UČNI NAČRT PREDMETA / COURSE SYLLABUS (leto / year 2017/18)			
Predmet:	Obdelava biomedicinskih signalov in slik		
Course title:	Biomedical signal and image processing		

Študijski program in stopnja **Study programme and level**	**Študijska smer** **Study field**	**Letnik** **Academic year**	**Semester** **Semester**
Interdisciplinarni magistrski študijski program Računalništvo in matematika	ni smeri	1 ali 2	prvi
Interdisciplinary Master's study programme Computer Science and Mathematics	none	1 or 2	first

Vrsta predmeta / Course type	izbirni / elective
Univerzitetna koda predmeta / University course code:	63514

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

Nosilec predmeta / Lecturer:	prof. dr. Franc Jager

Jeziki / Languages:	**Predavanja / Lectures:**	slovenski / Slovene, angleški / English
	Vaje / Tutorial:	slovenski / Slovene, angleški / English

Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:	**Prerequisites:**
Vpis v letnik študija.	Enrolment in the programme.
Vsebina:	**Content (Syllabus outline):**

Predavanja: Predstavitev biomedicinskih signalov in slik kot so: kardiološki signali (EKG), nevrofiziološki signali (EEG, EMG), medicinske slike (CT, MRI, ultrazvok) ter predstavitev modernih računalniških tehnologij v izbranih kliničnih okoljih. Mednarodne standardizirane referenčne podatkovne baze medicinskih vzorcev (MIT/BIH DB, ESC DB, LTST DB, Internetni strežniki). Izločanje značilk (časovni prostor, Fourierjeva transformacija, valčki, principalne komponente – transformacija Karhunena in Loeveja, predstavitve značilk). Izločanje motenj (linearni postopki v časovnem prostoru, postopki v prostorih značilk, uteženo povprečenje, robustni pristopi). Spektralna analiza ter karakterizacija vzorcev in značilk (časovno frekvenčne predstavitve, prostori diagnostičnih in morfoloških značilk). Analiza časovnih vrst in nestacionarnih signalov. Modeliranje (linearni naključni in nelinearni modeli, avtoregresivno modeliranje). Odkrivanje dogodkov, rojenje in klasifikacije (tehnike v časovnem prostoru in prostoru značilk). Procesiranje slik in 3-dimenzionalnih CT ter MRI slik z namenom redukcije motenj, izločanja kontur ter segmentacije in vizualizacije anatomskih struktur. Vrednotenje zmogljivosti biomedicinskih računalniških sistemov (metrike, protokoli, napovedovanje zmogljivosti v realnem svetu, ocene robustnosti, standardi).	Lectures: Introduction to biomedical signals and images like: electrocardiographic signals (ECG), neurophysiological signals (EEG, EMG), medical images (CT, MRI, ultrasound) and introduction to modern computer technologies in selected clinical settings. International standardized reference databases of medical samples (MIT/BIH BD, ESC DB, LTST DB, Internet servers). Feature extraction (time domain, Fourier transform, wavelets, principal components – Karhunen-Loeve transform, feature representations). Noise extraction (linear procedures in time domain, feature space procedures, weigted averaging, robust approaches). Spectral analysis and characterization of samples and features (time-frequency representations, spaces of diagnostic and morphologic features). Analysis of time series and nonstationary signals. Modeling (linear stochastic and non-linear models, autoregressive modeling). Event detection, clustering ans classification (techniques in time domain and in feature space). Image processing and processing of 3-dimensional CT and MRI images with the aim of noise reduction, conture extraxtion, and segmentation and visualization of anatomical structures. Performance evaluation of biomedical computer systems (metrics, protocols, predictioning

Vaje: Vaje bodo potekale v obliki projektnega dela v primerno opremljenih študentskih laboratorijih. Študentje v okviru projektov samostojno implementirajo postopke. Obvezno delo na projektih omogoča poglobljeno in kritično razumevanje obravnavane snovi in spodbuja k samostojnosti in kreativnosti.	performance in real world, assessing robustness, standards). Laboratory work:Practical work will be performed in the form of project work in suitable equipped student laboratories. Students in the scope of projects independently implement procedures. Obligatory work on projects allows deepen and critical understanding of the subjet topics and stimulates to independence and creativity.

Temeljni literatura in viri / Readings:

Kayvan Najaran, Biomedical Signal and Image Processing, C.H.I.P.S., 2005.

Advanced Methods and Tools for ECG Data Analysis (2006) Clifford G, Azuaje F, McSharry PE (editors) Artech House, Inc.

Sornmo L, Laguna P (2005) Biological Signal Processing in Cardiac and Neurological Applications, Elsevier, Inc.

Akay M (2001) Nonlinear biomedical signal processing, vol II. Dynamic analysis and modeling. IEEE Inc.

Selected articles from journals: IEEE Transactions on Biomedical Engineering, Medical and Biological Engineering and Computing, Physiological Measurements, Computers in Biology and Medicine.

