research, ISSN 0377-2217. [Print ed.], 2010, vol. 202, iss. 1, str. 99-106. [COBISS.SI-ID 15160921]

CABELLO, Sergio, JAKOVAC, Marko. On the b-chromatic number of regular graphs. Discrete applied mathematics, ISSN 0166-218X. [Print ed.], 2011, vol. 159, iss. 13, str. 1303-1310. [COBISS.SI-ID 15914329]

CABELLO, Sergio, MOHAR, Bojan. Crossing and weighted crossing number of near-planar graphs. V: TOLLIS, Ioannis G. (ur.), PATRIGNANI, Maurizio (ur.). Graph drawing : 16th international symposium, GD 2008, Heraklion, Crete, Greece, September 21-24, 2008 : revised papers, (Lecture notes in computer science, ISSN 0302-9743, 5417). Berlin, Heidelberg: Springer, cop. 2009, str. 38-49. [COBISS.SI-ID 15099225]

KONVALINKA, Matjaž. Skew quantum Murnaghan-Nakayama rule. Journal of algebraic combinatorics, ISSN 0925-9899, 2012, vol. 35, no. 4, str. 519-545. [COBISS.SI-ID 16250713]

KONVALINKA, Matjaž, PAK, Igor. Geometry and complexity of O'Hara's algorithm. Advances in applied mathematics, ISSN 0196-8858, 2009, vol. 42, iss. 2, str. 157-175. [COBISS.SI-ID 15545945]

KONVALINKA, Matjaž. On quantum immanants and the cycle basis of the quantum permutation space. Annals of combinatorics, ISSN 0218-0006, 2012, vol. 16, no. 2, str. 289-304. [COBISS.SI-ID 16310873]

UČNI NAČRT PREDMETA / COURSE SYLLABUS (leto / year 2017/18)			
Predmet:	Splošna topologija		
Course title:	Point-set topology		
Študijski program in stopnja **Study programme and level**	**Študijska smer** **Study field**	**Letnik** **Academic year**	**Semester** **Semester**
Interdisciplinarni univerzitetni študijski program Računalništvo in matematika	ni smeri	3	prvi
Interdisciplinary first cycle academic study programme Computer Science and Mathematics	none	3	first

Vrsta predmeta / Course type	izbirni / elective
Univerzitetna koda predmeta / University course code:	27217

Predavanja **Lectures**	**Seminar** **Seminar**	**Vaje** **Tutorial**	**Klinične vaje** **work**	**Druge oblike študija**	**Samost. delo** **Individ. work**	**ECTS**
30		**30**			**90**	**5**

Nosilec predmeta / Lecturer:	prof. dr. Janez Mrčun, prof. dr. Petar Pavešić, prof. dr. Dušan Repovš

Jeziki / Languages:	**Predavanja / Lectures:**	slovenski / Slovene
	Vaje / Tutorial:	slovenski / Slovene

Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:	**Prerequisites:**
Vpis v letnik študija. Opravljen predmet Analiza 1.	Enrolment in the programme. Completed course Analysis 1.
Vsebina:	**Content (Syllabus outline):**

Topologija, baza, podprostori, zvezne preslikave, odprte in zaprte preslikave, homeomorfizmi, separacijske lastnosti. Kompaktni prostori in podprostori, zvezne preslikave na kompaktih, lokalna kompaktnost, Bairov izrek. Povezani prostori, povezane množice na premici, komponente, lokalna povezanost, povezanost s potmi, popolna nepovezanost, Cantorjeva množica. Urisonova lema, Tietzejev izrek, Stone-Weierstrassov izrek. Končni in neskončni topološki produkti, zvezne preslikave v produkte, multiplikativne lastnosti.	Topology, base, subspaces, continuous maps, open and closed maps, homeomorphisms, separation properties. Compact spaces and subspaces, continuous maps on compact spaces, locally compactness, the Bair theorem. Connected spaces, connected sets on line, components, locally connectedness, path connectedness, totally disconnectedness, the Cantor set. The Urysohn lemma, the Tietze theorem, the Stone-Weierstrass theorem. Finite and infinite topological products, continuous maps on products, multiplicative properties.

Temeljni literatura in viri / Readings:

J. Dugundji: Topology, Allyn and Bacon, Boston, 1978.

J. R. Munkres: Topology : A First Course, Prentice Hall, Englewood Cliffs, 1975.

N. Prijatelj: Matematične strukture III : Okolice, DZS, Ljubljana, 1985.

J. Mrčun: Topologija, zapiski predavanj, Fakulteta za matematiko in fiziko, Ljubljana, 2003.

Cilji in kompetence:	**Objectives and competences:**
Študent spozna osnove splošne topologije, kot so povezanost, kompaktnost, separacijske lastnosti, topologija na produktih in funkcijskih prostorih.	Student gets familiar with basic concepts point-set topology, such as connectedness, compactness, separation properties, topology on products and function spaces.

Predvideni študijski rezultati:	**Intended learning outcomes:**
Znanje in razumevanje: Razumevanje pojmov topologije, zvezne preslikave, povezanosti in kompaktnosti. Poznavanje osnovnih prijemov za delo s temi pojmi in povezav z drugimi področji matematike.	Knowledge and understanding: Understanding of notions such as topology, continuous map, connectedness and compactnes. Knowledge of basic concepts of the above notions and connection with other areas of mathematics.

Uporaba: Splošna topologija sodi med temeljne matematične predmete. Študent spozna osnovne pojme in tehnike dela, na katerih sloni vrsta drugih matematičnih predmetov. Refleksija: Razumevanje teorije na podlagi primerov in uporabe. Prenosljive spretnosti – niso vezane le na en predmet: Formulacija problemov v primernem jeziku, reševanje in analiza doseženega na primerih.	Application: Point-set topology is one of the basic mathematical courses. Student gets familiar with basic definitions and techniques that are fondations for several other mathematical courses. Reflection: Understanding of the theory from the applications. Transferable skills: The ability to formualate a problem in suitable language, find a solution of the problems and analyse the method on real examples.

Metode poučevanja in učenja:	**Learning and teaching methods:**
Predavanja, vaje, domače naloge, konzultacije	Lectures, exercises, homework, consultations

Načini ocenjevanja:	Delež (v %) / Weight (in %)	**Assessment:**
Način (pisni izpit, ustno izpraševanje, naloge, projekt): izpit iz vaj, izpit iz teorije ocene: 1-5 (negativno), 6-10 (pozitivno) (po Statutu UL)	 50% 50%	Type (examination, oral, coursework, project): written exam oral exam grading: 1-5 (fail), 6-10 (pass) (according to the Statute of UL)

Reference nosilca / Lecturer's references:

Janez Mrčun:

KALIŠNIK, Jure, MRČUN, Janez. A Cartier-Gabriel-Kostant structure theorem for Hopf algebroids. Advances in mathematics, ISSN 0001-8708, 2013, vol. 232, iss. 1, str. 295-310. [COBISS.SI-ID

16432473]

KALIŠNIK, Jure, MRČUN, Janez. Equivalence between the Morita categories of étale Lie groupoids and locally grouplike Hopf algebroids. Indagationes mathematicae, ISSN 0019-3577, 2008, vol. 19, no. 1, str. 73-96. [COBISS.SI-ID 14978393]

MRČUN, Janez. Topologija, (Izbrana poglavja iz matematike in računalništva, 44). Ljubljana: DMFA - založništvo, 2008. VI, 147 str., ilustr. ISBN 978-961-212-207-2. [COBISS.SI-ID 243021824]

MOERDIJK, Ieke, MRČUN, Janez. Introduction to foliations and Lie groupoids, (Cambridge studies in advanced mathematics, 91). Cambridge, UK: Cambridge University Press, 2003. IX, 173 str., ilustr. ISBN 0-521-83197-0. [COBISS.SI-ID 12683097]

Petar Pavešić:

PAVEŠIĆ, Petar. A note on trivial fibrations. Glasnik matematički. Serija 3, ISSN 0017-095X, 2011, vol. 46, no. 2, str. 513-519. [COBISS.SI-ID 16078681]

PAVEŠIĆ, Petar. Decompositions of groups of invertible elements in a ring. Proceedings. Section A, Mathematics, ISSN 0308-2105, 2009, vol. 139, iss 6, str. 1275-1287. [COBISS.SI-ID 15505497]

PAVEŠIĆ, Petar. Splošna topologija, (Izbrana poglavja iz matematike in računalništva, 43). Ljubljana: DMFA - založništvo, 2008. VI, 89 str., ilustr. ISBN 978-961-212-205-8. [COBISS.SI-ID 240425984]

PAVEŠIĆ, Petar. Rešene naloge iz topologije, (Izbrana poglavja iz matematike in računalništva, 32). Ljubljana: Društvo matematikov, fizikov in astronomov Slovenije, 1995. 132 str. ISBN 961-212-042-0. [COBISS.SI-ID 47811328]

Dušan Repovš:

KARIMOV, Umed H., REPOVŠ, Dušan. On generalized 3-manifolds which are not homologically locally connected. Topology and its Applications, ISSN 0166-8641. [Print ed.], 2013, vol. 160, iss. 3, str. 445-449. [COBISS.SI-ID 16558681]

CÁRDENAS, Manuel, LASHERAS, Francisco F., QUINTERO, Antonio, REPOVŠ, Dušan. On manifolds with nonhomogeneous factors. Central European Journal of Mathematics, ISSN 1895-1074, 2012, vol. 10, no. 3, str. 857-862. [COBISS.SI-ID 16241753]

BANAKH, Taras, REPOVŠ, Dušan. Direct limit topologies in the categories of topological groups and of uniform spaces. Tohoku mathematical journal, ISSN 0040-8735, 2012, vol. 64, no. 1, str. 1-24. [COBISS.SI-ID 16215897]

CENCELJ, Matija, REPOVŠ, Dušan. Topologija, (Zbirka Pitagora). 1. ponatis. Ljubljana: Pedagoška fakulteta, 2011. XVI, 169 str., ilustr. ISBN 978-86-7735-051-2. [COBISS.SI-ID 254230528]

UČNI NAČRT PREDMETA / COURSE SYLLABUS (leto / year 2017/18)			
Predmet:	Numerične metode 2		
Course title:	Numerical methods 2		

Študijski program in stopnja **Study programme and level**	**Študijska smer** **Study field**	**Letnik** **Academic year**	**Semester** **Semester**
Interdisciplinarni univerzitetni študijski program Računalništvo in matematika	ni smeri	3	drugi
Interdisciplinary first cycle academic study programme Computer Science and Mathematics	none	3	second

Vrsta predmeta / Course type	izbirni / elective
Univerzitetna koda predmeta / University course code:	27225

Predavanja **Lectures**	**Seminar** **Seminar**	**Vaje** **Tutorial**	**Klinične vaje** **work**	**Druge oblike študija**	**Samost. delo** **Individ. work**	**ECTS**
30		**30**			**90**	**5**

Nosilec predmeta / Lecturer:	prof. dr. Marjeta Krajnc, prof. dr. Bor Plestenjak

Jeziki / Languages:	**Predavanja / Lectures:**	slovenski / Slovene
	Vaje / Tutorial:	slovenski / Slovene

Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:	**Prerequisites:**
Vpis v letnik študija. Opravljena predmeta Analiza 1 in Algebra 1.	Enrolment in the programme. Completed courses Analysis 1 and Algebra 1.

Vsebina:	**Content (Syllabus outline):**

Nesimetrični problem lastnih vrednosti. Schurova forma. Potenčna metoda. Inverzna potenčna metoda. QR-iteracija. Simetrični problem lastnih vrednosti. Občutljivost. Tridiagonalna QR-iteracija. Rayleighev kvocient. Jacobijeva metoda. Posplošeni problemi lastnih vrednosti. Računanje singularnega razcepa. QR-iteracija za bidiagonalno matriko. Jacobijeva metoda. Aproksimacija podatkov. Metoda najmanjših kvadratov. Aproksimacija periodičnih podatkov. Konstrukcija empiričnih formul. Interpolacija s polinomi. Lagrangeeva oblika interpolacijskega polinoma. Linearna interpolacija. Zaporedne linearne interpolacije. Deljene diference. Newtonova oblika interpolacijskega polinoma. Numerično odvajanje. Numerično integriranje. Newton-Cotesova pravila. Sestavljena pravila. Rombergova ekstrapolacija. Gaussova kvadraturna pravila. Numerično reševanje navadnih diferencialnih enačb. Metode za reševanje enačb prvega reda. Enokoračne metode. Metode tipa Runge-Kutta.Večkoračne metode. Robni problemi.	Nonsymmetric eigenvalue problem. Schur form. Power iteration. Inverse iteration. QR iteration. Symmetric eigenvalue problem. Condition numbers. Tridiagonal QR iteration. Rayleigh quotient. Jacobi method. Genearlized eigenvalue problem. Singular value decomposition computation. QR iteration for bidiagonal matrices. Jacobi method. Data approximation. Least squares problems. Approximation of periodic data. Construction of empirical formulas. Polynomial interpolation. Lagrange interpolation. Linear interpolation. Successive linear interpolation. Divided differences. Newton interpolation. Numerical differentiation. Numerical integration. Newton-Cotes rules. Composite rules. Romberg extrapolation. Gaussian quadrature. Numerical methods for ordinary differential equations. Methods for initial value problems. One-step methods. Runge-Kutta methods. Multi-step methods. Boundary problems.

Temeljni literatura in viri / Readings:

J. W. Demmel: Uporabna numerična linearna algebra, DMFA-založništvo, Ljubljana, 2000.

B. N. Datta: Numerical Linear Algebra and Applications, Brooks/Cole, Pacific Grove, 1995.

Z. Bohte: Numerične metode, DMFA-založništvo, Ljubljana, 1991.

L. N. Trefethen, D. Bau: Numerical Linear Algebra, SIAM, Philadelphia, 1997.

D. R. Kincaid, E. W. Cheney: Numerical Analysis : Mathematics of Scientific Computing, 3rd edition, Brooks/Cole, Pacific Grove, 2002.

R. L. Burden, J. D. Faires: Numerical Analysis, 8th edition, Brooks/Cole, Pacific Grove, 2005.

E. Zakrajšek: Uvod v numerične metode, DMFA-založništvo, Ljubljana, 2000.

Cilji in kompetence:

Študent spozna osnovne metode za reševanje problemov lastnih vrednosti in osnovne metode v numerični aproksimaciji in interpolaciji, numeričnem integriranju ter numeričnem reševanju navadnih diferencialnih enačb. Pri vajah in z domačimi nalogami pridobljeno znanje praktično utrdi.

Objectives and competences:

Students learn basic numerical methods for eigenvalue computation, polynomial approximation and interpolation, numerical quadrature, and methods for the ordinary differential equations. The acquired knowledge is consolidated by exercises and homework assignements.

Predvideni študijski rezultati:

Znanje in razumevanje: Obvladanje osnovnih numeričnih algoritmov za računanje lastnih vrednosti, interpolacijo, integriranje, in reševanje diferencialnih enačb. Znanje programiranja in uporabe programskega paketa Matlab oziroma drugih sorodnih orodij za reševanje tovrstnih problemov.

Uporaba: Ekonomično in natančno numerično reševanje različnih matematičnih problemov. Poleg matematike se uporablja še v številnih preostalih področjihm, vsakič ko je mogoče problem opisati z matematičnim modelom in se išče rezultat v numerični obliki. Številnih problemov se ne da rešiti analitično, temveč le numerično, v nekaterih primerih pa je numerično reševanje mnogo bolj ekonomično od analitičnega.

Refleksija: Razumevanje teorije na podlagi primerov in uporabe.

