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| **UČNI NAČRT PREDMETA / COURSE SYLLABUS** | | | | | | | | | | | | | | | | | |
| **Predmet:** | | | Nevrokibernetika | | | | | | | | | | | | | | |
| **Course title:** | | | Neurocybernetics | | | | | | | | | | | | | | |
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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 | | 2 | | |
| 2nd cycle masters study programme in Electrical Engineering | | | | | Biomedical Engineering | | | | | | | | 1 | | 2 | | |
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| **Vrsta predmeta / Course type** | | | | | | | | | | | | Obvezni-strokovni / Compulsory professional | | | | | |
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| **Univerzitetna koda predmeta / University course code:** | | | | | | | | | | | | 64212 | | | | | |
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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:** | | | | | Damijan Miklavčič | | | | | | | | | | | | |
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| **Jeziki /**  **Languages:** | | **Predavanja / Lectures:** | | | | slovenski jezik/slovenian language | | | | | | | | | | | |
| **Vaje / Tutorial:** | | | | slovenski in angleški jezik/slovenian and english language | | | | | | | | | | | |
| **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):** | | | | | | | |
| Zgradba nevrona, Nernstova enačba, mirovna membranska napetost, nastanek akcijskega potenciala, prenos signalov vzdolž nevronov in med nevroni, sinapse, nevrotransmiterji in njihovi receptorji. Ideja formalnega nevrona in osnove nevronskih mrež. Zgradba mišic in posebnosti skeletnih, gladkih in srčne mišice. Hillova enačba, proces mišičnega utrujanja. Gibanje in njegov nadzor: spodnji motorični nevron, zgornji motorični nevron, vloga možganskega debla, malih možganov, globjih možganskih struktur in motoričnega korteksa. Receptorji in senzorični organi: nastanek in oblika signala, ki je posledica percepcije; vid, sluh, bolečina in zaznavanje kemijskih substanc. Refleksi. Višje možganske funkcije, spomin, učenje, senzorično-motorična integracija. Elektrotehniške naprave, ki nadomeščajo izgubljene telesne funkcije. | | | | | | | |  | | Structure of the neuron, Nernst equation, transmembrane potential, the formation of an action potential, transmission of signals along the neurons and between neurons, synapses, neurotransmitters and their receptors. The idea of formal neuron and the basic neural networks. Muscles and specialities of skeletal, smooth and cardiac muscle. Hill’s equation, the process of muscle fatigue. Movement and its control: the lower motor neuron, upper motor neuron, the role of the brainstem, cerebellum, deeper brain structures and motor cortex. Receptors and sensory organs: the formation and shape of the signal, which is a result of perception; vision, hearing, pain and detection of chemical substances. Reflexes. Higher brain functions, memory, learning, sensory-motor integration. Electrotechnical devices that replace lost body functions. | | | | | | | |

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| **Temeljni literatura in viri / Readings:** | | | | | |
| 1. Purves D, Augustine GJ, Fitzpatrick D, Hall WC, LaMantia AS, McNamara JO, White LE. Neuroscience. Sinauer Associates; 4th Edition edition, 2007. 2. Deutsch S, Deutsch A. Understanding the nervous system An engineering perspective. Wiley-IEEE Press, 1993. 3. Pflanzer RG. Experimental and Applied Physiology. McGraw-Hill, 2007. 4. Guyton AC, Hall JE. Textbook Of Medical Physiology. W.B. Saunders Company: 10th ed. 2000. 5. Barth FG, Humphrey JAC, Secomb TW. Sensors and sensing in biology and enginnering. Springer, 2003. | | | | | |
| **Cilji in kompetence:** | |  | | **Objectives and competences:** | |
