

UČNI NAČRT PREDMETA/COURSE SYLLABUS

Predmet: Biomedicinska elektronika
Course title: Biomedical Electronics

Študijski programi in stopnja	Študijska smer	Letnik	Semestri
Elektrotehnika, druga stopnja, magistrski	Biomedicinska tehnika (smer)	1. letnik	Zimski

Univerzitetna koda predmeta/University course code: 64211

Predavanja	Seminar	Vaje	Klinične vaje	Druge oblike študija	Samostojno delo	ECTS
45		30			75	6

Nosilec predmeta/Lecturer: Tomaž Jarm

Vrsta predmeta/Course type: Vpis v letnik./Compulsory professional

Jeziki/Languages:	Predavanja/Lectures:	Slovenščina
	Vaje/Tutorial:	Slovenščina

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

Prerequisites:

Vpis v letnik.	Enrolment in the year of the course.
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Vsebina:

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).

Content (Syllabus outline):

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).

Temeljna literatura in viri/Readings:

- 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
- N. Leitgeb: Safety of electromedical devices. Springer, 2010.
- J.D. Bronzino (editor): The biomedical engineering handbook (3rd ed.). CRC Press, 2006.
- J. G. Webster (editor): Medical Instrumentation Application and Design (4th edition). Wiley, 2008.
- Alojz Kralj (editor): Osnove medicinske elektrotehnike. Dopsna delavska univerza Univerzum, Ljubljana, 1983.
- A. Šantić: Biomedicinska elektronika, Školska knjiga Zagreb, 1994.

Cilji in kompetence: 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.	Objectives and competences: 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: Po uspešno opravljenem predmetu na bi bili študenti zmožni: - Opisati namen in delovanje elektronskih medicinskih naprav, ki jih pogosto srečamo v kliničnem ali raziskovalnem okolju. - Razložiti delovanje posameznih specifičnih elektronskih sklopov, ki nastopajo v merilni, diagnostični ali terapevtski medicinski opremi. - Razložiti fiziološko ozadje učinkov električnega toka na človeka. - Pojasniti razna dejstva v zvezi z nevarnostmi električnega udara in zagotavljanjem varnosti pri uporabi električnih medicinskih aparatov. - Uporabiti nekatere biomedicinske naprave za določen namen. - Zgraditi bioojačevalnik (ali neko drugo medicinsko napravo) za varen zajem elektrofiziološkega signala. - Ovrednotiti delovanje elektromedicinske aparature. - Zasnovati preprosto elektromedicinsko napravo za merjenje izbrane veličine. - Zgraditi in preizkusiti preprosto elektromedicinsko napravo.	Intended learning outcomes: After successful completion of the course, students should be able to: - Describe the purpose and function of electronic medical devices typical for clinical or research environment. - Explain the function of specific electric circuits commonly encountered in measurement, diagnostic or therapeutic medical instruments. - Explain physiological background of effects of electric currents on humans. - Explain various aspects related to electrical hazards and safety assurance requirements for use of electrical medical devices. - Use selected biomedical devices in practical application. - Build a bioamplifier (or some other medical device) for safe acquisition of an electrophysiological signal. - Quantify the performance of electrical medical device. - Design a simple electrical medical device for measurement of selected physical quantity. - Build and test a simple electrical medical device.	
Metode poučevanja in učenja: 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.	Learning and teaching methods: 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: Način: laboratorijske vaje (lahko delno izvedeno kot projekt), izpit (pisni ali ustni ali kombinacija obeh oblik). Ocena 5 je negativna ocena, ocene	Delež/Weight	Assessment: Type: laboratory exercises (can be partially realized as a project), exam (written, oral or a combination of both). Negative grade is 5,

od vključno 6 do 10 so pozitivne. Pozitivna ocena laboratorijskih vaj je pogoj za pristop k izpitu. Prispevki k oceni: - izpit - vaje		positive grades: from 6 to 10. Positive evaluation of laboratory exercises is a prerequisite for the exam. Contributions to the final grade: - exam - practicals
- izpit	60,00 %	- exam
- vaje	40,00 %	- 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. EDHEMOVIČ, Ibrahim, GADŽIJEV, Eldar, BRECELJ, Erik, MIKLAVČIČ, Damijan, KOS, Bor, ŽUPANIČ, Anže, MALI, Barbara, JARM, Tomaž, PAVLIHA, Denis, MARČAN, Marija, GAŠLJEVIČ, 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]