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| **UČNI NAČRT PREDMETA / COURSE SYLLABUS** | | | | | | | | | | | | | | | | | |
| **Predmet:** | | | Merjenje in obdelava biomedicinskih signalov | | | | | | | | | | | | | | |
| **Course title:** | | | Measurement and processing of biomedical signals | | | | | | | | | | | | | | |
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| **Študijski program in stopnja**  **Study programme and level** | | | | | **Študijska smer**  **Study field** | | | | | | | | **Letnik**  **Academic year** | | **Semester**  **Semester** | | |
| doktorski študijski program tretje stopnje Elektrotehnika | | | | | Ni smeri | | | | | | | | 1 | |  | | |
| 3rd cycle: doctoral study programme Electrical Engineering | | | | |  | | | | | | | |  | |  | | |
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| **Vrsta predmeta / Course type** | | | | | | | | | | | | Izbirni/Elective | | | | | |
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| **Univerzitetna koda predmeta / University course code:** | | | | | | | | | | | | 64881 | | | | | |
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| **Predavanja**  **Lectures** | **Seminar**  **Seminar** | | | **Vaje**  **Tutorial** | | | **Klinične vaje**  **work** | | | | **Druge oblike študija** | | | **Samost. delo**  **Individ. work** | |  | **ECTS** |
| **30** | **30** | | |  | | |  | | | |  | | | **65** | |  | **5** |
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| **Nosilec predmeta / Lecturer:** | | | | | Izr.prof. Tomaž Jarm | | | | | | | | | | | | |
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| **Jeziki /**  **Languages:** | | **Predavanja / Lectures:** | | | | **slovenski/Slovenian**  **(po potrebi angleški/English if needed)** | | | | | | | | | | | |
| **Vaje / Tutorial:** | | | |  | | | | | | | | | | | |
| **Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:** | | | | | | | | |  | **Prerequisits:** | | | | | | | |
| Vpis na podiplomski doktorski študij | | | | | | | | |  | Inscription in postgraduate doctoral study program | | | | | | | |
| **Vsebina:** | | | | | | | |  | | **Content (Syllabus outline):** | | | | | | | |
| Poglobljen pregled izbranih signalov biološkega izvora, ki jih srečujemo v raziskovalnem ali kliničnem medicinskem okolju. Fiziološki izvor in lastnosti teh signalov. Fizikalno ozadje in uporaba metod za zajem in merjenje teh signalov. Elektrode in merilne sonde za zajem neelektričnih veličin. Metode za obdelavo teh signalov v časovnem in frekvenčnem prostoru za pridobitev klinično ali raziskovalno relevantne informacije o signalnem viru (biološkem sistemu). Konkretni primeri uporabe.  Obravnavali bomo signale naslednjih izvorov: elektrofiziološki signali (elektrokardiografija, elektromiografija skeletnih in gladkih mišic, elektroencefalografija, prevajanje po živcih); pretok krvi (ultrazvok, laser Doppler); oksigenacija (bližnje infrardeča spektroskopija in metode za oksimetrijo); meritve za določitev lastnosti bioloških celic (mikroskopija, spektroskopija). | | | | | | | |  | | Advanced overview of selected signals of biological origin encountered in research or in medical clinical environment. Physiological origin and typical properties of these signals. Physical background and application of methods for acquisition and measurement of these signals. Electrodes and probes for acquisition of non-electrical quantities. Signal processing methods in time and frequency domain for extraction of clinically or experimentally relevant information about the biological system. Concrete examples of application.  The signals of these origins are to be discussed: electrophysiological signals (electrocardiography, electromyography of skeletal and smooth muscles, electroencephalography, nerve conduction); blood flow (ultrasound, laser Doppler); oxygenation (near infrared spectroscopy and methods for oximetry); measurement of biological cell properties (microscopy and spectroscopy). | | | | | | | |

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| **Temeljni literatura in viri / Readings:** | | | | | |
| L. Soernmo, P. Laguna: Bioelectrical signal processing in cardiac and neurological applications. Academic Press, 2005.  R.M. Rangayyan: Biomedical signal analysis: a case-study approach. Wiley-IEEE Press, 2002.  Electromyography  J.D. Bronzino (ed.): The Biomedical Engineering Handbook, (3rd ed.), Vol. 2: Medical Devices and Systems. CRC Press, 2006.  R. Merletti, P. Parker: Electromyography. IEEE Press/Wiley, 2004.  T. Tagawa, T. Tamura, P. Ake Oberg: Biomedical Sensors and Instruments (2nd ed.). CRC Press, 2011.  T. G. Leighton: The Acoustic Bubble. Elsevier, 1994.  Izbrani članki iz znanstvenih revij/Selected papers from scientific journals | | | | | |