Prenosljive spretnosti – niso vezane le na en predmet: Izbira primerne metode, reševanje

Intended learning outcomes:

Knowledge and understanding: Understanding of basic numerical methods for eigenvalue computation, interpolation, quadrature, and methods for the ordinary differential equations. Knowledge of computer programming and Matlab or other similar software for solving such problems.

Application: Economical and accurate numerical solution of various mathematical problems. In addition to mathematics, numerical methods are used in many other fields when the problem can be described by a mathematical model and a result in a numerical form is required. Many problems can not be solved analytically but only numerically. Also, in some cases, the numerical solution is much more economical than the analytical one.

Reflection: Understanding of the theory from the applications.

Transferable skills: The ability to select an appropriate method, solve a problem, and

problema, analiza doseženega rezultata na primerih. Spretnost uporabe računalnika pri reševanju matematičnih problemov. Razumevanje razlik med eksaktnim in numeričnim računanjem. Predmet konstruktivno nadgrajuje znanja algebre in analize.	analize the obtained results. The ability to solve mathematical problems using a computer. Understanding the differences between the exact and the numerical computation. The subject enriches constructively the knowledge of algebra and analysis.

Metode poučevanja in učenja:	**Learning and teaching methods:**
Predavanja, laboratorijske vaje, domače naloge, konzultacije	Lectures, lab exercises, homework, consultations

Načini ocenjevanja:	Delež (v %) / Weight (in %)	**Assessment:**
Način (pisni izpit, ustno izpraševanje, naloge, projekt):		Type (examination, oral, coursework, project):
Sprotno preverjanje (domače naloge, kolokviji in projektno delo)		Continuing (homework, midterm exams, project work)Final (written and oral exam)
Končno preverjanje (pisni in ustni izpit)	50%	
Ocene: 6-10 pozitivno, 1-5 negativno	50%	Grading: 6-10 pass, 1-5 fail (according to the Statute of UL)
(v skladu s Statutom UL)		

Reference nosilca / Lecturer's references:

Marjetka Krajnc:

KRAJNC, Marjetka. Interpolation scheme for planar cubic G [sup] 2 spline curves. Acta applicandae mathematicae, ISSN 0167-8019, 2011, vol. 113, no. 2, str. 129-143. [COBISS.SI-ID 16215385]

KRAJNC, Marjetka, VITRIH, Vito. Motion design with Euler-Rodrigues frames of quintic Pythagorean-hodograph curves. Mathematics and computers in simulation, ISSN 0378-4754. [Print ed.], 2012, vol. 82, iss. 9, str. 1696-1711. [COBISS.SI-ID 1024447572]

KOZAK, Jernej, KRAJNC, Marjetka. Geometric interpolation by planar cubic polynomial curves.

Computer Aided Geometric Design, ISSN 0167-8396, 2007, vol. 24, no. 2, str. 67-78. [COBISS.SI-ID 14227545]

Bor Plestenjak:

GHEORGHIU, C. I., HOCHSTENBACH, Michiel E., PLESTENJAK, Bor, ROMMES, Joost. Spectral collocation solutions to multiparameter Mathieu's system. Applied mathematics and computation, ISSN 0096-3003. [Print ed.], 2012, vol. 218, iss. 24, str. 11990-12000. [COBISS.SI-ID 16484185]

MUHIČ, Andrej, PLESTENJAK, Bor. On the quadratic two-parameter eigenvalue problem and its linearization. Linear Algebra and its Applications, ISSN 0024-3795. [Print ed.], 2010, vol. 432, iss. 10, str. 2529-2542. [COBISS.SI-ID 15469913]

PLESTENJAK, Bor. Numerical methods for the tridiagonal hyperbolic quadratic eigenvalue problem. V: Fifth international workshop on accurate solution in eigenvalue problems : hagen, Germany from June 29 to July 1, 2004. Philadelphia: SIAM, 2006, vol. 28, no. 4, str. 1157-1172. [COBISS.SI-ID 14367833]

UČNI NAČRT PREDMETA / COURSE SYLLABUS (leto / year 2017/18)			
Predmet:	Numerične metode		
Course title:	Numerical methods		
Študijski program in stopnja **Study programme and level**	**Študijska smer** **Study field**	**Letnik** **Academic year**	**Semester** **Semester**
Interdisciplinarni univerzitetni študijski program Računalništvo in matematika	ni smeri	3	prvi
Interdisciplinary first cycle academic study programme Computer Science and Mathematics	none	3	first

Vrsta predmeta / Course type	obvezni / compulsory
Univerzitetna koda predmeta / University course code:	27215

Predavanja **Lectures**	**Seminar** **Seminar**	**Vaje** **Tutorial**	**Klinične vaje** **work**	**Druge oblike študija**	**Samost. delo** **Individ. work**	**ECTS**
45		**45**			**120**	**7**

Nosilec predmeta / Lecturer:	prof. dr. Marjeta Krajnc, prof. dr. Bor Plestenjak, prof. dr. Emil Žagar

Jeziki / Languages:	**Predavanja / Lectures:**	slovenski / Slovene
	Vaje / Tutorial:	slovenski / Slovene

Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:	**Prerequisites:**
Vpis v letnik študija.	Enrolment in the programme.
Vsebina:	**Content (Syllabus outline):**

Uvod v numerično računanje. Izvori napak pri numeričnem računanju. Občutljivost problemov, konvergenca metod in stabilnost računskih procesov. Ocena za celotno napako. Reševanje nelinearnih enačb. Bisekcija. Splošna iteracija. Tangentna in sekantna metoda. Reševanje algebraičnih enačb. Reševanje sistemov nelinearnih enačb. Splošna iteracija. Newtonova metoda. Reševanje sistemov linearnih enačb. Vektorske in matrične norme. Občutljivost. Ocena za napako. Gaussova eliminacijska metoda. Pivotiranje. Posebni linearni sistemi. Linearni problem najmanjših kvadratov. Predoločeni sistemi. Normalni sistem. Ortogonalni razcep. Givensove rotacije in Householderjeve transformacije. Singularni razcep. Pseudoinverz. Uporaba singularnega razcepa. Regularizacija. Nelinearni problem najmanjših kvadratov. Iterativne metode za linearne sisteme. Jacobijeva, Gauss-Seidlova in SOR iteracija.	Introduction to numerical computations. Sources of errors in numerical computing. Stability of problems, convergence of methods and stability of computational processes. Error bounds. Solving of nonlinear systems. Bisection. Iteration. Tangent and secant method. Solving of algebraic equations. Solving systems of nonlinear equations. Iteration. Newton method. Solving of systems of linear equations. Vector and matrix norms. Stability. Error bounds. Gauss elimination. Pivoting. Special linear systems. Linear least squares problem. Predetermined systems. Normal equations. QR decomposition. Givens rotations and Householder reflections. Singular value decomposition. Pseudoinverse. SVD applications. Regularization. Nonlinear least square problem. Iterative methods for systems of linear equations. Jacobi, Gauss-Seidel, and SOR iteration.

Temeljni literatura in viri / Readings:

B. Plestenjak: Razširjen uvod v numerične metode, DMFA – založništvo, Ljubljana, 2015

M. T. Heath, Scientific Computing: An Introductory Survey, McGraw-Hill, Boston, 2002.

J. W. Demmel: Uporabna numerična linearna algebra, DMFA-založništvo, Ljubljana, 2000.

D. Kincaid, W. Cheney, Numerical Analysis, Brooks/Cole, Pacific Grove, 1996.

B. N. Datta: Numerical Linear Algebra and Applications, Brooks/Cole, Pacific Grove, 1995.

Cilji in kompetence:	**Objectives and competences:**

Študent spozna osnove numeričnega računanja in dopolni poznavanje analitičnih metod za reševanje nelinearnih enačb in sistemov linearnih enačb z nekaterimi najbolj znanimi numeričnimi metodami. Pri vajah in z domačimi nalogami se pridobljeno znanje praktično utrdi kot tudi spozna programsko opremo, namenjeno predvsem numeričnem računanju.	Student learns basic facts on numerical computation and analytical methods for solving nonlinear equations and systems of linear equations with some of well known numerical methods. In tutorial and homework the gained knowledge is increased and computer software, used by numerical computations, is applied.

Predvideni študijski rezultati:	**Intended learning outcomes:**
Znanje in razumevanje: Razumevanje računanja s plavajočo vejico in izvorov napak pri numeričnem računanju. Obvadanje osnovnih algoritmov za reševanje linearnih in nelinearnih sistemov. Znanje programiranja in uporabe Matlaba oz. drugih sorodnih orodij za reševanje tovrstnih problemov.	Knowledge and understanding: Understanding of computation in floating point arithmetics and causes of errors in numerical computations. Knowledge of basic algorithms for solving systems of linear equations and systems of nonlinear equations. Programming and use of Matlab and other similar tools for solving these kinds of problems.

Metode poučevanja in učenja:	**Learning and teaching methods:**
Predavanja, vaje, domače naloge, konzultacije.	Lectures, tutorial, homework, consultations.

Načini ocenjevanja:	Delež (v %) / Weight (in %)	**Assessment:**
Način (pisni izpit, ustno izpraševanje, naloge, projekt) pisni in ustni izpit, 2 domači nalogi ocene: 1-5 (negativno), 6-10 (pozitivno) (po Statutu UL)	30/50/20	Type (examination, oral, coursework, project): written and oral exam, 2 homeworks grades: 1-5 (negative), 6-10 (positive) (by The statues of UL)

Reference nosilca / Lecturer's references:

Marjetka Krajnc:

KRAJNC, Marjetka. Interpolation scheme for planar cubic G [sup] 2 spline curves. Acta applicandae mathematicae, ISSN 0167-8019, 2011, vol. 113, no. 2, str. 129-143. [COBISS.SI-ID 16215385]

KRAJNC, Marjetka, VITRIH, Vito. Motion design with Euler-Rodrigues frames of quintic Pythagorean-hodograph curves. Mathematics and computers in simulation, ISSN 0378-4754. [Print ed.], 2012, vol. 82, iss. 9, str. 1696-1711. [COBISS.SI-ID 1024447572]

KOZAK, Jernej, KRAJNC, Marjetka. Geometric interpolation by planar cubic polynomial curves. Computer Aided Geometric Design, ISSN 0167-8396, 2007, vol. 24, no. 2, str. 67-78. [COBISS.SI-ID 14227545]

Bor Plestenjak:

MEERBERGEN, Karl, PLESTENJAK, Bor. An Sylvester-Arnoldi type method for the generalized eigenvalue problem with two-by-two operator determinants. Numerical linear algebra with applications, ISSN 1070-5325, 2015, vol. 22, iss. 6, str. 1131-1146. [COBISS.SI-ID 17494105]

PLESTENJAK, Bor, GHEORGHIU, C. I., HOCHSTENBACH, Michiel E. Spectral collocation for multiparameter eigenvalue problems arising from separable boundary value problems. Journal of computational physics, ISSN 0021-9991, 2015, vol. 298, str. 585-601. [COBISS.SI-ID 17347417]

MUHIČ, Andrej, PLESTENJAK, Bor. On the quadratic two-parameter eigenvalue problem and its linearization. Linear Algebra and its Applications, ISSN 0024-3795. [Print ed.], 2010, vol. 432, iss. 10, str. 2529-2542. [COBISS.SI-ID 15469913]

Emil Žagar:

KOVAČ, Boštjan, ŽAGAR, Emil. Some new G[sup]1 quartic parametric approximants of circular arcs. Applied mathematics and computation, ISSN 0096-3003. [Print ed.], 2014, vol. 239, str. 254-264. [COBISS.SI-ID 17031769]

JAKLIČ, Gašper, KOZAK, Jernej, KRAJNC, Marjetka, VITRIH, Vito, ŽAGAR, Emil. An approach to geometric interpolation by Pythagorean-hodograph curves. Advances in computational mathematics, ISSN 1019-7168, 2012, vol. 37, no. 1, str. 123-150. [COBISS.SI-ID 16051289]

JAKLIČ, Gašper, KOZAK, Jernej, KRAJNC, Marjetka, VITRIH, Vito, ŽAGAR, Emil. Hermite geometric interpolation by rational Bézier spatial curves. SIAM journal on numerical analysis, ISSN 0036-1429, 2012, vol. 50, no. 5, str. 2695-2715. [COBISS.SI-ID 16449369]

UČNI NAČRT PREDMETA / COURSE SYLLABUS (leto / year 2017/18)			
Predmet:	Matematično modeliranje		
Course title:	Mathematical modelling		

Študijski program in stopnja **Study programme and level**	**Študijska smer** **Study field**	**Letnik** **Academic year**	**Semester** **Semester**
Interdisciplinarni univerzitetni študijski program Računalništvo in matematika	ni smeri	3	drugi
Interdisciplinary first cycle academic study programme Computer Science and Mathematics	none	3	second

Vrsta predmeta / Course type	izbirni / elective
Univerzitetna koda predmeta / University course code:	27224

Predavanja **Lectures**	**Seminar** **Seminar**	**Vaje** **Tutorial**	**Klinične vaje** **work**	**Druge oblike študija**	**Samost. delo** **Individ. work**	**ECTS**
30		**30**			**90**	**5**

Nosilec predmeta / Lecturer:	doc. dr. George Mejak, prof. dr. Emil Žagar

Jeziki / Languages:	**Predavanja / Lectures:**	slovenski / Slovene
	Vaje / Tutorial:	slovenski / Slovene

Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:	**Prerequisites:**
Vpis v letnik študija.	Enrolment in the programme.
Vsebina:	**Content (Syllabus outline):**

Reševanje problemov s programskim paketom Matlab: osnove programskega paketa Matlab, delo z matrikami in polji, grafika, pisanje programskih in funkcijskih datotek, pregled osnovnih Matlabovih knjižnic (reševanje linearnih in nelinearnih sistemov enačb, optimizacija, numerično integriranje in reševanje diferencialnih enačb, delo z razpršenimi matrikami), uporaba programskega paketa Matlab pri reševanju preprostih problemov. Optimizacija: reševanje problemov, vezanih na iskanje ekstremov funkcij (diskretna verižnica, simetrična diskretna verižnica, simetrična verižnica s sodo in liho mnogo členki, nihanje paličja). Variacijski račun: problem brahistohrone, zvezna verižnica, minimalna rotacijska ploskev. Statistika: test χ2 (hi-kvadrat), statistične simulacije, simulacije iger.	Problem solving using Matlab package: introduction into Matlab package, manipulation of matrices and arrays, graphics, writing scripts and functions, overview of basic Matlab toolboxes (numerical solution of sytems of linear and nonlinear equations, optimization, numerical integration and numerical solution of ordinary differential equations, sparse matrices), Matlab as a tool for solving some simple problems. Optimization: solving problems based on constrained optimization (discrete catenary, symmetric discrete catenary, symmetric discrete catenary having an odd or even number of segments, truss oscillation). Calculus of variations: brachistochrone problem, catenary, minimal rotational surface. Statistics: χ2 test (chi square test), statistical simulations, simulation of games.

Temeljni literatura in viri / Readings:

E. Zakrajšek: Matematično modeliranje, DMFA-založništvo, Ljubljana, 2004.

D. J. Higham, N. J. Higham: Matlab Guide, 2nd edition, SIAM, Philadelphia, 2005.

B. Jurčič Zlobec, A. Berkopec: Matlab z uvodom v numerične metode, Založba FE in FRI, Ljubljana, 2005.

V. M. Tikhomirov: Stories About Maxima and Minima, AMS, Providence, 1991.

D. E. Knuth: The Art of Computer Programming II : Seminumerical Algorithms, Addison-Wesley, Reading, 1981.

Cilji in kompetence:	**Objectives and competences:**
Slušatelj spozna osnovne pristope za reševanje problemov matematičnega modeliranja, nauči se uporabljati Matlab kot orodje in kritično presojati dobljene rezultate. Podrobneje spozna nekaj problemov, ki temeljijo na iskanju ekstremov gladkih funkcij, problemov iz	A student is faced with bacis concepts of problem solving, particularly those arising from mathematical modelling. She or he is able to use matlab as a tool and learns how to evaluate obtained results. Some deeper skills are

variacijskega računa, statistike in simulacij.	obtained in solving problems based on finding extrema, calculus or variations and statistical simulations.

