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| **UČNI NAČRT PREDMETA / COURSE SYLLABUS** | | | | | | | | | | | | | | | | | |
| **Predmet:** | | | Biomedicinska elektronika | | | | | | | | | | | | | | |
| **Course title:** | | | Biomedical Electronics | | | | | | | | | | | | | | |
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| **Študijski program in stopnja**  **Study programme and level** | | | | | **Študijska smer**  **Study field** | | | | | | | | **Letnik**  **Academic year** | | **Semester**  **Semester** | | |
| Podiplomski magistrski študijski program druge stopnje Elektrotehnika | | | | | Biomedicinska tehnika | | | | | | | | 1 | | 1 | | |
| 2nd cycle masters study programme in Electrical Engineering | | | | | Biomedical Engineering | | | | | | | | 1 | | 1 | | |
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| **Vrsta predmeta / Course type** | | | | | | | | | | | | Obvezni-strokovni / Compulsory professional | | | | | |
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| **Univerzitetna koda predmeta / University course code:** | | | | | | | | | | | | 64211 | | | | | |
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| **Predavanja**  **Lectures** | **Seminar**  **Seminar** | | | **Vaje**  **Tutorial** | | | **Klinične vaje**  **work** | | | | **Druge oblike študija** | | | **Samost. delo**  **Individ. work** | |  | **ECTS** |
| **45** | **0** | | | **30** | | |  | | | |  | | | **75** | |  | **6** |
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| **Nosilec predmeta / Lecturer:** | | | | | Tomaž Jarm | | | | | | | | | | | | |
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| **Jeziki /**  **Languages:** | | **Predavanja / Lectures:** | | | | Slovensko/Slovene | | | | | | | | | | | |
| **Vaje / Tutorial:** | | | | Slovensko/Slovene | | | | | | | | | | | |
| **Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:** | | | | | | | | |  | **Prerequisits:** | | | | | | | |
| Vpis v letnik. | | | | | | | | |  | Enrolment in the year of the course. | | | | | | | |
| **Vsebina:** | | | | | | | |  | | **Content (Syllabus outline):** | | | | | | | |
| Zajem biomedicinskih signalov: pogojevanje bioelektričnih in drugih signalov; galvanska ločitev signalov; predojačevalniki; viri šuma in ukrepi za zmanjšanje električnih motenj; merjenje majhnih signalov; ojačevalniki in krmilniki; instrumentacijski ojačevalnik; pasivni in aktivni filtri; frekvenčna področja biomedicinskih signalov; pasovno prepustno filtriranje biomedicinskih signalov; viri signalov za električno stimulacijo v biomedicini. Inštrumentacija za zajem bioelektričnih signalov: elektrokardiograf, elektroencefalograf, elektromiograf. Električna stimulacija vzdražnih tkiv: srčni spodbujevalniki, kardioverterji, defibrilatorji. Električni kirurški nož. Elektromagnetna kompatibilnost medicinskih naprav in varnost (nevarnosti električnega udara, uhajavi tokovi, varnostni ukrepi pri načrtovanju in uporabi elektronskih naprav, označevanje in testiranje medicinske opreme, varnostni standardi). | | | | | | | |  | | Biomedical signal acquisition: conditioning of bioelectric and other signals; signal isolation, preamplifiers; noise sources and measures to limit their contribution to signal contamination; small signal acquisition; instrumentation amplifiers; active and passive filters; frequency bands of typical biomedical signals; filtering of biomedical signals; pulse and waveform generators for electrical stimulation of tissues.  Biomedical instrumentation for signal acquisition: ECG, EMG, EEG. Electrical stimulation of excitable tissues, heart pacemakers, cardioverters, defibrillators, functional electrical stimulation. Electrosurgical devices. Electromagnetic compatibility and safety of electrical medical devices (sources of danger (electrical hazards), safety measures, leakage currents, safety-related markings on equipment, safety testing, safety and other standards). | | | | | | | |