| **Cilji in kompetence:** | |  | | **Objectives and competences:** | |
| Pridobiti znanje in razumevanje o metodah zajema in obdelave različnih signalov fiziološkega izvora s s praktičnim namenom pridobitve klinično ali raziskovalno pomembnih podatkov o lastnostih in delovanju biološkega sistema. Z izdelavo usmerjene projektne naloge študenti lahko pridobljeno znanje uporabijo za reševanje konkretnega problema. | |  | | To gain knowledge and understanding of the methods for acquisition and processing of different physiological signals from the practical point of view of extracting relevant information (for clinical or reserch use) about properties and function of a biological system. By working on a project students can apply this knowledge to solving a concrete problem on a selected topic. | |
| **Predvideni študijski rezultati:** | | |  | **Intended learning outcomes:** | |
| Spoznati širši nabor različnih biomedicinskih signalov, vključno z izvorom (celica, tkivo, organ), fiziološkim mehanizmom nastanka, lastnostmi in pomenom za klinično ali raziskovalno delo. Razumeti fizikalni princip merilnih metod za zajem biomedicinskih signalov.  Na tipičnih primerih uporabe spoznati metodologijo obdelave signalov za pridobitev želene informacije. Pridobiti spretnost za reševanje konkretnega problema iz biomedicinskega področja. | | |  | To learn about different biomedical signals, including their sources (cell, tissue, organ), physiological mechanisms of appearance, properties and relevance for clinical or research work. To understand physical principles of methods for measurement of biomedical signals.  To learn about methodology of signal processing to obtain required information, using typical examples from the biomedical field. To gain skills for solving a concrete problem from this field. | |
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| **Metode poučevanja in učenja:** | | |  | **Learning and teaching methods:** | |
| Predavanja v primeru zadostnega števila vpisanih študentov, sicer samostojen študij z rednimi individualnimi konzultacijami.  Vsak študent dobi konkretno uporabno projektno nalogo z izbranega ožjega področja zajema in obdelave biomedicinskih signalov, v okviru katere razišče problematiko problema in poda rešitev. | | |  | Lectures in case of sufficient number of students, otherwise independent study with regular individual consultations.  Every student is presented with a concrete applicative project on a selected topic from biomedical signal measurement and processing and is expected to find a solution to the problem based on literature search and practical work. | |
| **Načini ocenjevanja:** | Delež (v %) /  Weight (in %) | | | | **Assessment:** |
| V primeru predavanj: pisni in/ali ustni izpit (50%) in ocena projekta (50%).  V primeru samostojnega študija: delne ocene sprotnega dela ob rednih srečanjih (50%) in projekt (50%)  Končne ocene so lahko : 6(zadostno); 7(dobro); 8 in 9(zelo dobro), 10(odlično) | **Izpit/**  **Exam: 50%**  **Projekt/**  **Project: 50%** | | | | In case of lecturs: written or oral exam (50%) and project assessment (50%).  In case of independent study: partial assessment of study results at periodical meeting (50%) and project assessment (50%).  The final grades are: 6(passing grade), 7(good), 8-9(very good), 10(excellent). |
| **Reference nosilca / Lecturer's references:** | | | | | |
| 1. Mali B, Gorjup V, Edhemovic I, Brecelj E, Cemažar M, Sersa G, Strazisar B, Miklavcic D, Jarm T (2015). Electrochemotherapy of colorectal liver metastases - an observational study of its effects on the electrocardiogram. Biomed Eng Online 14(suppl. 3):1-17 (http://www.biomedical-engineering-online.com/content/14/S3/S5) 2. Mali B, Zulj S, Magijarevic R, Miklavcic D, Jarm T (2014) Matlab-based tool for ECG and HRV analysis. Biomed Signal Proc Control 10:108-116 3. Mali B, Jarm T, Snoj M, Sersa G, Miklavcic D (2013) Antitumor effectiveness of electrochemotherapy : a systematic review and meta-analysis. Eur J Surg Oncol 39(1):4-16 4. Stirn I, Jarm T, Kapus V, Strojnik V (2011) Evaluation of muscle fatigue during 100-m front crawl. Eur J Appl Physiol 111(1):101-113 5. Jarm T, Cemazar M, Miklavcic D, Sersa G (2010) Antivascular effects of electrochemotherapy : implications in treatment of bleeding metastases. Exp Rev Anticancer Ther 10(5):729-746 | | | | | |