Predvideni študijski rezultati:	**Intended learning outcomes:**
Znanje in razumevanje: Poznavanje osnov programiranja v programskem paketu Matlab. Sposobnost reševanja nekaterih preprostih problemov matematičnega modeliranja s pomočjo Matlaba. Poznavanje teoretičnih osnov za praktično iskanje ekstremov gladkih funkcij, reševanje nalog variacijskega računa ter izvajanje statističnih testov in simulacij. Uporaba: Uporaba programskega paketa Matlab kot orodja za reševanje preprostejših problemov, ki slonijo na matematičnih modelih. Refleksija: Razumevanje teorije na podlagi izkušenj praktičnega dela (programiranja). Prenosljive spretnosti – niso vezane le na en predmet: Spretnost uporabe računalnika, posebej paketa Matlab. Poznavanje osnovnih pristopov za reševanje matematičnih problemov in kritično presojanje rezultatov. Predmet nadgrajuje znanja iz mnogih predmetov študija matematike (analiza, algebra, programiranje ...)	Knowledge and understanding: Basic programming in Matlab. Capability of solving some simple problems of mathematical modelling using Matlab. Understandig of theoretical fundamentals to solve problems involving scalar field extrema, capability of solving problems in calculus of variations and skills in implementation of statistical simulations. Application: Using Matlab package as a tool for solving some simple problems arising from mathematical models. Reflection: Understanding theory through practical experiments (computer programme coding). Transferable skills: Capability of using computer software, particularly Matlab package. Understanding of basic approaches for solving mathematical problems and evaluation of results. The subject upgrades the knowledge obtained from several other subjects of mathematical studies (analysis, algebra, programming,…)

Metode poučevanja in učenja:	**Learning and teaching methods:**

predavanja, vaje, domače naloge, laboratorijsko delo, konzultacije, samostojna izdelava projekta	Lectures, exercises, homework, laboratory work, consultations, individual projects

Načini ocenjevanja:	Delež (v %) / Weight (in %)	**Assessment:**
Način (pisni izpit, ustno izpraševanje, naloge, projekt): 2 domači nalogi in projekt namesto izpita iz vaj, izpit iz vaj, izpit iz teorije ocene: 1-5 (negativno), 6-10 (pozitivno) (po Statutu UL)	 50% 50%	Type (examination, oral, coursework, project): 2 homeworks and a project instead of written exam, written exam oral exam grading: 1-5 (fail), 6-10 (pass) (according to the Statute of UL)

Reference nosilca / Lecturer's references:

George Mejak:

MEJAK, George. Eshebly tensors for a finite spherical domain with an axisymmetric inclusion. European journal of mechanics. A, Solids, ISSN 0997-7538. [Print ed.], 2011, vol. 30, iss. 4, str. 477-490. [COBISS.SI-ID 16025177]

MEJAK, George. Two scale finite element method. V: 21st International congress of theoretical and applied mechanics, August 15-21, 2004, Warsaw, Poland. ICTAM04 : abstracts and CD-ROM proceedings. Warszawa: IPPT PAN, 2004, str. 209. [COBISS.SI-ID 13216857]

MEJAK, George. Finite element solution of a model free surface problem by the optimal shape design approach. International journal for numerical methods in engineering, ISSN 0029-5981. [Print ed.], 1997, vol. 40, str. 1525-1550. [COBISS.SI-ID 9983833]

Emil Žagar:

JAKLIČ, Gašper, KOZAK, Jernej, KRAJNC, Marjetka, VITRIH, Vito, ŽAGAR, Emil. An approach to geometric interpolation by Pythagorean-hodograph curves. Advances in computational mathematics, ISSN 1019-7168, 2012, vol. 37, no. 1, str. 123-150. [COBISS.SI-ID 16051289]

JAKLIČ, Gašper, ŽAGAR, Emil. Curvature variation minimizing cubic Hermite interpolants. Applied mathematics and computation, ISSN 0096-3003. [Print ed.], 2011, vol. 218, iss. 7, str. 3918-3924.

[COBISS.SI-ID 16049241]

JAKLIČ, Gašper, KOZAK, Jernej, KRAJNC, Marjetka, VITRIH, Vito, ŽAGAR, Emil. Hermite geometric interpolation by rational Bézier spatial curves. SIAM journal on numerical analysis, ISSN 0036-1429, 2012, vol. 50, no. 5, str. 2695-2715. [COBISS.SI-ID 16449369]

UČNI NAČRT PREDMETA / COURSE SYLLABUS (leto / year 2017/18)			
Predmet:	Finančna matematika 1		
Course title:	Financial mathematics 1		

Študijski program in stopnja **Study programme and level**	**Študijska smer** **Study field**	**Letnik** **Academic year**	**Semester** **Semester**
Interdisciplinarni univerzitetni študijski program Računalništvo in matematika	ni smeri	3	drugi
Interdisciplinary first cycle academic study programme Computer Science and Mathematics	none	3	second

Vrsta predmeta / Course type	izbirni / elective
Univerzitetna koda predmeta / University course code:	27222

Predavanja **Lectures**	**Seminar** **Seminar**	**Vaje** **Tutorial**	**Klinične vaje** **work**	**Druge oblike študija**	**Samost. delo** **Individ. work**	**ECTS**
30		**30**			**90**	**5**

Nosilec predmeta / Lecturer:	prof. dr. Janez Bernik, prof. dr. Tomaž Košir, prof. dr. Mihael Perman

Jeziki / Languages:	**Predavanja / Lectures:**	slovenski / Slovene
	Vaje / Tutorial:	slovenski / Slovene

Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:	**Prerequisites:**
Vpis v letnik študija.	Enrolment in the programme.
Vsebina:	**Content (Syllabus outline):**

Obrestni račun, vrednotenje denarnih tokov, časovna struktura obrestnih mer. Obveznice. Izvedeni finančni instrumenti. Modeli trgov: opis tipov vrednostnih papirjev, diskretni modeli gibanja cen, osnovna izreka vrednotenja. Vrednotenje opcij: definicije opcij, evropske opcije, ameriške opcije, eksotične opcije. Vrednotenje evropskih opcij: Binomski model. Black-Scholesova formula. Optimalne naložbe: pojem strategije, statistični primer, dinamični primer. Ameriške opcije: pogojne terjatve ameriškega tipa, časi ustavljanja, Snellova ovojnica, kupčeva cena, prodajalčeva cena. Stohastične obrestne mere: diskretni modeli, opcije na obrestne mere.	Interest rates, time value of money, term structure. Bonds, financial derivatives. Market model: finite sets of assets, discrete time, The Fundamental Asset Pricing Theorems. Option pricing: definitions, European options, American options, exotic options. Pricing of European options: Binomial model, Black-Scholes Formula. Optimal investement: strategies, static model, dynamic model. American options: American contingent claims, stopping times, Snell enveloppe, buyer's price, seller's price. Stochastic models of interest rates: discrete models, term rate options.

Temeljni literatura in viri / Readings:

P. Koch Medina, S. Merino. Mathematical finance and probability: a discrete introduction. Birkhäuser, 2003.

J. Hull. Options, futures and other derivatives. Prentice Hall. 8. izdaja, 2011.

S. E. Shreve. Stochastic calculus for finance 1: The binomial asset pricing model. Springer, 2005.

S. M. Ross, An elementary introduction to mathematical finance : options and other topics. 2. izdaja, Cambridge University Press, 2003.

D.G. Luenberger. Investment science. Oxford University Press, 2. izdaja, 2013.

Z. Bodie, A. Kane, A. Marcus. Investments. 9. izdaja, McGraw-Hill Irwin, Boston, ZDA, 2011.

B. Steiner. Mastering financial calculations: A step-by-step guide to the mathematics of financial market instruments. 2. izdaja, Financial Times Prentice Hall, 2007.

M. Capiński, T. Zastawniak: Mathematics for Finance : An Introduction to Financial Engineering, Springer, London, 2005.

J. Y. Campbell, L. M. Viceira: Strategic Asset Allocation : Portfolio Choice for Long-Term Investors, Oxford Univ. Press, Oxford, 2002.

Cilji in kompetence:

Celotni finančni matematiki je skupnih nekaj osnovnih principov. Namen predmeta je predstaviti te principe na diskretnih modelih, kjer je najlaže predstaviti intuitivne ideje. V prvem delu obravnavamo vprašanje naložb. To nas navede na vprašanje modelov trga, optimalne izbire naložb, osnovnega izreka vrednotenja opcij in mer tveganja. Osrednji del je namenjen binomskemu modelu in Black-Scholesovi formuli ter časom ustavljanja in vrednotenju pogojnih terjatev ameriškega tipa. Pomemben element finančne matematike so tudi stohastični modeli obrestnih mer.

Objectives and competences:

There are some fundamental principles underlying the modern financial methematics. The aim of the course is to present these principles (the law of one price, the no arbitrage condition) in the simplest discrete models. Optimal investment theory leads to market models, the fundamental asset pricing theorem and to option pricing theory. The main topics include binomial model and the Black-Scholes Formula. Stopping times are introduce and pricing of aAmerican claim is presented. Important element of the theory are also stochastic models for interets rates.

Predvideni študijski rezultati:

Znanje in razumevanje: Razumevanje matematičnih modelov, ki se uporabljajo za vrednotenje finančnih produktov. Razumevanje zveze med izbiro modela in posledicami izbire modela.

Uporaba: Uporabnost konceptov je dana sama po sebi, saj so vse metode neposredno uporabne v finančnem svetu. Poleg tega je ta tečaj osnova za matematično bolj zahtevne modele.

Refleksija: Razumevanje teoretičnih konceptov na številnih primerih iz prakse.

Prenosljive spretnosti – niso vezane le na en predmet: Pridobljene spretnosti so neposredno prenosljive v delovno prakso v finančnih

Intended learning outcomes:

Knowledge and understanding: Understanding of mathematical models that are used in the pricing and hedging on the financial markets. Understanding the relation of model selection and its consequences.

Application: All the methods are directly applicable in the financial markets. They also give a base to study more advanced models.

Reflection: Understanding theoretical concepts in practice.

Transferable skills: The knowledge is directly transferable to the practice in financial institutions, such as banks and insurance companies. Beside the practical aspects also skills of financial modelling are advanced

ustanovah, kot so banke ali zavarovalnice. Poleg praktične vrednosti pa gre za brušenje sposobnosti matematičnega modeliranja.	through the course.

Metode poučevanja in učenja:	**Learning and teaching methods:**
Predavanja, vaje, konzultacije	Lectures, exercises, consultations

Načini ocenjevanja:	Delež (v %) / Weight (in %)	**Assessment:**
Način (pisni izpit, ustno izpraševanje, naloge, projekt): 2 kolokvija namesto izpita iz vaj, izpit iz vaj, izpit iz teorije ocene: 1-5 (negativno), 6-10 (pozitivno) (po Statutu UL)	 50% 50%	Type (examination, oral, coursework, project): 2 midterm exams instead of written exam, written exam theoretical exam grading: 1-5 (fail), 6-10 (pass) (according to the Statute of UL)

Reference nosilca / Lecturer's references:

Mihael Perman:

KOMELJ, Janez, PERMAN, Mihael. Joint characteristic functions construction via copulas. Insurance. Mathematics & economics, ISSN 0167-6687, 2010, vol. 47, iss. 2, str. 137-143. [COBISS.SI-ID 16242777]

HUZAK, Miljenko, PERMAN, Mihael, ŠIKIĆ, Hrvoje, VONDRAČEK, Zoran. Ruin probabilities and decompositions for general perturbed risk processes. Annals of applied probability, ISSN 1050-5164, 2004, vol. 14, no. 3, str. 1378-1397. [COBISS.SI-ID 13168985]

HUZAK, Miljenko, PERMAN, Mihael, ŠIKIĆ, Hrvoje, VONDRAČEK, Zoran. Ruin probabilities for competing claim processes. Journal of Applied Probability, ISSN 0021-9002, 2004, vol. 41, no. 3, str.

679-690. [COBISS.SI-ID 13207641]

Tomaž Košir:

GRUNENFELDER, Luzius, KOŠIR, Tomaž, OMLADIČ, Matjaž, RADJAVI, Heydar. Finite groups with submultiplicative spectra. Journal of Pure and Applied Algebra, ISSN 0022-4049. [Print ed.], 2012, vol. 216, iss. 5, str. 1196-1206. [COBISS.SI-ID 16183385]

BUCKLEY, Anita, KOŠIR, Tomaž. Plane curves as Pfaffians. Annali della Scuola normale superiore di Pisa, Classe di scienze, ISSN 0391-173X, 2011, vol. 10, iss. 2, str. 363-388. [COBISS.SI-ID 15928409]

KOŠIR, Tomaž, OBLAK, Polona. On pairs of commuting nilpotent matrices. Transformation groups, ISSN 1083-4362, 2009, vol. 14, no. 1, str. 175-182. [COBISS.SI-ID 15077977]

Janez Bernik:

BERNIK, Janez, MASTNAK, Mitja. Lie algebras acting semitransitively. Linear Algebra and its Applications, ISSN 0024-3795. [Print ed.], 2013, vol. 438, iss. 6, str. 2777-2792. [COBISS.SI-ID 16553561]

BERNIK, Janez, MARCOUX, Laurent W., RADJAVI, Heydar. Spectral conditions and band reducibility of operators. Journal of the London Mathematical Society, ISSN 0024-6107, 2012, vol. 86, no. 1, str. 214-234. [COBISS.SI-ID 16357721]

BERNIK, Janez, MASTNAK, Mitja, RADJAVI, Heydar. Positivity and matrix semigroups. Linear Algebra and its Applications, ISSN 0024-3795. [Print ed.], 2011, vol. 434, iss. 3, str. 801-812. [COBISS.SI-ID 15745625]

UČNI NAČRT PREDMETA / COURSE SYLLABUS (leto / year 2017/18)			
Predmet:	Algebraične krivulje		
Course title:	Algebraic curves		

Študijski program in stopnja **Study programme and level**	**Študijska smer** **Study field**	**Letnik** **Academic year**	**Semester** **Semester**
Interdisciplinarni univerzitetni študijski program Računalništvo in matematika	ni smeri	3	drugi
Interdisciplinary first cycle academic study programme Computer Science and Mathematics	none	3	second

Vrsta predmeta / Course type	izbirni / elective
Univerzitetna koda predmeta / University course code:	27218

Predavanja **Lectures**	**Seminar** **Seminar**	**Vaje** **Tutorial**	**Klinične vaje** **work**	**Druge oblike študija**	**Samost. delo** **Individ. work**	**ECTS**
30		**30**			**90**	**5**

Nosilec predmeta / Lecturer:	prof. dr. Tomaž Košir, prof. dr. Pavle Saksida

Jeziki / Languages:	**Predavanja / Lectures:**	slovenski / Slovene
	Vaje / Tutorial:	slovenski / Slovene

Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:	**Prerequisites:**
Vpis v letnik študija. Opravljen predmet Linearna algebra.	Enrolment in the programme. Completed course Linear algebra.