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| **Temeljni literatura in viri / Readings:** | | | | | |
| 1. David Prutchi, Michael Norris: Design and Development of Medical Electronic Instrumentation: A Practical Perspective of the Design, Construction, and Test of Medical Devices. Wiley-Interscience, 2004 2. N. Leitgeb: Safety of electromedical devices. Springer, 2010. 3. J.D. Bronzino (editor): The biomedical engineering handbook (3rd ed.). CRC Press, 2006. 4. J. G. Webster (editor): Medical Instrumentation Application and Design (4th edition). Wiley, 2008. 5. Alojz Kralj (editor): Osnove medicinske elektrotehnike. Dopisna delavska univerza Univerzum, Ljubljana, 1983. 6. A. Šantić: Biomedicinska elektronika, Školska knjiga Zagreb, 1994. | | | | | |
| **Cilji in kompetence:** | |  | | **Objectives and competences:** | |
| Spoznati specifične elektronske sklope ter zgradbo in komponente elektronskih biomedicinskih naprav. Pridobiti praktične izkušnje z uporabo nekaterih obravnavanih inštrumentov ter z izgradnjo in preizkusom varno delujočega merilnega ojačevalnika za zajem elektrofiziološkega signala (EKG ali EMG) ali električnega stimulatorja.  Zgraditi zavest o potrebi po zagotavljanju varnega delovanja biomedicinskih naprav s stališča uporabnika in operaterja in pridobiti osnovno znanje o zagotavljanju varnosti pred električnim udarom v medicinskem okolju. | |  | | To learn about specific electronic circuits and elements typically encountered in medical instruments used in clinical and research environment. To gain practical experience from using the instruments and from building and testing a biopotential amplifier or electrical stimulator or some other device.  To build awareness of the need for safe design, operation and use of biomedical devices from the patient's and the operator's point of view. To gain elementary knowledge about standards and measures needed to protect against electrical hazards in medical environment. | |
| **Predvideni študijski rezultati:** | | |  | **Intended learning outcomes:** | |
| Znanje in razumevanje:  Poznavanje zgradbe in razumevanje delovanja nekaterih elektronskih medicinskih naprav. Poznavanje posameznih specifičnih elektronskih sklopov, ki nastopajo v merilni, diagnostični ali terapevtski elektronski opremi. Poznavanje in razumevanje dejstev v zvezi z nevarnosti električnega udara v medicinskem okolju ter ukrepi za njihovo preprečitev.  Uporaba: Usposobljenost za osnovno uporabo nekaterih biomedicinskih inštrumentov Uporaba pridobljenega znanja za izgradnjo ojačevalnika za varen in kvaliteten zajem majhnih bioelektričnih signalov in drugih osnovnih elektronskih sklopov.  Refleksija: Zavedanje o različnih varnostnih vidikih uporabe elektronskih naprav v medicinskem okolju.  Prenosljive spretnosti: Vrednotenje delovanja medicinske elektronike in naprav. Sposobnost izbrati primeren inštrument ali elektronski sklop za določen namen in hkrati prepoznati omejitve izbranega. Samostojno iskanje dodatnih virov informacij. | | |  | Knowledge and understanding: Knowledge about structure and understanding of the function of typical electronic medical devices and specific electric circuits commonly encountered in measurement, diagnostic or therapeutic instruments. Understanding of potential electrical hazards and measures for their prevention in medical environment.  Practical use: Ability for elementary use of selected biomedical instruments. Application of knowledge to build a biopotential amplifier (and acquire signals), an electrical stimulator or some other device and to evaluate its characteristics.  Reflexion: Awareness of different sources of danger in application of electrical devices in medical environment.  Transferable skills: Ability to evaluate electrical medical devices. Ability to select an appropriate method or a device for a specific purpose and to recognize its limitations,. | |