Cilji in kompetence:	**Objectives and competences:**
Cilj predmeta je študentom računalništva in informatike predstaviti osnovne obdelave biomedicinskih signalov in slik s poudarkom na problemih biomedicinskih raziskav in klinične medicine. Predmet pokriva principe in postopke za obdelavo determinističnih signalov, naključnih signalov in slik. Teme pokrivajo zajemanje signalov, standardizirane podatkovne baze vzorcev signalov, filtriranje, izločanje značilk, vizualizacijo, spektralno analizo, modeliranje, odkrivanje dogodkov, rojenje, klasifikacije, analizo slik in vrednotenje	Objectives of the course are to represent students of computer and information scence the basics of biomedical signal and image processing with the emphasis on the problems of biomedical researches and clinical medicine. The course covers principles and procedures for processing of deterministic signals, stochastic signals and images. The course topics cover signal acquisition, standardized databases of signal samples, filtering, feature extraction, visualization, spectral analysis, modeling, event detection, clustering, classification, image analysis and performace evaluation of automatic

zmogljivosti avtomatskih postopkov.	procedures.

Predvideni študijski rezultati:	**Intended learning outcomes:**
Znanje in razumevanje: Poznavanje računalniških tehnologij in avtomatskih postopkov analize biomedicinskih signalov in slik za razvoj avtomatskih analizatorjev v pomoč pri diagnosticiranju. Uporaba: Uporaba računalniških tehnologij in avtomatskih postopkov analize biomedicinskih signalov in slik pri specifičnih aplikacijah medicinskih preiskav in medicinske prakse. Refleksija: Spoznavanje in razumevanje uglašenosti med teorijo in njeno aplikacijo na konkretnih primerih s področja razvoja avtomatskih analizatorjev za pomoč pri diagnosticiranju. Prenosljive spretnosti - niso vezane le na en predmet: Reševanje sorodnih problemov analize eno in več- dimenzionalnih signalov na osnovi modelov analize biomedicinskih signalov in slik.	Knowledge and understanding: Acquaintancing of computer technologies and automatic procedures of biomedical signal and image analysis to develop automatic analyzers for help in diagnose.Application: Use of computer technologies and automatic procedures of biomedical signal and image analysis in specific applications of medical examination and medical praxis.Reflection: Acquaintancing and understandig of harmony between theory and its application on the concrete examples from the field of development of automatic analyzers for help in diagnose.Transferable skills: Solving of modern problems of one - and multi-dimensional signals on the basis of biomedical signal and image analysis models.

Metode poučevanja in učenja:	**Learning and teaching methods:**
Predavanja, vaje z aktivnim sodelovanjem, seminarski način dela pri individualnih projektih. Poseben poudarek je pri sprotnem študiju in sprotnem delu pri vajah in seminarjih.	Lectures, laboratory work with active cooperation, seminar type of work on individual projects. Special emphasize is given to prompt study and prompt work on laboratory work and seminars.

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 (according to the rules of University of Ljubljana)

Reference nosilca / Lecturer's references:

AMON, Miha, JAGER, Franc. Electrocardiogram ST-segment morphology delineation method using orthogonal transformations. PloS one, ISSN 1932-6203, 2016, vol. 11, no. 2, str. 1-18, graf. prikazi. [COBISS.SI-ID 1536764611]

TROJNER-BREGAR, Andreja, LUČOVNIK, Miha, VERDENIK, Ivan, JAGER, Franc, GERŠAK, Ksenija, GARFIELD, Robert. Uterine electromyography during active phase compared with latent phase of labor at term. Acta obstetricia et gynecologica Scandinavica, ISSN 0001-6349. [Print ed.], Feb. 2016, vol. 95, no. 2, str. 197-202. [COBISS.SI-ID 1536765379]

PANGERC, Urška, JAGER, Franc. Robust detection of heart beats in multimodal records using slope- and peak-sensitive band-pass filters. Physiological measurement, ISSN 0967-3334. [Print ed.], Aug. 2015, vol. 36, no. 8, str. 1645-1664, ilustr. [COBISS.SI-ID 1536389571]

JAGER, Franc. Introduction to feature extraction. V: CLIFFORD, Gari D. (ur.), AZUAJE, Francisco (ur.), MCSHARRY, Patrick E. (ur.). Advanced methods and tools for ECG data analysis, (Artech House engineering in medicine & biology series). Boston; London: Artech House, cop. 2006, str. 245-267. [COBISS.SI-ID 9880916]

JAGER, Franc, TADDEI, Alessandro, MOODY, George B., EMDIN, Michele, ANTOLIČ, Gorazd, DORN, Roman, SMRDEL, Aleš, MARCHESI, Carlo, MARK, Roger G. Long-term ST database : a reference for the development and evaluation of automated ischaemia detectors and for the study of the dynamics of myocardial ischaemia. Medical & biological engineering & computing, ISSN 0140-0118. [Print ed.], 2003, vol. 41, str. 172-182. [COBISS.SI-ID 3464532]