Vsebina:	**Content (Syllabus outline):**

Afine algebraične krivulje. Nerazcepnost in povezanost. Projektivno zaprtje. Presečna večkratnost med krivuljo in premico. Bezouteva lema. Tangente. Singularnosti. Polare in Hessove krivulje. Dualna krivulja. Plückerjeva formula. Racionalne krivulje. Stožnice. Kubične krivulje. Izrek o rodu in stopnji nesingularne krivulje.	Affine algebraic curves. Irreducibility and connectedness. Projectivization. Multiplicity of intersection between a line and a curve. Bezout lemma. Tangents. Singularity. Polars and Hess curves. Dual curve. Plücker formula. Rational curves , Conics. Cubic curves. Degree-genus formula for nonsingular curves.

Temeljni literatura in viri / Readings:

G. Fisher: Plane Algebraic Curves, AMS, Providence, 2001.

C. G. Gibson: Elementary Geometry of Algebraic Curves, Cambridge Univ. Press, Cambridge, 1998.

M. Reid: Undergraduate Algebraic Geometry, Cambridge Univ. Press, Cambridge, 1988.

K. Hulek: Elementary Algebraic Geometry, AMS, Providence, 2003.

F. Kirwan: Complex Algebraic Curves, Cambridge Univ. Press, Cambridge, 1992.

C. H. Clemens: A Scrapbook of Complex Curve Theory, 2nd edition, AMS, Providence, 2003.

Cilji in kompetence:	**Objectives and competences:**
Je eden od treh osnovnih predmetov, pri katerem študent spozna geometrijski način razmišljanja. Osnovni cilj je spoznati temeljne pojme in lastnosti algebraičnih krivulj.	This is one of the three basic courses in which students learn to think geometrically. The basic goal is to understand the basic definitions and properties of algebraic curves.

Predvideni študijski rezultati:	**Intended learning outcomes:**
Znanje in razumevanje: Razumevanje povezave med algebraičnimi enačbami in geometrijskimi objekti. Sposobnost obravnave geometrijskih	Knowledge and understanding: Understanding the relation between the algebraic equations and the geometric objects. Ability of treating

objektov s pomočjo orodij iz teorije polinomov. Poznavanje in razumevanje osnovnih pojmov in definicij iz teorije algebraičnih krivulj in algebraične geometrije. Uporaba: Algebraični opis objektov, ki se pojavljajo pri problemih v drugih vejah matematike in njene uporabe. Uporaba algebraično-geometrijskih sredstev pri obravnavi teh problemov. Refleksija: Dojemanje istih objektov (krivulj) z različnih aspektov. Razvijanje geometrijskega razmišljanja pri reševanju problemov iz prakse. Prenosljive spretnosti – niso vezane le na en predmet: Formulacija problemov v primernem jeziku, reševanje in analiza doseženega na primerih. Ker je za razumevanje predmeta potrebno solidno obvladanje nekaterih vsebin iz analize in linearne algebre, se študent nauči uporabljati znanje, pridobljeno pri drugih predmetih. Nauči se tudi spretnosti uporabe tuje literature.	some geometric problems by means of tools, coming from the theory of polynomials. Knowledge and understanding of the fundamental concepts of the theory of algebraic curves and algebraic geometry. Application: Algebraic description of objects, appearing in problems from other areas of mathematics and its applications. Application of algebro-geometric methods in the treatment of such problems. Reflection: Ability of percieving mathematical object from different points of view. Development of the geometric approach to solving problems in applicative mathematics. Transferable skills: Formulation of problems in suitable contexts, evaluation of developed tools in concrete examples. This course demands a firm knowledge of certain chapters from mathematical analysis and algebra. Therefore students learn how to use previously acquired knowledge in new situations. Students learn the use of study literature in foreign languages.

Metode poučevanja in učenja:	**Learning and teaching methods:**
Predavanja, vaje, konzultacije	Lectures, exercises, consultations

Načini ocenjevanja:	Delež (v %) / Weight (in %)	**Assessment:**
Način (pisni izpit, ustno izpraševanje, naloge, projekt): 2 kolokvija namesto izpita iz vaj, izpit iz vaj,	50% 50%	Type (examination, oral, coursework, project): 2 midterm exams instead of written exam, written exam

izpit iz teorije ocene: 1-5 (negativno), 6-10 (pozitivno) (po Statutu UL)		oral exam grading: 1-5 (fail), 6-10 (pass) (according to the Statute of UL)

Reference nosilca / Lecturer's references:

GRUNENFELDER, Luzius, GURALNICK, Robert M., KOŠIR, Tomaž, RADJAVI, Heydar. Permutability of characters on algebras. Pacific journal of mathematics, ISSN 0030-8730, 1997, let. 178, št. 1, str. 63-70. [COBISS.SI-ID 7437145]

GRUNENFELDER, Luzius, KOŠIR, Tomaž. Coalgebras and spectral theory in one and several parameters. V: GOHBERG, I. (ur.), LANCASTER, P. (ur.), SHIVAKUMAR, P. N. (ur.). Recent developments in operator theory and its applications : International Conference in Winnipeg, October 2-6, 1994, (Operator theory, ISSN 0255-0156, vol. 87). Basel, Boston, Berlin: Birkhäuser, cop. 1996, str. 177-192. [COBISS.SI-ID 7436889]

GRUNENFELDER, Luzius, KOŠIR, Tomaž. Koszul cohomology for finite families of comudule maps end applications. Communications in algebra, ISSN 0092-7872, 1997, let. 25, št. 2, str. 459-479. [COBISS.SI-ID 7127641]

SAKSIDA, Pavle. Nahm's equations and generalizations Neumann system. Proceedings of the London Mathematical Society, ISSN 0024-6115, 1999, let. 78, št. 3, str. 701-720. [COBISS.SI-ID 8853849]

SAKSIDA, Pavle. Neumann system, spherical pendulum and magnetic fields. Journal of physics. A, Mathematical and general, ISSN 0305-4470, 2002, vol. 35, no. 25, str. 5237-5253. [COBISS.SI-ID 11920217]

SAKSIDA, Pavle. Integrable anharmonic oscillators on spheres and hyperbolic spaces. Nonlinearity, ISSN 0951-7715, 2001, vol. 14, no. 5, str. 977-994. [COBISS.SI-ID 10942809]

UČNI NAČRT PREDMETA / COURSE SYLLABUS (leto / year 2017/18)			
Predmet:	Afina in projektivna geometrija		
Course title:	Affine and projective geometry		

Študijski program in stopnja **Study programme and level**	**Študijska smer** **Study field**	**Letnik** **Academic year**	**Semester** **Semester**
Interdisciplinarni univerzitetni študijski program Računalništvo in matematika	ni smeri	3	drugi
Interdisciplinary first cycle academic study programme Computer Science and Mathematics	none	3	second

Vrsta predmeta / Course type	izbirni / elective
Univerzitetna koda predmeta / University course code:	27220

Predavanja **Lectures**	**Seminar** **Seminar**	**Vaje** **Tutorial**	**Klinične vaje** **work**	**Druge oblike študija**	**Samost. delo** **Individ. work**	**ECTS**
30		**30**			**90**	**5**

Nosilec predmeta / Lecturer:	prof. dr. Tomaž Košir, prof. dr. Bojan Magajna, doc. dr. Aleš Vavpetič

Jeziki / Languages:	**Predavanja / Lectures:**	slovenski / Slovene
	Vaje / Tutorial:	slovenski / Slovene

Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:	**Prerequisites:**
Vpis v letnik študija. Opravljen predmet Linearna algebra.	Enrolment in the programme. Completed course Linear algebra.

Vsebina:	**Content (Syllabus outline):**

Afina geometrija: afini prostori, afine transformacije, osnovni izrek afine geometrije. Projektivna geometrija: projektivni prostori, dualnost, vložitev afine geometrije v projektivno, kolineacije in projektivnosti, osnovni izrek projektivne geometrije, projektivno ogrodje, dvorazmerje, harmonična četverka, perspektivnost. Stožnice v projektivni ravnini: pol in polara, dvorazmerje na stožnici, Pascalov izrek, klasifikacija stožnic. Izbirna vsebina: Klasifikacija izometrij v evklidski ravnini. Leonardov izrek, frizne in tapetne grupe. Končne grupe izometrij v trirazsežnem evklidskem prostoru.	Affine Geometry: affine spaces, affine transformations, the fundamental theorem of affine geometry. Projective Geometry: projective spaces, embedding of affine spaces into projective spaces, collineations and projectivities, the fundamental theorem of projective geometry, projective coordinates, cross-ratio, harmonic ratio, perspectivities. Conics in projective plane: poles and polars, cross-ration on a conic, Pascal's Theorem, classification of conics. Additional topics: classification of isometries in the Euclidean plane, Leonardo's Theorem, frieze groups and wallpaper groups, finite groups of isometries in Euclidean 3-space.

Temeljni literatura in viri / Readings:

T. Košir, B. Magajna: Transformacije v geometriji, DMFA-založništvo, Ljubljana, 1997.

Vidav: Afina in projektivna geometrija, DMFA-založništvo, Ljubljana, 1981.

M. Berger: Geometry I, Springer, Berlin, 2004.

M. Berger: Geometry II, Springer, Berlin, 1996.

E. G. Rees: Notes on Geometry, Springer, Berlin-New York, 2005.

R. A. Rosenbaum: Introduction to Projective Geometry and Modern Algebra, Addison-Wesley, Reading, 1963.

Cilji in kompetence:	**Objectives and competences:**
Študent spozna osnovne pojme afine in projektivne geometrije. Pri tem uporablja že znana orodja iz algebre in linearne algebre. Razvije geometrijsko intuicijo.	The main objective is to introduce affine and projective geometry using the tools from algebra and linear algebra. The student develops geometric intution.

Predvideni študijski rezultati:	**Intended learning outcomes:**

Znanje in razumevanje: Razumevanje osnovnih pojmov afine in projektivne geometrije. Sposobnost povezovanja znanj iz algebre in analize v uporabi pri geometriji. Uporaba: Uporaba geometrijskih tehnik pri drugih predmetih in reševanju praktičnih problemov. Refleksija: Sposobnost povezovanja različnih pristopov: analitičnega, algebraičnega in geometričnega. Prenosljive spretnosti – niso vezane le na en predmet: Spretnost prenosa teorije v uporabo.	Knowledge and understanding: The understanding of the fundamental notions of affine and projective geometry. The ability to apply the knowledge obtained in algebra and mathemetical analysis courses in geometry. Application: The application of geometric techniques in other subjects and in practice. Reflection: The ability to connect different approaches: analytical, algebraic and geometric. Transferable skills: The ability to apply theoretical knowledge in practice.

Metode poučevanja in učenja:	**Learning and teaching methods:**
Predavanja, vaje, konzultacije	Lectures, exercises, consultations

Načini ocenjevanja:	Delež (v %) / Weight (in %)	**Assessment:**
Način (pisni izpit, ustno izpraševanje, naloge, projekt): 2 kolokvija namesto izpita iz vaj, izpit iz vaj, izpit iz teorije ocene: 1-5 (negativno), 6-10 (pozitivno) (po Statutu UL)	 50% 50%	Type (examination, oral, coursework, project): 2 midterm exams instead of written exam, written exam oral exam grading: 1-5 (fail), 6-10 (pass) (according to the Statute of UL)

Reference nosilca / Lecturer's references:

Tomaž Košir:

BUCKLEY, Anita, KOŠIR, Tomaž. Plane curves as Pfaffians. Annali della Scuola normale superiore di Pisa, Classe di scienze, ISSN 0391-173X, 2011, vol. 10, iss. 2, str. 363-388. [COBISS.SI-ID 15928409]

BINDING, Paul, KOŠIR, Tomaž. Root vectors for geometrically simple two-parameter eigenvalues. Transactions of the American Mathematical Society, ISSN 0002-9947, 2004, vol. 356, no. 5, str. 1705-1726. [COBISS.SI-ID 13013081]

KOŠIR, Tomaž. Root vectors for geometrically simple multiparameter eigenvalues. Integral equations and operator theory, ISSN 0378-620X, 2004, vol. 48, no. 3, str. 365-396. [COBISS.SI-ID 12895321]

Bojan Magajna:

MAGAJNA, Bojan. Fixed points of normal completely positive maps on B(H). Journal of mathematical analysis and applications, ISSN 0022-247X. [Print ed.], 2012, vol. 389, iss. 2, str. 1291-1302. [COBISS.SI-ID 16227673]

BLECHER, David P., MAGAJNA, Bojan. Dual operator systems. Bulletin of the London Mathematical Society, ISSN 0024-6093, 2010, vol. 43, iss. 2, str. 311-320. [COBISS.SI-ID 15862617]

MAGAJNA, Bojan. Pointwise approximation by elementary complete contractions. Proceedings of the American Mathematical Society, ISSN 0002-9939, 2009, vol. 137, no. 7, str. 2375-2385. [COBISS.SI-ID 15178585]

Aleš Vavpetič:

CENCELJ, Matija, DYDAK, Jerzy, VAVPETIČ, Aleš, VIRK, Žiga. A combinatorial approach to coarse geometry. Topology and its Applications, ISSN 0166-8641. [Print ed.], 2012, vol. 159, iss. 3, str. 646-658. [COBISS.SI-ID 16094809]

CENCELJ, Matija, DYDAK, Jerzy, MITRA, Atish, VAVPETIČ, Aleš. Hurewicz-Serre theorem in extension theory. Fundamenta mathematicae, ISSN 0016-2736, 2008, vol. 198, no. 2, str. 113-123. [COBISS.SI-ID 14551385]

VAVPETIČ, Aleš, VIRUEL, Antonio. Symplectic groups are N-determined 2-compact groups. Fundamenta mathematicae, ISSN 0016-2736, 2006, vol. 192, no. 2, str. 121-139. [COBISS.SI-ID 14185305]

VAVPETIČ, Aleš. Afina in projektivna geometrija. Ljubljana: samozal. A. Vavpetič, 2011. VI, 114 str., ilustr. [COBISS.SI-ID 15994969]

UČNI NAČRT PREDMETA / COURSE SYLLABUS (leto / year 2017/18)			
Predmet:	Optimizacijske metode		
Course title:	Optimization methods		

Študijski program in stopnja **Study programme and level**	**Študijska smer** **Study field**	**Letnik** **Academic year**	**Semester** **Semester**
Interdisciplinarni univerzitetni študijski program Računalništvo in matematika	ni smeri	2	drugi
Interdisciplinary first cycle academic study programme Computer Science and Mathematics	none	2	second

Vrsta predmeta / Course type	obvezni / compulsory
Univerzitetna koda predmeta / University course code:	27210

Predavanja **Lectures**	**Seminar** **Seminar**	**Vaje** **Tutorial**	**Klinične vaje** **work**	**Druge oblike študija**	**Samost. delo** **Individ. work**	**ECTS**
45		**45**			**120**	**7**

Nosilec predmeta / Lecturer:	prof. dr. Marko Petkovšek, doc. dr. Arjana Žitnik

Jeziki / Languages:	**Predavanja / Lectures:**	slovenski / Slovene
	Vaje / Tutorial:	slovenski / Slovene

Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:	**Prerequisites:**
Vpis v letnik študija.	Enrolment in the programme.
Vsebina:	**Content (Syllabus outline):**

• Optimizacijske naloge in problemi, primeri, podobne in enakovredne naloge, • rešljivost, globalni in lokalni ekstremi, • lokalna optimizacija, konveksnost, reševanje v Rn, sedla, prirejene in dualne naloge, • Lagrangeova prirejenost, Karush-Kuhn-Tuckerjev izrek, numerični postopki, kazenske metode, • linearno programiranje, metoda simpleksov, dualne naloge, • diskretne optimizacijske naloge, zahtevnost problemov, pristopi k reševanju diskretnih nalog, primeri (predavatelj izbere nekatere izmed naslednjih tem: najcenejši razvoz, pretoki po omrežju, prirejanja in pokritja, barvanje grafov, razvrščanje v skupine, ...).	• Optimization problems, examples, similar and equivalent problems • solvability, global and local extrema, • local optimization, convex problems, solving in Rn, saddle points, associated and dual problems, • Lagrange duality, Karush-Kuhn-Tucker theorem, numerical algorithms, penalty methods, • linear programming, simplex method, dual problem, • discrete optimization problems, complexity, approaches to solving discrete optimization problems, examples (the lecturer chooses some of the following topics: transshipment problem, network flow, matchings and coverings, graph colorings, clustering...).