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| **Metode poučevanja in učenja:** | | |  | **Learning and teaching methods:** | |
| Na predavanjih študenti spoznajo teoretične osnove zgradbe in delovanja tipičnih elektronskih biomedicinskih naprav in posameznih specifičnih sestavnih sklopov. Praktične vaje so namenjene izvedbi konkretnih nalog. Vključujejo projektno nalogo, v okviru katere študenti načrtujejo in zgradijo osnovni ojačevalnik majhnih bioelektričnih potencialov (EKG ali EMG), katerega delovanje preizkusijo in ovrednotijo ter primerjajo s komercialno napravo za ta namen. Vaje in predavanja pri tem predmetu se dopolnjujejo z vsebinami predmeta Meritve in senzorji v biomedicini. | | |  | Lectures, individual practical lab assignments, one major project assignment (planning, designing, building and evaluation of a biopotential amplifier or some other device to acquire a specific biomedical signal), self  study. This course should be taken together with the course Measurements and Sensors in Biomedicine (both courses run in parallel and share some of the lab work and the project). | |
| **Načini ocenjevanja:** | Delež (v %) /  Weight (in %) | | | | **Assessment:** |
| Način: laboratorijske vaje (lahko delno izvedeno kot projekt), izpit (pisni in/ali ustni).  Ocene od 1 do vključno 5 so negativne, ocene od vključno 6 do 10 so pozitivne.  Pozitivna ocena laboratorijskih vaj je pogoj za pristop k izpitu.  Prispevki k oceni:   * izpit * vaje | 60%  40% | | | | Type: laboratory exercises (can be partially realized as a project), exam (written and/or oral).  Negative grades: from 1 to 5, positive grades: from 6 to 10.  Positive evaluation of laboratory exercises is a prerequisite for the exam.  Contributions to the final grade:   * exam * practicals |
| **Reference nosilca / Lecturer's references:** | | | | | |
| 1. JARM, Tomaž. Elektronika : priročnik za laboratorijske vaje. 3. popravljena in dopolnjena izd. Ljubljana: Založba FE in FRI, 2010. ISBN 978-961-243-140-2. [COBISS.SI-ID 250105344] 2. MIKLAVČIČ, Damijan, SERŠA, Gregor, BRECELJ, Erik, GEHL, Julie, SODEN, Declan M., BIANCHI, Guiseppe, RUGGIERI, Pietro, ROSSI, Carlo Riccardo, CAMPANA, Luca G., JARM, Tomaž. Electrochemotherapy : technological advancements for efficient electroporation-based treatment of internal tumors. Medical & biological engineering & computing, vol. 50, no. 12, str. 1213-1225. 3. EDHEMOVIĆ, Ibrahim, GADŽIJEV, Eldar, BRECELJ, Erik, MIKLAVČIČ, Damijan, KOS, Bor, ŽUPANIČ, Anže, MALI, Barbara, JARM, Tomaž, PAVLIHA, Denis, MARČAN, Marija, GAŠLJEVIĆ, Gorana, GORJUP, Vesna, MAROLT-MUŠIČ, Maja, PEČNIK-VAVPOTIČ, Tjaša, ČEMAŽAR, Maja, SNOJ, Marko, SERŠA, Gregor. Electrochemotherapy : a new technological approach in treatment of metastases in the liver. Technology in cancer research and treatment, vol. 10, no. 5, str. 475-485. 4. JARM, Tomaž, ČEMAŽAR, Maja, SERŠA, Gregor. Tumor blood flow-modifying effects of electroporation and electrochemotherapy - experimental evidence and implications for the therapy. V: PAKHOMOV, Andrei G. (ur.), MIKLAVČIČ, Damijan (ur.), MARKOV, Marko S. (ur.). Advanced electroporation techniques in biology and medicine, (Biological effects of electromagnetics series). CRC Press, cop. 2010., str. 401-423. 5. JARM, Tomaž, ČEMAŽAR, Maja, MIKLAVČIČ, Damijan, SERŠA, Gregor. Antivascular effects of electrochemotherapy : implications in treatment of bleeding metastases. Expert rev. anticancer ther., 2010, vol. 10, no. 5, str. 729-746. [COBISS.SI-ID 929659] | | | | | |