| Seznaniti slušatelje z delovanjem živih organizmov in njihovih sestavnih delov. Poudarek je na razumevanju načinov sprejemanja različnih informacij iz okolja, prenašanju informacij po organizmu, procesiranju informacij, integraciji različnih tipov informacij in nastanku odziva na te informacije. Fiziologija živega organizma je predstavljena z inženirskega stališča. Tak način omogoča slušatelju bodisi prenos optimiranih rešitev iz narave v tehniško okolje (bionika) bodisi idejno snovanje novih naprav, ki bodo nadomeščale izgubljene ali dopolnjevale okrnjene telesne funkcije. | |  | | To introduce the students with the activity of living organisms and their components. The focus of the course is in understanding the ways of acquiring various information from the environment, transferring information in the organism, information processing, integration different types of information and producing appropriate response to this information. Physiology of a living organism is represented by an engineering point of view. This concept allows the student the transfer of optimized solutions from the nature to the technical environment (bionics) or design of the new facilities that are appropriate for compensation of lost body functions. | |
| **Predvideni študijski rezultati:** | | |  | **Intended learning outcomes:** | |
| Znanje in razumevanje:  Poglobiti, razširiti in integrirati znanje fiziologije živih organizmov z inženirskega stališča. | | |  | Knowledge and understanding:  Deepen, extend and integrate knowledge of the physiology of living organisms from the engineering point of view. | |
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| **Metode poučevanja in učenja:** | | |  | **Learning and teaching methods:** | |
| Snov predmeta bodo študenti osvojili na predavanjih, z vodenim individualnim študijem in na laboratorijskih vajah. | | |  | The course will be guided through lectures in the class, individual study and laboratory work. | |
| **Načini ocenjevanja:** | Delež (v %) /  Weight (in %) | | | | **Assessment:** |
| Način (pisni izpit, ustno izpraševanje, naloge, projekt)  Ocene od 1 do vključno 5 so negativne, ocene od vključno 6 do 10 so pozitivne.  Preverjanje znanja: laboratorijske vaje, domača naloga in ustni izpit; pozitivna ocena laboratorijskih vaj in domače naloge je pogoj za pristop k ustnemu izpitu.  Prispevki k oceni:   * laboratorijsko delo in domače naloge, * ustni izpit | 55%  45% | | | | Type (examination, oral, homework, laboratory exercises, project)  Negative grades: from 1 to 5  Positive grades: from 6 to 10  Positive evaluation of laboratory exercises and homework is a prerequisite for the final exam.  Contributions to the final grade:   * laboratory work and home work, * oral examination |
| **Reference nosilca / Lecturer's references:** | | | | | |
| 1. MALI, Barbara, ZULJ, Sara, MAGJAREVIĆ, Ratko, MIKLAVČIČ, Damijan, JARM, Tomaž. Matlab-based tool for ECG and HRV analysis. *Biomedical signal processing and control*, 2014, vol. 10, str. 108-116. 2. MALI, Barbara, MIKLAVČIČ, Damijan, SERŠA, Gregor, JARM, Tomaž. Comparison of protocols for synchronized electroporation pulse delivery. V: 6th European Conference of the International Federation for Medical and Biological Engineering, MBEC 2014, 7-11 September 2014, Dubrovnik, Croatia. LACKOVIĆ, Igor (ur.), VASIĆ, Darko (ur.). *IFMBE proceedings*, (IFMBE proceedings, ISSN 1680-0737, vol. 45). Cham [etc.]: Springer, cop. 2014, str. 586-589, ilustr. 3. MALI, Barbara, JARM, Tomaž, ČOROVIĆ, Selma, PAULIN-KOŠIR, Marija Snežna, ČEMAŽAR, Maja, SERŠA, Gregor, MIKLAVČIČ, Damijan. The effect of electroporation pulses on functioning of the heart. *Medical & biological engineering & computing*, 2008, vol. 46, no. 8, str. 745-757. 4. ŽUPANIČ, Anže, RIBARIČ, Samo, MIKLAVČIČ, Damijan. Increasing the repetition frequency of electric pulse delivery reduces unpleasant sensations that occur in electrochemotherapy. *Neoplasma*, 2007, vol. 54, 3, str. 246-250. 5. MIKLAVČIČ, Damijan, PUCIHAR, Gorazd, PAVLOVEC, Miran, RIBARIČ, Samo, MALI, Marko, MAČEK LEBAR, Alenka, PETKOVŠEK, Marko, NASTRAN, Janez, KRANJC, Simona, ČEMAŽAR, Maja, SERŠA, Gregor. The effect of high frequncy electric pulses on muscle contractions and antitumor efficiency in vivo for a potential use in clinical electrochemotherapy. *Bioelectrochemistry*, 2005, vol. 65, no. 2, str. 121-128. | | | | | |