Temeljni literatura in viri / Readings:

Vašek Chvátal: Linear Programming, W. H. Freeman and Co., New York, 1983

B. H. Korte, J. Vygen: Combinatorial Optimization : Theory and Algorithms, 3. izdaja, Springer, Berlin, 2006.

Stephen Boyd, Lieven Vandenberghe: Convex Optimization, Cambridge University Press, Cambridge, 2004

V. Batagelj: Optimizacijske metode, Zapiski predavanj, Ljubljana.http://vlado.fmf.uni-lj.si/vlado/optim/opt1.pdfhttp://vlado.fmf.uni-lj.si/vlado/optim/lp.pdf

V. Batagelj, M. Kaufman: Naloge iz optimizacijskih metod, Ljubljana.http://vlado.fmf.uni-lj.si/vlado/optim/optnal.pdf

Jiří Matoušek, Bernd Gärtner: Understanding and Using Linear Programming, Springer 2007

M.Minoux: Mathematical programming. Theory and algorithms. Wiley, Chichester, 1986

M.S.Bazaraa, H.D.Sherali, C.M.Shetty: Nonlinear Programming, Theory and Algorithms. Wiley, New York 1993.

C.H.Papadimitriou, K.Steiglitz: Combinatorial optimization: Algorithms and complexity. Prentice-Hall, Englewood Cliffs, New Jersey 1990

Cilji in kompetence:

Podati v poenoteni obliki osnovna znanja o ``zvezni'' in kombinatorični optimizaciji.

Objectives and competences:

To provide a basic knowledge on ``continuous'' and combinatorial optimization in a unified way.

Predvideni študijski rezultati:

Znanje in razumevanje: Študent pridobi osnovno znanje o zvezni in kombinatorični optimizaciji. Obvlada temeljne optimizacijske postopke in jih zna uporabiti ob pomoči računalnika.

Uporaba: Reševanje optimizacijskih problemov v vsakdanjem življenju.

Refleksija: Pomen ustreznega modeliranja problemov iz uporabe za njihovo učinkovito reševanje.

Prenosljive spretnosti – niso vezane le na en predmet: Sposobnost predstavitve različnih praktičnih problemov v obliki matematičnih optimizacijskih nalog. Veščina uporabe izbranega programskega orodja za reševanje osnovnih optimizacijskih problemov.

Intended learning outcomes:

Knowledge and understanding: The student obtains basic knowledge about continuous and combinatorial optimization. He or she is familiar with basic optimization methods and knows how to solve them with a computer.

Application: Solving optimization problems from real life.

Reflection: The importance of modelling of problems for their effective resolution.

Transferable skills: The ability to present various everyday problems in the form of mathematical optimization tasks. Ability to use computer programs to solve basic optimization problems.

Metode poučevanja in učenja:

Learning and teaching methods:

predavanja, vaje, domače naloge, konzultacije	lectures, exercises, homeworks, consultations

Načini ocenjevanja:	Delež (v %) / Weight (in %)	**Assessment:**
Način (pisni izpit, ustno izpraševanje, naloge, projekt)		Type (examination, oral, coursework, project):
domače naloge ali projekt		homeworks or project
pisni izpit	10%	written exam
ustni izpit	45%	oral exam
Ocene: 1-5 (negativno), 6-10 (pozitivno) (po Statutu UL)	45%	Grading: 1-5 (fail), 6-10 (pass) (according to the Statute of UL)

Reference nosilca / Lecturer's references:

Marko Petkovšek:

ABRAMOV, Sergei A., PETKOVŠEK, Marko. Polynomial ring automorphisms, rational (w, [sigma])-canonical forms, and the assignment problem. Journal of symbolic computation, ISSN 0747-7171, 2010, vol. 45, no. 6, str. 684-708. [COBISS.SI-ID 15580505]

BRESSLER, Andrew, GREENWOOD, Torin, PEMANTLE, Robin, PETKOVŠEK, Marko. Quantum random walk on the integer lattice: examples and phenomena. V: AMS Special Sessions on Algorithmic Probability and Combinatorics, October 5-6, 2007, DePaul University, Chicago (Illinois), October 4-5, 2008, University of British Columbia, Vancouver (BC, Canada). LLADSER, Manuel (ur.), et al. Algorithmic probability and combinatorics : AMS special sessions on algorithmic probability and combinatorics, October 5-6, 2007, DePaul University, Chicago, Illinois, October 4-5, 2008, University of British Columbia, Vancouver, BC, Canada, (Contemporary mathematics, ISSN 0271-4132, 520). Providence: American Mathematical Society, cop. 2010, str. 41-60. [COBISS.SI-ID 15813977]

ABRAMOV, Sergei A., BARKATOU, Moulay A., VAN HOEIJ, Mark, PETKOVŠEK, Marko. Subanalytic solutions of linear difference equations and multidimensional hypergeometric sequences. Journal

of symbolic computation, ISSN 0747-7171, 2011, vol. 46, iss. 11, str. 1205-1228. [COBISS.SI-ID 16083033]

Arjana Žitnik:

MILANIČ, Martin, PISANSKI, Tomaž, ŽITNIK, Arjana. Dilation coefficient, plane-width, and resolution coefficient of graphs. Monatshefte für Mathematik, ISSN 0026-9255, 2013, vol. 170, no. 2, str. 179-193. [COBISS.SI-ID 1024499540]

PISANSKI, Tomaž, ŽITNIK, Arjana. Representing graphs and maps. V: BEINEKE, Lowell W. (ur.), WILSON, Robin J. (ur.). Topics in topological graph theory, (Encyclopedia of mathematics and its applications, ISSN 0953-4806, 128). Cambridge [etc.]: Cambridge University Press, cop. 2009, str. 151-180. [COBISS.SI-ID 15227481]

ŽITNIK, Arjana. Series parallel extensions of plane graphs to dual-eulerian graphs. Discrete Mathematics, ISSN 0012-365X. [Print ed.], 2007, vol. 307, iss. 3-5, str. 633-640. [COBISS.SI-ID 14183769]

UČNI NAČRT PREDMETA / COURSE SYLLABUS (leto / year 2017/18)			
Predmet:	Kombinatorika		
Course title:	Combinatorics		
Študijski program in stopnja **Study programme and level**	**Študijska smer** **Study field**	**Letnik** **Academic year**	**Semester** **Semester**
Interdisciplinarni univerzitetni študijski program Računalništvo in matematika	ni smeri	2	prvi
Interdisciplinary first cycle academic study programme Computer Science and Mathematics	none	2	first

Vrsta predmeta / Course type	obvezni / compulsory
Univerzitetna koda predmeta / University course code:	27208

Predavanja **Lectures**	**Seminar** **Seminar**	**Vaje** **Tutorial**	**Klinične vaje** **work**	**Druge oblike študija**	**Samost. delo** **Individ. work**	**ECTS**
45		**45**			**120**	**7**

Nosilec predmeta / Lecturer:	prof. dr. Sandi Klavžar, prof. dr. Matjaž Konvalinka, prof. dr. Primož Potočnik

Jeziki / Languages:	**Predavanja / Lectures:**	slovenski / Slovene
	Vaje / Tutorial:	slovenski / Slovene

Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:	**Prerequisites:**
Vpis v letnik študija.	Enrolment in the programme.
Vsebina:	**Content (Syllabus outline):**

Osnovna načela preštevanja. Binomski koeficienti, razdelitve, Stirlingova števila 1. in 2. vrste, Bellova števila, Lahova števila, razčlenitve naravnega števila. Dvanajstera pot. Načelo vključitev in izključitev in trdnjavski polinomi. Polyeva teorija: delovanje grupe na množici, Burnsidova lema, število orbit. Rodovne funkcije in uporaba pri rekurzivnih enačbah. Catalanova števila. Delno urejene množice in mreže: verige in antiverige, Dilworthov izrek, Spernerjev izrek. Teorija načrtov: načrti, t-načrti, ciklične konstrukcije načrtov.	Basic principles of counting. Binomial coefficients, set partitions, Stirling numbers of the first and second kind, Bell numbers, Lah numbers, partitions of integers. Twelve-fold way. Inclusion exclusion principle, rook polynomials. Polya theory: action of groups on sets, Burnside lemma, number of orbits. Generating function and applications to recurrence relations. Catalan numbers. Partially ordered sets and lattices: chains and antichains, Dilworth's theorem, Sperner's theorem. Design theory: designs, t-designs, cyclic constructions of designs.

Temeljni literatura in viri / Readings:

Miklos Bona, A Walk Through Combinatorics, 2nd ed. World Scientific, New York, 2006.

N. Biggs, Discrete Mathematics, 2nd ed., Oxford Univerisity Press (2002)

M. Juvan, P. Potočnik: Teorija grafov in kombinatorika, DMFA-založništvo, Ljubljana, 2000.

Primož Potočnik, Zapiski predavanj iz Diskretne matematike I, http://www.fmf.uni-lj.si/~potocnik/Ucbeniki/DM-Zapiski2010.pdf

Cilji in kompetence:	**Objectives and competences:**
Študent se spozna z nekaterimi klasičnimi problemi kombinatorike in se jih nauči samostojno reševati.	Students familiarize themselves with some classical problems of combinatorics and learn how to independently solve them.

Predvideni študijski rezultati:	**Intended learning outcomes:**
Znanje in razumevanje: Poznavanje osnovnih pojmov iz klasične kombinatorike ter razumevanje osnovnih povezav med njimi. Osnovno znanje natančnega štetja objektov z določenimi lastnostmi iz dane množice. Uporaba: Uporaba diskretnih matematičnih	Knowledge and understanding: Knowledge about basic concepts from classical combinatoricsRF, and understanding of basic connections among them. Basic knowledge of exact counting of objects from a given set and with specific properties.

struktur za predstavitev različnih objektov in procesov. Tovrstne predstavitve so nepogrešljive na primer pri obdelavi podatkov z računalniki. Refleksija: Povezovanje teoretičnih spoznanj s praktičnimi uporabami na primer v optimizaciji in pri programiranju. Sposobnost prepoznavanja problemov, ki jih lahko uspešno opišemo z diskretnimi matematičnimi modeli. Prenosljive spretnosti – niso vezane le na en predmet: Poznavanje osnovnih prijemov za delo z diskretnimi matematičnimi strukturami. Natančnost pri razmišljanju in reševanju problemov. Sposobnost prebiranja strokovne literature iz diskretne matematike in sorodnih področij.	Application: Use of discrete mathematical structures for representation of various objects and processes. Such representations play a key role in data processing with computers. Reflection: Connection of theoretical knowledge with applications, for instance in optimizations and computer programming. Capability of recognizing problems that could be successfully described by discrete mathematical models. Transferable skills: Knowledge about basic approaches regarding use of discrete mathematical structures. Exactness at thinking and problem solving. Capability of reading and understanding of expert literature on discrete mathematics and other closely related fields.

Metode poučevanja in učenja:	**Learning and teaching methods:**
Predavanja in vaje.	Lecture and exercises.

Načini ocenjevanja:	Delež (v %) / Weight (in %)	**Assessment:**
Pisni in ustni izpit.	100%	Written and oral exam.

Reference nosilca / Lecturer's references:

Sandi Klavžar:

BREŠAR, Boštjan, KLAVŽAR, Sandi, RALL, Douglas. Domination game and an imagination strategy. SIAM journal on discrete mathematics, ISSN 0895-4801, 2010, vol. 24, no. 3, str. 979-991. [COBISS.SI-ID 15648089]

HAMMACK, Richard H., IMRICH, Wilfried, KLAVŽAR, Sandi. Handbook of product graphs, (Discrete

mathematics and its applications). Boca Raton, London, New York: CRC Press, cop. 2011. XVIII, 518 str., ilustr. ISBN 978-1-4398-1304-1. [COBISS.SI-ID 15916121]

IMRICH, Wilfried, KLAVŽAR, Sandi, RALL, Douglas F. Topics in graph theory : graphs and their Cartesian product. Wellesley (Mass.): A. K. Peters, 2008. XIV, 205 str., ilustr. ISBN 978-1-56881-429-2. [COBISS.SI-ID 14965081]

Matjaž Konvalinka:

KONVALINKA, Matjaž. Skew quantum Murnaghan-Nakayama rule. Journal of algebraic combinatorics, ISSN 0925-9899, 2012, vol. 35, no. 4, str. 519-545. [COBISS.SI-ID 16250713]

KONVALINKA, Matjaž, PAK, Igor. Geometry and complexity of O'Hara's algorithm. Advances in applied mathematics, ISSN 0196-8858, 2009, vol. 42, iss. 2, str. 157-175. [COBISS.SI-ID 15545945]

KONVALINKA, Matjaž. On quantum immanants and the cycle basis of the quantum permutation space. Annals of combinatorics, ISSN 0218-0006, 2012, vol. 16, no. 2, str. 289-304. [COBISS.SI-ID 16310873]

Primož Potočnik:

POTOČNIK, Primož. Tetravalent arc-transitive locally-Klein graphs with long consistent cycles. European journal of combinatorics, ISSN 0195-6698, 2014, vol. 36, str. 270-281. [COBISS.SI-ID 16862041]

POTOČNIK, Primož, SPIGA, Pablo, VERRET, Gabriel. Cubic vertex-transitive graphs on up to 1280 vertices. Journal of symbolic computation, ISSN 0747-7171, 2013, vol. 50, str. 465-477. [COBISS.SI-ID 16520537]

POTOČNIK, Primož. Edge-colourings of cubic graphs admitting a solvable vertex-transitive group of automorphisms. Journal of combinatorial theory. Series B, ISSN 0095-8956, 2004, vol. 91, no. 2, str. 289-300. [COBISS.SI-ID 13087321]

UČNI NAČRT PREDMETA / COURSE SYLLABUS (leto / year 2017/18)			
Predmet:	Izbrana poglavja iz matematike		
Course title:	Topics in mathematics		

Študijski program in stopnja **Study programme and level**	**Študijska smer** **Study field**	**Letnik** **Academic year**	**Semester** **Semester**
Interdisciplinarni univerzitetni študijski program Računalništvo in matematika	ni smeri	2	drugi
Interdisciplinary first cycle academic study programme Computer Science and Mathematics	none	2	second

Vrsta predmeta / Course type	obvezni / compulsory
Univerzitetna koda predmeta / University course code:	27209

Predavanja **Lectures**	**Seminar** **Seminar**	**Vaje** **Tutorial**	**Klinične vaje** **work**	**Druge oblike študija**	**Samost. delo** **Individ. work**	**ECTS**
30		**30**			**90**	**5**

Nosilec predmeta / Lecturer:	prof. dr. Sergio Cabello Justo, prof. dr. Primož Potočnik

Jeziki / Languages:	**Predavanja / Lectures:**	slovenski / Slovene
	Vaje / Tutorial:	slovenski / Slovene

Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:	**Prerequisites:**
Vpis v letnik študija.	Enrolment in the programme.
Vsebina:	**Content (Syllabus outline):**

Predavatelj izbere nekaj od naslednjih tem: Izbrane teme iz analize z uporabami (oscilator in resonanca, zvezna in diskretna Fourierova transformacija z uporabami, toplotna in valovna enačba, analiza signala, kompresija slike itd), Izbrane teme iz teorije števil z uporabami (modularna aritmetika, Eulerjeva fi funkcija, RSA, testiranje praštevilskosti) Izbrane teme iz algebre (polgrupe in avtomati, končni obsegi) Izbrane teme iz diskretne matematike (ekstremalna kombinatorika in teorija grafov, latinski kvadrati, algebraična kombinatorika), druge matematične teme po predavateljevem izboru.	Lecturer chooses amongst the following topics: Selected topics in analysis (oscillator and resonance, contiuous and discrete Fourier transform with applications, sygnal analysis, heat and wave equation, image compression), Selected topics in number theory with applications (modular arithmetics, Euler totient, RSA, testing primality), Selected topics in algebra (semigrupus and automata, finite fields), Selected topics in discrete mathematics (extremal combinatorics, latin squares, algebraic combinatorics) Other mathematical topics of lecturer's choosing.

Temeljni literatura in viri / Readings:

E. Kreyszig: Advanced Engineering Mathematics, 9th ed., Weiley (2006)

S. Coutinho: The Mathematics of Ciphers: Number Theory and RSA Cryptography, A.K. Peters ltd.,1999

T. W. Judson: Abstract Algebra Theory and Applications (2013), http://abstract.ups.edu/

Cilji in kompetence:	**Objectives and competences:**
Študent se spozna z izbranimi matematičnimi problemi in se jih nauči samostojno reševati.	Students familiarise with the selected mathematical problems and learn how to idependently solve them.

Predvideni študijski rezultati:	**Intended learning outcomes:**

Znanje in razumevanje: Študent se nauči in razume predstavljeno snov.	Knowledge and understanding: Students learns and understands the topic of the course.

Metode poučevanja in učenja:	**Learning and teaching methods:**
Predavanja in vaje.	Lecture and exercises.

Načini ocenjevanja:	Delež (v %) / Weight (in %)	**Assessment:**
Pisni izpit z usntim zagovorom	100%	Written exam with oral defense

Reference nosilca / Lecturer's references:

Sergio Cabello:

CABELLO, Sergio. Many distances in planar graphs. Algorithmica, ISSN 0178-4617, 2012, vol. 62, no. 1-2, str. 361-381. [COBISS.SI-ID 15702873]

CABELLO, Sergio. Finding shortest contractible and shortest separating cycles in embedded graphs. V: 20th Annual ACM-SIAM Symposium on Discrete Algorithms, January 4-6, New York. SODA 2009 : special issue, (ACM transactions on algorithms, ISSN 1549-6325, Vol. 6, iss. 2). New York: Association for Computing Machinery, 2010, article No.: 24 (18 str.). [COBISS.SI-ID 15572057]

CABELLO, Sergio, KNAUER, Christian. Algorithms for graphs of bounded treewidth via orthogonal range searching. Computational geometry, ISSN 0925-7721. [Print ed.], 2009, vol. 42, iss. 9, str. 815-824. [COBISS.SI-ID 15160409]

Primož Potočnik:

POTOČNIK, Primož. Tetravalent arc-transitive locally-Klein graphs with long consistent cycles. European journal of combinatorics, ISSN 0195-6698, 2014, vol. 36, str. 270-281. [COBISS.SI-ID 16862041]

POTOČNIK, Primož, SPIGA, Pablo, VERRET, Gabriel. Cubic vertex-transitive graphs on up to 1280 vertices. Journal of symbolic computation, ISSN 0747-7171, 2013, vol. 50, str. 465-477. [COBISS.SI-ID 16520537]

POTOČNIK, Primož. Edge-colourings of cubic graphs admitting a solvable vertex-transitive group of automorphisms. Journal of combinatorial theory. Series B, ISSN 0095-8956, 2004, vol. 91, no. 2, str. 289-300. [COBISS.SI-ID 13087321]

UČNI NAČRT PREDMETA / COURSE SYLLABUS (leto / year 2017/18)			
Predmet:	Analiza 3		
Course title:	Analysis 3		

Študijski program in stopnja **Study programme and level**	**Študijska smer** **Study field**	**Letnik** **Academic year**	**Semester** **Semester**
Interdisciplinarni univerzitetni študijski program Računalništvo in matematika	ni smeri	2	prvi
Interdisciplinary first cycle academic study programme Computer Science and Mathematics	none	2	first

Vrsta predmeta / Course type	obvezni / compulsory
Univerzitetna koda predmeta / University course code:	27207

Predavanja **Lectures**	**Seminar** **Seminar**	**Vaje** **Tutorial**	**Klinične vaje** **work**	**Druge oblike študija**	**Samost. delo** **Individ. work**	**ECTS**
30		**30**			**90**	**5**

Nosilec predmeta / Lecturer:	prof. dr. Pavle Saksida, doc. dr. Aleš Vavpetič

Jeziki / Languages:	**Predavanja / Lectures:**	slovenski / Slovene
	Vaje / Tutorial:	slovenski / Slovene

Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:	**Prerequisites:**
Vpis v letnik študija. Opravljena predmeta Analiza 1 in Analiza 2.	Enrolment in the programme. Completed courses Analysis 1 and Analysis 2.

Vsebina:	**Content (Syllabus outline):**

Večkratni integrali: integrali s parametrom, dvojni integral in večkratni integral, dolžina krivulje in površina ploskve. Sistemi diferencalnih enačb: obstoj in enoličnost rešitev, struktura prostora rešitev, sistemi s konstantnimi koeficienti, fazni proctor, stacionarne točke, stabilnost. Funkcije kompleksne spremenljivvke: elementarne funkcije komplesne spremenljivke, Cauchyjev izrek, residui in računanje integralov, transformacije kompleksne ravnnine.	Multiple integrals: integrals with a parameter, double and multiple integrals, length of a curve, area of a surface. Systems of differential equations: existence and uniqueness of solutions, structure of the space of solutions, systems with constant coefficients, phase space, stationary points, stability. Functions of a complex variable: elementary functions of a complex variable, the Cauchy theorem, residues and evaluation of integrals, transformations of the complex plane.

Temeljni literatura in viri / Readings:

Ivan Vidav: Višja matematika 2, Državna založba Slovenije, Ljubljana, 1979, 591 str.

Erwin Kreyszig: Advanced engineering mathematics, 9th ed., J.Wiley, Hoboken, 2006.

Gabrijel Tomšič, Tomaž Slivnik: Matematika III, Založba FE in FRI, Ljubljana, 2001, 175 str.

Tomo Žitko: Zbirka nalog iz matematike III, Založba FE in FRI, Ljubljana, 2002, 92 str.

Serge Lang: Calculus of several variables, Springer-Verlag, 1995.

Cilji in kompetence:	**Objectives and competences:**
Študent pri predmetu spozna nekaj novih pojmov in tehnik matematične analize, kot so dvojni in trojni integrali, reševanje diferencialnih enačb, kompleksna analiza. Te vsebine sodijo v uporabno matematiko in so nujno potrebne za razumevanje mnogih drugih predmetov, ki jih študent sreča pri študiju. Na predavanjih in vajah se študent uči matematičnega razmišljanja in strogosti, ter pridobiva praktično, delovno znanje obravnavanih področij.	By attending the course students get acquainted with some new notions and techniques of mathematical analysis, such as the double and the triple integrals, differential equations and complex analysis. These topics belong to the applied mathematics and are an essential component in the education of the students majoring in natural sciences or engineering. During the lectures and the classes students learn the mathematical rigor. They also acquire practical working knowledge of the topics, covered in the course.

Predvideni študijski rezultati:	**Intended learning outcomes:**

Znanje in razumevanje: Razumevanje in uporaba nekaterih zahtevnejših konceptov matematične analize.	Knowledge and understanding: Understanding of certain advanced topics of mathematical analysis.

Metode poučevanja in učenja:	**Learning and teaching methods:**
Predavanja, vaje, domače naloge, konzultacije.	Lectures, classes, homework, consultations.

Načini ocenjevanja:	Delež (v %) / Weight (in %)	**Assessment:**
Način (pisni izpit, ustno izpraševanje, naloge, projekt)		Type (examination, oral, coursework, project):

Reference nosilca / Lecturer's references:

Pavle Saksida:

SAKSIDA, Pavle. On the nonlinear Fourier transform associated with periodic AKNS-ZS systems and its inverse. Journal of physics. A, Mathematical and theoretical, ISSN 1751-8113, 2013, vol. 46, no. 46, 465204 (22 str.). [COBISS.SI-ID 16833369]

SAKSIDA, Pavle. Integrable anharmonic oscillators on spheres and hyperbolic spaces. Nonlinearity, ISSN 0951-7715, 2001, vol. 14, no. 5, str. 977-994. [COBISS.SI-ID 10942809]

SAKSIDA, Pavle. Nahm's equations and generalizations Neumann system. Proceedings of the London Mathematical Society, ISSN 0024-6115, 1999, let. 78, št. 3, str. 701-720. [COBISS.SI-ID 8853849]

Aleš Vavpetič:

CENCELJ, Matija, DYDAK, Jerzy, VAVPETIČ, Aleš, VIRK, Žiga. A combinatorial approach to coarse geometry. Topology and its Applications, ISSN 0166-8641. [Print ed.], 2012, vol. 159, iss. 3, str. 646-658. [COBISS.SI-ID 16094809]

CENCELJ, Matija, DYDAK, Jerzy, MITRA, Atish, VAVPETIČ, Aleš. Hurewicz-Serre theorem in extension theory. Fundamenta mathematicae, ISSN 0016-2736, 2008, vol. 198, no. 2, str. 113-123. [COBISS.SI-ID 14551385]

CENCELJ, Matija, MRAMOR KOSTA, Neža, VAVPETIČ, Aleš. G-complexes with a compatible CW structure. Journal of mathematics of Kyoto University, ISSN 0023-608X, 2003, vol. 43, no. 3, str. 585-597. [COBISS.SI-ID 12807769]

UČNI NAČRT PREDMETA / COURSE SYLLABUS (leto / year 2017/18)			
Predmet:	Linearna algebra		
Course title:	Linear algebra		

Študijski program in stopnja **Study programme and level**	**Študijska smer** **Study field**	**Letnik** **Academic year**	**Semester** **Semester**
Interdisciplinarni univerzitetni študijski program Računalništvo in matematika	ni smeri	1	prvi in drugi
Interdisciplinary first cycle academic study programme Computer Science and Mathematics	none	1	first and second

Vrsta predmeta / Course type	obvezni / compulsory
Univerzitetna koda predmeta / University course code:	27203

Predavanja **Lectures**	**Seminar** **Seminar**	**Vaje** **Tutorial**	**Klinične vaje** **work**	**Druge oblike študija**	**Samost. delo** **Individ. work**	**ECTS**
60		**60**			**180**	**10**

Nosilec predmeta / Lecturer:	prof. dr. Jakob Cimprič, prof. dr. Karin Cvetko-Vah

Jeziki / Languages:	**Predavanja / Lectures:**	slovenski / Slovene
	Vaje / Tutorial:	slovenski / Slovene

Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:	**Prerequisites:**
Vpis v letnik študija.	Enrolment in the programme.
Vsebina:	**Content (Syllabus outline):**

Prvi semester (obveznosti za 5 ECTS):	First semester (5 ECTS)
Vektorji v Rn. Osnove analitične geometrije.	Vectors in Rn. Fundamentals of analytic geometry.
Matrike in determinante. Sistemi linearnih enačb.	Matrices and determinants. Systems of linear equations.
Osnovne algebraične structure.	Basic algebraic structures.
Vektorski prostori, linearna neodvisnost, baze.	Vector spaces, linear independence, bases.
Linearne preslikave in njihove matrike.	Linear transformations and their matrices.
Drugi semester (obveznosti za 5 ECTS):	Second semester (5 ECTS)
Lastne vrednosti in lastni vektorji matrik.	Eigenvalues and eigenvectors of matrices.
Diagonalizacija in Jordanova kanonična forma.	Diagonalization and Jordan canonical form.
Vektorski prostori s skalarnim produktom, ortonormirane baze. Adjungirana preslikava.	Inner product spaces, orthonormal bases, adjoint of a linear transformation.
Simetrične, normalne in ortogonalne matrike.	Symmetric, normal and orthogonal matrices.
Kvadratne forme. Krivulje in ploskve 2. reda.	Quadratic forms. Curves and surfaces of degree two.

Temeljni literatura in viri / Readings:

Učbeniki in zbirke vaj (Textbooks and problem sets)

J. Grasselli, A. Vadnal: Linearna algebra, linearno programiranje, DMFA založništvo, Ljubljana, 1986.

S. I. Grossman, Elementary linear algebra with applications, McGraw-Hill 1994.

E. Kramar, Rešene naloge iz linearne algebre, DMFA, Ljubljana 1994.

M. Dobovišek, D. Kobal, B. Magajna, Naloge iz algebre I, DMFA, Ljubljana, 2000.

S. Lipschutz: Linear Algebra (Schaum's O.S.), McGraw-Hill, New York 1968.

Elektronski viri (Electronic sourses)

Tomaž Košir, Algebra 1, http://www.fmf.uni-lj.si/~kosir/poucevanje/0910/alg1-fm.html

Bojan Orel, Linearna algebra, http://matematika.fri.uni-lj.si/LA/la1.pdf

Cilji in kompetence:	Objectives and competences:

Predvideni študijski rezultati:	Intended learning outcomes:
Poznavanje in razumevanje osnovnih pojmov in postopkov linearne algebra. Sposobnost uporabe pridobljenega znanja v matematiki in drugod.	Familiarity with basic notions and algorithms of Linear algebra. Ability to apply the knowledge in mathematics and elsewhere.

Metode poučevanja in učenja:	Learning and teaching methods:
Predavanja, vaje, domače naloge, konzultacije.	Lectures, tutorials, homework assignments, consultations.

Načini ocenjevanja:	Delež (v %) / Weight (in %)	Assessment:
Način:		Type:
pisni izpit, naloge	50%	Written exam, coursework
ustno izpraševanje	50%	Oral exam

Reference nosilca / Lecturer's references:

Jaka Cimprič:

CIMPRIČ, Jaka. Strict positivstellensätze for matrix polynomials with scalar constraints. Linear Algebra and its Applications, ISSN 0024-3795. [Print ed.], 2011, vol. 434, iss. 8, str. 1879-1883. [COBISS.SI-ID 15863385]

CIMPRIČ, Jaka. Archimedean operator-theoretic Positivstellensätze. Journal of functional analysis, ISSN 0022-1236, 2011, vol. 260, iss. 10, str. 3132-3145. [COBISS.SI-ID 15997529]

CIMPRIČ, Jaka. Real algebraic geometry for matrices over commutative rings. Journal of algebra, ISSN 0021-8693, 2012, vol. 359, str. 89-103. [COBISS.SI-ID 16315993]

Karin Cvetko Vah:

CVETKO-VAH, Karin, LEECH, Jonathan. Rings whose idempotents form a multiplicative set. Communications in algebra, ISSN 0092-7872, 2012, vol. 40, no. 9, str. 3288-3307. [COBISS.SI-ID 16432729]

CVETKO-VAH, Karin. On strongly symmetric skew lattices. Algebra universalis, ISSN 0002-5240, 2011, vol. 66, no. 1-2, str. 99-113. [COBISS.SI-ID 16219993]

CVETKO-VAH, Karin. Internal decompositions of skew lattices. Communications in algebra, ISSN 0092-7872, 2007, vol. 35, no. 1, str. 243-247. [COBISS.SI-ID 14223193]

UČNI NAČRT PREDMETA / COURSE SYLLABUS (leto / year 2017/18)			
Predmet:	Diskretne strukture 2		
Course title:	Discrete structures 2		
Študijski program in stopnja **Study programme and level**	**Študijska smer** **Study field**	**Letnik** **Academic year**	**Semester** **Semester**
Interdisciplinarni univerzitetni študijski program Računalništvo in matematika	ni smeri	1	drugi
Interdisciplinary first cycle academic study programme Computer Science and Mathematics	none	1	second

Vrsta predmeta / Course type	obvezni / compulsory
Univerzitetna koda predmeta / University course code:	27205

Predavanja **Lectures**	**Seminar** **Seminar**	**Vaje** **Tutorial**	**Klinične vaje** **work**	**Druge oblike študija**	**Samost. delo** **Individ. work**	**ECTS**
45		**45**			**90**	**6**

Nosilec predmeta / Lecturer:	prof. dr. Primož Potočnik, prof. dr. Riste Škrekovski

Jeziki / Languages:	**Predavanja / Lectures:**	slovenski / Slovene
	Vaje / Tutorial:	slovenski / Slovene

Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:	**Prerequisites:**
Vpis v letnik študija.	Enrolment in the programme.
Vsebina:	**Content (Syllabus outline):**

Osnovno o grafih. Drevesa. Eulerjevi in Hamiltonovi grafi. Usmerjeni grafi in turnirji. Povezanost in ravninskost grafov. Barvanje vozlišč in povezav grafa. Osnove algebre: grupe, kolobarji, polinomi, komutativni obsegi.	Basics of graph theory. Eulerian and Hamiltonian graphs. Digraphs and tournaments. Connectivity and planarity. Vertex and edge colorings. Basics of abstract algebra: groups, rings, polynomials, fields.

Temeljni literatura in viri / Readings:

Gašper Fijavž: Diskretne strukture, Fakulteta za računalništvo in informatiko (2015) [elektronski vir], http://matematika.fri.uni-lj.si/ds/ds.pdf

Riste Škrekovski: Diskretne strukture II [Elektronski vir] : zapiski predavanj, http://www.fmf.uni-lj.si/skreko/Gradiva/DS2-skripta.pdf , ISBN 978-961-92887-3-3, 62 str.

I. N. Herstein, Abstract Algebra, Wiley and sons (1999).

Martin Juvan in Primož Potočnik: Teorija grafov in kombinatorika: primeri in rešene naloge, Društvo matematikov, fizikov in astronomov Slovenije, Ljubljana 2000, ISBN: 961-212-105-2, 173 str.

Cilji in kompetence:	**Objectives and competences:**
Pri Diskretnih strukturah 2 študent osvoji zahtevnejše vsebine iz teorije grafov in se spozna z osnovami abstraktne algebre.	In Discrete Structures 2 student gains the demanding contents from graph theory and learn the basics of abstract algebra.

Predvideni študijski rezultati:	**Intended learning outcomes:**
Znanje in razumevanje: Predmet temelji na znanju, pridobljenem pri Diskretnih strukturah 1. Vsebine predmeta Diskretne strukture 2 so del potrebnega predznanja za predmete Teorija kodiranja in kriptografija, Kombinatorika ter Optimizacijske metode. Uporaba: Teorija grafov je uporabna v teoriji algoritmov kot orodje za modeliranje raznih problemov. Algebrske strukture se uporabljajo v kriptografiji in kodiranju.	Knowledge and understanding: The course is based on the knowledge gained in Discrete Structures 1 The contents of the course Discrete Structures 2 are part of the necessary background knowledge for the courses Coding theory and criptography, Combinatorics and Optimization methods. Application: Graph theory is useful in the theory of algorithms as a tool for modeling various problems. Algebraic structures used in

Refleksija: Študentje spoznajo razliko med zvezno in diskretno matematiko. Prenosljive spretnosti - niso vezane le na en predmet: Modeliranje problemov in omrežnih struktur z grafi in drevesi. Obvladanje osnovnih algebrskih struktur.	cryptography and coding. Reflection: Students learn the difference between continuous and discrete mathematics. Transferable skills: Modeling problems and network structures with graphs and trees. Mastering basic algebraic structures.

Metode poučevanja in učenja:	**Learning and teaching methods:**
Predavanja in vaje, domače naloge.	Lectures and tutorial sessions, homework.

Načini ocenjevanja:	Delež (v %) / Weight (in %)	**Assessment:**
2 kolokvija namesto izpita iz vaj, izpit iz vaj, ustni izpit / izpit iz teorije. 6-10 (pozitivno), in 1-5 (negativno) (po Statutu UL).	50 50	2 midterm exams instead of written exam, written exam, oral exam / theoretical test. 6-10 (pass), 1-5 (fail) (according to the Statute of UL)

Reference nosilca / Lecturer's references:

Primož Potočnik:

POTOČNIK, Primož. Tetravalent arc-transitive locally-Klein graphs with long consistent cycles. European journal of combinatorics, ISSN 0195-6698, 2014, vol. 36, str. 270-281. [COBISS.SI-ID 16862041]

POTOČNIK, Primož, SPIGA, Pablo, VERRET, Gabriel. Cubic vertex-transitive graphs on up to 1280 vertices. Journal of symbolic computation, ISSN 0747-7171, 2013, vol. 50, str. 465-477. [COBISS.SI-ID 16520537]

POTOČNIK, Primož. Edge-colourings of cubic graphs admitting a solvable vertex-transitive group of automorphisms. Journal of combinatorial theory. Series B, ISSN 0095-8956, 2004, vol. 91, no. 2, str. 289-300. [COBISS.SI-ID 13087321]

KAISER, Tomáš, ŠKREKOVSKI, Riste. T-joins intersecting small edge-cuts in graphs. Journal of graph

theory, ISSN 0364-9024, 2007, vol. 56, no. 1, str. 64-71. [COBISS.SI-ID 14373977]

DVOŘÁK, Zdeněk, ŠKREKOVSKI, Riste. A theorem about a contractible and light edge. SIAM journal on discrete mathematics, ISSN 0895-4801, 2006, vol. 20, no. 1, str. 55-61. [COBISS.SI-ID 14249305]

JUNGIĆ, Veselin, KRÁL', Daniel, ŠKREKOVSKI, Riste. Colorings of plane graphs with no rainbow faces. Combinatorica, ISSN 0209-9683, 2006, vol. 26, no. 2, str. 169-182. [COBISS.SI-ID 13954393]

UČNI NAČRT PREDMETA / COURSE SYLLABUS (leto / year 2017/18)			
Predmet:	Diskretne strukture 1		
Course title:	Discrete structures 1		

Študijski program in stopnja **Study programme and level**	**Študijska smer** **Study field**	**Letnik** **Academic year**	**Semester** **Semester**
Interdisciplinarni univerzitetni študijski program Računalništvo in matematika	ni smeri	1	prvi
Interdisciplinary first cycle academic study programme Computer Science and Mathematics	none	1	first

Vrsta predmeta / Course type	obvezni / compulsory
Univerzitetna koda predmeta / University course code:	27202

Predavanja **Lectures**	**Seminar** **Seminar**	**Vaje** **Tutorial**	**Klinične vaje** **work**	**Druge oblike študija**	**Samost. delo** **Individ. work**	**ECTS**
45		**45**			**90**	**6**

Nosilec predmeta / Lecturer:	prof. dr. Primož Potočnik, prof. dr. Riste Škrekovski

Jeziki / Languages:	**Predavanja / Lectures:**	slovenski / Slovene
	Vaje / Tutorial:	slovenski / Slovene

Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:	**Prerequisites:**
Vpis v letnik študija.	Enrolment in the programme.
Vsebina:	**Content (Syllabus outline):**

Izjavni račun, predikatni račun. Množice in relacije. Urejenosti in mreže. Funkcije in permutacije. Moč množic. Teorija števil.	Predicate logic, predicate calculus. Sets and relations. Orders and lattices. Functions and permutations. Cardinality of sets. Number theory.

Temeljni literatura in viri / Readings:

Riste Škrekovski: Diskretne strukture I [Elektronski vir] : zapiski predavanj, http://www.fmf.uni-lj.si/skreko/Gradiva/DS1-skripta.pdf , ISBN 978-961-92887-2-6, 88 str.

G. Fijavž, Diskretne strukture, Ljubljana, 2014, matematika.fri.uni-lj.si/ds/ds.pdf.

Vladimir Batagelj, Izidor Hafner: Matematika – logika, Drzavna zalozba Slovenije, Ljubljana 1991, 62 str.

Vladimir Batagelj: Diskretne strukture – logika, samozaložba, Ljubljana 1998, 100.

Vladimir Batagelj: Diskretne strukture – množice, samozaložba, Ljubljana 1998, 40.

Vladimir Batagelj in Sandi Klavžar: DS1 – Logika in množice: naloge, Društvo matematikov, fizikov in astronomov Slovenije, Ljubljana 2000, ISBN: 961-212-039-0, 126 str.

Cilji in kompetence:	**Objectives and competences:**
Diskretne strukture predstavljajo osnovo računalniške znanosti, saj je delovno poznavanje osnovnih konceptov diskretnih struktur potrebno na skoraj vseh področjih računalništva. Pri Diskretnih strukturah I študent spozna osnovne pojme logike, teorije množic, teorije števil.	Discrete structures are the basis of computer science, because it is a working knowledge of the basic concepts of discrete structures needed in almost all areas of computing. In Discrete Structures I, the student learns the basic concepts of logic, set theory, number theory.

Predvideni študijski rezultati:	**Intended learning outcomes:**

Znanje in razumevanje: Študentje spoznajo: osnove logike, osnove teorije množic, osnove relacijskega računa, osnovne pojme teorije števil. Uporaba: Študentje znajo: logično sklepati s pomočjo naravne dedukcije, ugotavljati lastnosti relacij in struktur urejenosti, reševati linearne diofantske enačbe z dvema neznankama, računati s kongruencami. Refleksija: Študentje spoznajo razliko med zvezno in diskretno matematiko. Prenosljive spretnosti - niso vezane le na en predmet: uporaba matematične logike za analizo sklepanja, modeliranje odnosov v realnem svetu z relacijami in mrežami.	Knowledge and understanding: Students learn about: fundamentals of logic, set theory basics, basics of calculus queries, the basic concepts of the theory of numbers. Application: Students know: a logical conclusion with the help of deduction, to determine the properties of relations and the structures of orders, solve linear Diophantine equations with two unknowns, to reckon with congruity. Reflection: Students learn the difference between continuous and discrete mathematics. Transferable skills: the use of mathematical logic for the analysis of reasoning, modeling relationships in the real world of relationships and networks.

Metode poučevanja in učenja:	**Learning and teaching methods:**
Predavanja in vaje, domače naloge.	Lectures and tutorial sessions, homework.

Načini ocenjevanja:	Delež (v %) / Weight (in %)	**Assessment:**
2 kolokvija namesto izpita iz vaj, izpit iz vaj, ustni izpit / izpit iz teorije.	50	2 midterm exams instead of written exam, written exam, oral exam / theoretical test.
6-10 (pozitivno), in 1-5 (negativno) (po Statutu UL).	50	6-10 (pass), 1-5 (fail) (according to the Statute of UL)

Reference nosilca / Lecturer's references:

Primož Potočnik:

POTOČNIK, Primož. Tetravalent arc-transitive locally-Klein graphs with long consistent cycles. European journal of combinatorics, ISSN 0195-6698, 2014, vol. 36, str. 270-281. [COBISS.SI-ID

16862041]

POTOČNIK, Primož, SPIGA, Pablo, VERRET, Gabriel. Cubic vertex-transitive graphs on up to 1280 vertices. Journal of symbolic computation, ISSN 0747-7171, 2013, vol. 50, str. 465-477. [COBISS.SI-ID 16520537]

POTOČNIK, Primož. Edge-colourings of cubic graphs admitting a solvable vertex-transitive group of automorphisms. Journal of combinatorial theory. Series B, ISSN 0095-8956, 2004, vol. 91, no. 2, str. 289-300. [COBISS.SI-ID 13087321]

KAISER, Tomáš, ŠKREKOVSKI, Riste. T-joins intersecting small edge-cuts in graphs. Journal of graph theory, ISSN 0364-9024, 2007, vol. 56, no. 1, str. 64-71. [COBISS.SI-ID 14373977]

DVOŘÁK, Zdeněk, ŠKREKOVSKI, Riste. A theorem about a contractible and light edge. SIAM journal on discrete mathematics, ISSN 0895-4801, 2006, vol. 20, no. 1, str. 55-61. [COBISS.SI-ID 14249305]

JUNGIĆ, Veselin, KRÁL', Daniel, ŠKREKOVSKI, Riste. Colorings of plane graphs with no rainbow faces. Combinatorica, ISSN 0209-9683, 2006, vol. 26, no. 2, str. 169-182. [COBISS.SI-ID 13954393]

UČNI NAČRT PREDMETA / COURSE SYLLABUS (leto / year 2017/18)			
Predmet:	Analiza 2		
Course title:	Analysis 2		

Študijski program in stopnja **Study programme and level**	**Študijska smer** **Study field**	**Letnik** **Academic year**	**Semester** **Semester**
Interdisciplinarni univerzitetni študijski program Računalništvo in matematika	ni smeri	1	drugi
Interdisciplinary first cycle academic study programme Computer Science and Mathematics	none	1	second

Vrsta predmeta / Course type	obvezni / compulsory
Univerzitetna koda predmeta / University course code:	27204

Predavanja **Lectures**	**Seminar** **Seminar**	**Vaje** **Tutorial**	**Klinične vaje** **work**	**Druge oblike študija**	**Samost. delo** **Individ. work**	**ECTS**
45		**45**			**120**	**7**

Nosilec predmeta / Lecturer:	prof. dr. Janez Mrčun, prof. dr. Sašo Strle

Jeziki / Languages:	**Predavanja / Lectures:**	slovenski / Slovene
	Vaje / Tutorial:	slovenski / Slovene

Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:	**Prerequisites:**
Vpis v letnik študija.	Enrolment in the programme.
Vsebina:	**Content (Syllabus outline):**

Integral: nedoločeni integral, osnovna pravila za računanje, določeni integral, zveza med določenim in nedoločenim integralom, posplošeni integral, uporaba integrala. Osnove krivulj in ploskev: podajanje krivulj in ploskev (eksplicitno, implicitno, parametrično, polarno), tangenta na krivuljo, risanje krivulj, dolžina loka. Številske in funkcijske vrste: vrste realnih in kompleksnih števil, absolutna in pogojna konvergenca, testi za konvergenco, alternirajoče vrste, funkcijske vrste, enakomerna konvergenca, odvajanje in integriranje vrst po členih, potenčne vrste, Taylorjeva vrsta, Fourierova vrsta. Osnove diferencialnih enačb: diferencialne enačbe 1. reda (ločljive, eksaktne, linearne), linearne diferencialne enačbe 2. reda.	Integral: indefinite integral, integration rules, definite integral, relation between the definite and indefinite integral, improper integrals, applications of integration. Basics of curves and surfaces: descriptions of curves and surfaces (explicit, implicit, parametric, polar coordinates), tangent to a curve, drawing of curves, arc lenght. Number and function series: convergence: series of real and complex numbers, absolute and conditional convergence, convergence tests, alternating series, series of functions, uniform convergence, differentiation and integration of series of functions, power series, Taylor series, Fourier series. Elementary differential equations: differential equations of first order (separable, exact, linear), linear differential equations of second order.

Temeljni literatura in viri / Readings:

Ivan Vidav: Višja matematika I, Ljubljana: DMFA-založništvo, 1994.

Gabrijel Tomšič, Bojan Orel, Neža Mramor Kosta: Matematika I, Ljubljana: Založba FE in FRI, 2001.

Neža Mramor Kosta, Borut Jurčič Zlobec: Zbirka nalog iz matematike I, Ljubljana: Založba FE in FRI, 2001.

Pavlina Mizori-Oblak: Matematika za študente tehnike in naravoslovja, Del 1. Ljubljana: Fakulteta za strojništvo, 1991.

James Stuart: Calculus, Brooks/Cole Publishing Company, 1999.

M. H. Protter, C. B. Morrey, Intermediate Calculus. Springer-Verlag, New York-Heidelberg, 1985.

W. Rudin, Principles of mathematical analysis. McGraw-Hill, Auckland, 1976.

Cilji in kompetence:	**Objectives and competences:**

Študent spozna osnovne pojme matematične analize kot so integral funkcije ene realne spremenljivke, številske in funkcijske vrste, Taylorjeva in Fourierova vrsta, in spozna osnovne metod reševanj diferencialnih enačb prvega in drugega reda. Analiza 2 sodi med temeljne predmete pri študiju matematike in računalništva.	Student learns the basic concepts of mathematical analysis such as integral of real functions of one real variable, numerical and function series, Taylor and Fourier series, and learns the basic metods for solving differential equations of first and second order. Analysis 2 is one of the fundamental courses of the study of mathematics and computer science.

Predvideni študijski rezultati:	**Intended learning outcomes:**
Znanje in razumevanje: Poznavanje in razumevanje osnovnih pojmov, definicij in izrekov. Uporaba: Analiza 2 sodi med temeljne predmete študijskega programa. Razumevanje snovi predmeta je nepogrešljivo pri mnogih drugih matematičnih in računalniških predmetih na programu. Refleksija: Razumevanje teorije na podlagi uporabe. Prenosljive spretnosti - niso vezane le na en predmet: Spretnosti uporabe domače in tuje literature in drugih virov, identifikacija in reševanje problemov, kritična analiza.	Knowledge and understanding: Knowledge and understanding of basic notions, definitions and theorems. Application: Analysis 2 is one of the fundamental courses of the program. Understanding of the material of this course is indispensable for many other mathematics and computer science courses of the program. Reflection: Understanding the theory from the applications. Transferable skills: Skills in using the literature and other sources, the ability to identify and solve the problem, critical analysis.

Metode poučevanja in učenja:	**Learning and teaching methods:**
Predavanja in vaje, domače naloge.	Lectures and tutorial sessions, homework.

Načini ocenjevanja:	Delež (v %) / Weight (in %)	**Assessment:**

2 kolokvija namesto izpita iz vaj, izpit iz vaj, ustni izpit / izpit iz teorije. 6-10 (pozitivno), in 1-5 (negativno) (po Statutu UL).	50 50	2 midterm exams instead of written exam, written exam, oral exam / theoretical test. 6-10 (pass), 1-5 (fail) (according to the Statute of UL)

Reference nosilca / Lecturer's references:

Janez Mrčun:

MOERDIJK, Ieke, MRČUN, Janez. On the developatibility of Lie subalgebroids. Advances in mathematics, ISSN 0001-8708, 2007, vol. 210, no. 1, str.1-21. [COBISS.SI-ID 14209881]

MRČUN, Janez. On isomorphisms of algebras of smooth functions. Proceedings of the American Mathematical Society, ISSN 0002-9939, 2005, vol. 133, no. 10, str. 3109-3113. [COBISS.SI-ID 13782361]

MOERDIJK, Ieke, MRČUN, Janez. On integrability of infinitesimal actions. American journal of mathematics, ISSN 0002-9327, 2002, vol. 124, no. 3, str. 567-593. [COBISS.SI-ID 11700057]

Sašo Strle:

RUBERMAN, Daniel, STRLE, Sašo. Concordance properties of parallel links. Indiana University mathematics journal, ISSN 0022-2518, 2013, vol. 62, no. 3, str. 799-814. [COBISS.SI-ID 16946265]

OWENS, Brendan, STRLE, Sašo. Dehn surgeries and negative-definite four-manifolds. Selecta mathematica. New series, ISSN 1022-1824, 2012, vol. 18, iss. 4, str. 839-854. [COBISS.SI-ID 16808025]

CHA, Jae Choon, KIM, Taehee, RUBERMAN, Daniel, STRLE, Sašo. Smooth concordance of links topologically concordant to the Hopf link. Bulletin of the London Mathematical Society, ISSN 0024-6093, 2012, vol. 44, iss. 3, str. 443-450. [COBISS.SI-ID 16807769]

UČNI NAČRT PREDMETA / COURSE SYLLABUS (leto / year 2017/18)			
Predmet:	Analiza 1		
Course title:	Analysis 1		

Študijski program in stopnja **Study programme and level**	**Študijska smer** **Study field**	**Letnik** **Academic year**	**Semester** **Semester**
Interdisciplinarni univerzitetni študijski program Računalništvo in matematika	ni smeri	1	prvi
Interdisciplinary first cycle academic study programme Computer Science and Mathematics	none	1	first

Vrsta predmeta / Course type	obvezni / compulsory
Univerzitetna koda predmeta / University course code:	27201

Predavanja **Lectures**	**Seminar** **Seminar**	**Vaje** **Tutorial**	**Klinične vaje** **work**	**Druge oblike študija**	**Samost. delo** **Individ. work**	**ECTS**
45		**45**			**120**	**7**

Nosilec predmeta / Lecturer:	prof. dr. Janez Mrčun, prof. dr. Sašo Strle

Jeziki / Languages:	**Predavanja / Lectures:**	slovenski / Slovene
	Vaje / Tutorial:	slovenski / Slovene

Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:	**Prerequisites:**
Vpis v letnik študija.	Enrolment in the programme.
Vsebina:	**Content (Syllabus outline):**

Uvod: naravna števila in matematična indukcija, realna števila, zaporedja, stekališča in limite, kompaktne podmnožice Evklidskih prostorov. Funkcije: pojem funkcije ene in več spremenljivk, nivojske krivulje in nivojske ploskve, zveznost in limita funkcije, lastnosti zveznih funkcij, elementarne funkcije. Odvod funkcij ene spremenljivke: definicija in geometrijski pomen odvoda, pravila za računanje, odvodi elementarnih funkcij, lastnosti odvedljivih funkcij, uporaba odvoda (risanje grafov, računanje limit, ekstremi), Taylorjeva formula. Odvod funkcij več spremenljivk: parcialni odvodi, gradient in smerni odvod, totalni diferencial in tangentni prostor, Taylorjeva formula, lokalni ekstremi in vezani ekstremi, izrek o implicitni funkciji.	Introduction: natural numbers and mathematical induction, real numbers, sequences and limits, compact subsets of Euclidean spaces. Functions: the notion of a function of one and many variables, level curves and level surfaces, continuity and limit of a function, properties of continuous functions, elementary functions. Derivative of a function of one variable: definition of the derivative and its geometric meaning, differentiation rules, derivatives of elementary functions, applications of the derivative (drawing graphs of functions, computations of limits, extrema), Taylor formula. Derivative of a function of many variables: partial derivatives, gradient and directional derivative, total differential and tangent space, Taylor formula, local extrema and conditional extrema, the implicit function theorem.

Temeljni literatura in viri / Readings:

Ivan Vidav: Višja matematika I, Ljubljana: DMFA-založništvo, 1994.

Gabrijel Tomšič, Bojan Orel, Neža Mramor Kosta: Matematika I, Ljubljana: Založba FE in FRI, 2001.

Neža Mramor Kosta, Borut Jurčič Zlobec: Zbirka nalog iz matematike I, Ljubljana: Založba FE in FRI, 2001.

Pavlina Mizori-Oblak: Matematika za študente tehnike in naravoslovja, Del 1. Ljubljana: Fakulteta za strojništvo, 1991.

James Stuart: Calculus, Brooks/Cole Publishing Company, 1999.

M. H. Protter, C. B. Morrey, Intermediate Calculus. Springer-Verlag, New York-Heidelberg, 1985.

W. Rudin, Principles of mathematical analysis. McGraw-Hill, Auckland, 1976.

Cilji in kompetence: **Objectives and competences:**

Študent spozna osnovne pojme matematične analize, kot so limita zaporedja in zveznost ter odvod funkcije ene oziroma več realnih spremenljivk. Analiza 1 sodi med temeljne predmete pri študiju matematike in računalništva.	Student learns the basic concepts of mathematical analysis such as limit of a sequence and continuity and derivative of real functions of one ans well as many real variables. Analysis 1 is one of the fundamental courses of the study of mathematics and computer science.

Predvideni študijski rezultati:	**Intended learning outcomes:**
Znanje in razumevanje: Poznavanje in razumevanje osnovnih pojmov, definicij in izrekov. Uporaba: Analiza 1 sodi med temeljne predmete študijskega programa. Razumevanje snovi predmeta je nepogrešljivo pri mnogih drugih matematičnih in računalniških predmetih na programu. Refleksija: Razumevanje teorije na podlagi uporabe. Prenosljive spretnosti - niso vezane le na en predmet: Spretnosti uporabe domače in tuje literature in drugih virov, identifikacija in reševanje problemov, kritična analiza.	Knowledge and understanding: Knowledge and understanding of basic notions, definitions and theorems. Application: Analysis 1 is one of the fundamental courses of the program. Understanding of the material of this course is indispensable for many other mathematics and computer science courses of the program. Reflection: Understanding the theory fromthe applications. Transferable skills: Skills in using the literature and other sources, the ability to identify and solve the problem, critical analysis.

Metode poučevanja in učenja:	**Learning and teaching methods:**
Predavanja in vaje, domače naloge.	Lectures and tutorial sessions, homework.

Načini ocenjevanja:	Delež (v %) / Weight (in %)	**Assessment:**
2 kolokvija namesto izpita iz vaj, izpit iz vaj, ustni izpit / izpit iz teorije.	50 50	2 midterm exams instead of written exam, written exam, oral exam / theoretical test.

6-10 (pozitivno), in 1-5 (negativno) (po Statutu UL).		6-10 (pass), 1-5 (fail) (according to the Statute of UL)

Reference nosilca / Lecturer's references:

Janez Mrčun:

MOERDIJK, Ieke, MRČUN, Janez. On the developatibility of Lie subalgebroids. Advances in mathematics, ISSN 0001-8708, 2007, vol. 210, no. 1, str.1-21. [COBISS.SI-ID 14209881]

MRČUN, Janez. On isomorphisms of algebras of smooth functions. Proceedings of the American Mathematical Society, ISSN 0002-9939, 2005, vol. 133, no. 10, str. 3109-3113. [COBISS.SI-ID 13782361]

MOERDIJK, Ieke, MRČUN, Janez. On integrability of infinitesimal actions. American journal of mathematics, ISSN 0002-9327, 2002, vol. 124, no. 3, str. 567-593. [COBISS.SI-ID 11700057]

Sašo Strle:

RUBERMAN, Daniel, STRLE, Sašo. Concordance properties of parallel links. Indiana University mathematics journal, ISSN 0022-2518, 2013, vol. 62, no. 3, str. 799-814. [COBISS.SI-ID 16946265]

OWENS, Brendan, STRLE, Sašo. Dehn surgeries and negative-definite four-manifolds. Selecta mathematica. New series, ISSN 1022-1824, 2012, vol. 18, iss. 4, str. 839-854. [COBISS.SI-ID 16808025]

CHA, Jae Choon, KIM, Taehee, RUBERMAN, Daniel, STRLE, Sašo. Smooth concordance of links topologically concordant to the Hopf link. Bulletin of the London Mathematical Society, ISSN 0024-6093, 2012, vol. 44, iss. 3, str. 443-450. [COBISS.SI-ID 16807769]

UČNI NAČRT PREDMETA / COURSE SYLLABUS	
Predmet:	**Diplomski seminar**
Course title:	**Diploma seminar**

Študijski program in stopnja Study programme and level	Študijska smer Study field	Letnik Academic year	Semester Semester
Univerzitetni študijski program prve stopnje Računalništvo in matematika	**ni smeri**	**3**	**letni**
University study programme Computer Science and Mathematics , 1st cycle	**none**	**3**	**spring**

Vrsta predmeta / Course type	**obvezni predmet / compulsory course**
Univerzitetna koda predmeta / University course code:	**63282**

Predavanja Lectures	Seminar Seminar	Vaje Tutorial	Klinične vaje Laboratory work	Druge oblike študija Field work	Samost. delo Individ. work	ECTS
/	/	/	/	/	20	4

Nosilec predmeta / Lecturer:	vsi ustrezno habilitirani pedagogi/ all appropriately habilitated teachers

Jeziki / Languages:	**Predavanja / Lectures:**	slovenščina Slovene
	Vaje / Tutorial:	slovenščina Slovene

Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:	**Prerequisites:**
Pogoj za vključitev v delo je vpis v 3. letnik študija.	Enrollment into 3rd year of studies.

Vsebina:	**Content (Syllabus outline):**

Vsebina je odvisna od izbrane teme.	Content depends on the selected topic.

Temeljni literatura in viri / Readings:

Literatura je odvisna od izbrane teme.

Literature depends on the selected topic.

Cilji in kompetence:	**Objectives and competences:**
Diplomski seminar je pisni izdelek, v katerem študent strokovno poglobljeno obdela problem, ki ga je določil izbrani mentor. Temeljni cilj predmeta je, da študent pridobi sposobnost samostojnega strokovnega dela in pisne ter ustne predstavitve rezultatov.	The diploma seminar is a written section in which the student addresses in the appropriate professional depth a problem determined by the mentor. The fundamental aim of the subject is for the student to acquire the ability for independent professional work and for written and oral presentation of results.
Predvideni študijski rezultati:	**Intended learning outcomes:**
Znanje in razumevanje Študent pridobi znanje in sposobnost samostojnega definiranja problema, določanja ciljev in metod dela ter priprave zaključenega strokovnega dela v pisni obliki. **Uporaba** Študent se usposobi, da znanje, pridobljeno v teku študija uporabi pri reševanju strokovnega problema. **Refleksija** Kritično vrednotenje pridobljenega znanja in spretnosti na izbranem strokovnem področju. **Prenosljive spretnosti – niso vezane le na en**	**Knowledge and understanding** Students acquire knowledge and the ability to independently define a problem, determine goals and methods of work and prepare a concluding professional piece of work in writing. **Application** Students gain the ability to apply the knowledge acquired during studies in solving professional problems. **Reflection** Critical evaluation of knowledge acquired and skills in the selected professional field. **Transferable skills – not tied to just one subject**

predmet Študent se usposobi za samostojno uporabo literature, kritični pritop pri zbiranju in interpretaciji podatkov ter za pisno in ustno sporočanje.	Students are trained in the independent use of literature, taking a critical approach to the collection and interpretation of data and in written and oral reporting.

Metode poučevanja in učenja:	**Learning and teaching methods:**
konzultacije, samostojno strokovno in raziskovalno delo	consultations, independent professional and research work

Načini ocenjevanja:	Delež (v %) / Weight (in %)	**Assessment:**
Pisna naloga in javni zagovor seminarja. Ocene: 6-10 pozitivno, 1-5 negativno (v skladu s Statutom UL)	100 %	Written assignment and public defence of seminar. Grading: 6-10 pass, 1-5 fail (according to University Statute)

Reference nosilca / Lecturer's references: