|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **UČNI NAČRT PREDMETA / COURSE SYLLABUS** | | | | | | | | | | | | | | | | | |
| **Predmet:** | | | Analogna elektronska vezja | | | | | | | | | | | | | | |
| **Course title:** | | | Analog Electronic Circuits | | | | | | | | | | | | | | |
|  | | | | |  | | | | | | | |  | |  | | |
| **Študijski program in stopnja**  **Study programme and level** | | | | | **Študijska smer**  **Study field** | | | | | | | | **Letnik**  **Academic year** | | **Semester**  **Semester** | | |
| Univerzitetni študijski program prve stopnje Elektrotehnika | | | | | Elektronika | | | | | | | | 3. | | letni | | |
| 1st cycle academic study programme Electrical Engineering | | | | | Electronics | | | | | | | | 3. | | summer | | |
|  | | | | | | | | | | | | | | | | | |
| **Vrsta predmeta / Course type** | | | | | | | | | | | | Obvezni strokovni predmet/ compulsory professional course | | | | | |
|  | | | | | | | | | | | |  | | | | | |
| **Univerzitetna koda predmeta / University course code:** | | | | | | | | | | | | 64152 | | | | | |
|  | | | | | | | | | | | | | | | | | |
| **Predavanja**  **Lectures** | **Seminar**  **Seminar** | | | **Vaje**  **Tutorial** | | | **Klinične vaje**  **work** | | | | **Druge oblike študija** | | | **Samost. delo**  **Individ. work** | |  | **ECTS** |
| **45** | **0** | | | **45** | | | **0** | | | | **0** | | | **85** | |  | **7** |
|  | | | | | | | | | | | | | | | | | |
| **Nosilec predmeta / Lecturer:** | | | | | Janez Krč | | | | | | | | | | | | |
|  | | | | | | | | | | | | | | | | | |
| **Jeziki /**  **Languages:** | | **Predavanja / Lectures:** | | | | slovenski / Slovenian  (foreign students – shortened lectures and consultations in English) | | | | | | | | | | | |
| **Vaje / Tutorial:** | | | | slovenski / Slovenian  (foreign students –consultations and instructions for laboratory practice in English) | | | | | | | | | | | |
| **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):** | | | | | | | |
| Vsebino predmeta sestavljajo naslednja poglavja:  UVOD v analogna elektronska vezja  POPAČENJA V OJAČEVALNIKIH: linearna in nelinearna popačenja, parametri THD, HD, določitev popačenj za različne tranzistorske ojač. stopnje  DIFERENCIALNI OJAČEVALNIK: izvedbe, DC in ac analiza, protifazno, diferencialno in sofazno ojačenje in modeli, simetričen in nesimetričen izhod, načrtovanje  MOČNOSTNI OJAČEVALNIKI: vezave audio ojačevalnikov, vhodne diferencialne stopnje, vmesne ojačevalne stopnje, izhodne stopnje (močnostni tranzistorji, razredi A, AB, B in drugi), načrtovanje celotnega močnostnega ojačevalnika, praktični primeri  OPERACIJSKI OJAČEVALNIKI: idealni, delno realni in realni model, vhodni ničelni parametri, šum, sheme znotraj operacijskega ojačevalnika, izvedbe, primeri praktične uporabe – aktivni filtri  KOMPARATORJI: zahteve, klasični komparatorji, komparatorji s histerezo, načrtovanje preprostih vezij s komparatorji in praktični primeri uporabe  OSCILATORJI: načrtovanje, relaksacijski, harmonični (fazni zamik. Colpittsov, Hartleyev), kvarčni, sheme preprostih funkcijskih generatorjev, praktični primeri uporabe oscilatorjev.  Iz navedenih vsebin študentje opravljajo skupaj 8 praktičnih laboratorijskih vaj (načrtajo, zvežejo vezje in pomerijo realna vezja na testni ploščici). | | | | | | | |  | | The contents of the course consists of the following chapters:  INTRODUCTION to analog electronic circuits  AMPLIFIER DISTORTIONS: linear and non-linear distortion, TDH, HD, determination of distortions for different amplifying stages  DIFFERENTIAL AMPLIFIER: realizations, DC and ac analysis, common-mode and differential amplification, models, (a)symmetrical output  POWER AMPLIFIERS: realizations of audio amplifiers, input differential stages, voltage amplifying stages, output power stages (power transistors, classes A; AB; B and others), design of a complete power amplifier, practical examples  OPERATIONAL AMPLIFIERS: ideal, semi-real and real model, input offset parameters, noise, internal circuits of selected operational amplifiers, examples of applications (active filters)  COMPARATORS: requirements, simple comparator, comparator with hysteresis, design of simple circuits with comparators, practical examples of applications  OSCILLATORS: design, relaxation, harmonic (phase shift, Colpitts, Hartley), quartz, circuits of simple signal generators, practical examples of usage  In the frame of laboratory practice students gain their practical experiences within 8 tasks, each including the design, realization on a proto-board and testing. | | | | | | | |

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Temeljni literatura in viri / Readings:** | | | | | |
| 1. D. A. Neamen, Microelectronics – circuit analysis and design, 4th Ed., Mc. Graw Hill, 2010 2. P. Horowitz, W. Hill, The Art of Electronics, 3rd Ed..Cambridge University Press, 2015. 3. B. Cordell, Designing audio power amplifiers, Mc Graw Hill, 2011. 4. dodatna študijska gradiva in prosojnice dostopne na e-Fe. / additional study material and slices available at e-Fe. | | | | | |
| **Cilji in kompetence:** | |  | | **Objectives and competences:** | |
| * nadgradnja temeljnih znanj o analognih vezjih pridobljenih pri predhodnih predmetih s tega področja * sposobnost praktičnega pristopa k načrtovanju in realizaciji analognih vezij – teorija in praksa | |  | | * upgrade of fundamental knowledge on analog electronic circuits acquired by related previous courses * capability of actual approach to the design and realization of analog electronic circuits – theory and practice | |
| **Predvideni študijski rezultati:** | | |  | **Intended learning outcomes:** | |
| Ob uspešno zaključenih študijskih obveznostih naj bi bili študenti sposobni načrtati, analizirati in izvesti testne realizacije raznih preprostih analognih vezij, tako na osnovi tranzistorjev, operacijskih ojačevalnikov, komparatorjev. Med njimi še posebej vezja močnostinih ojačevalnikov, preciznih ojačevalnikov na osnovi operacijskih ojačevalnikov, aktivnih filtrov, razna vezja s komparatorji, oscilatorji, … | | |  | On successful completion of the course students should be capable to design, analyse and make prototypes of various simple analog circuits based on either transistors, operational amplifiers or comparators. Among them are power amplifiers, precision amplifiers based on operational amplifiers, active filters, different circuits with comparators, oscillators, … | |
|  | | |  |  | |
| **Metode poučevanja in učenja:** | | |  | **Learning and teaching methods:** | |
| * predavanja (uporaba table in ppt prosojnic, interakcija s študenti) * laboratorijske vaje (načrtovanje konkretnih vezij, njihova realizacija na testni ploščici, merjenje) | | |  | * lectures (use of a blackboard and ppt slides, interactions with students) * laboratory practice (full design, realization, testing of concrete circuits on a proto-board) | |
| **Načini ocenjevanja:** | Delež (v %) /  Weight (in %) | | | | **Assessment:** |
| Način: pisni izpit in ustni izpit  Končno oceno izpita določata pisni in ustni izpit v deležu, ki je opredeljen v sosednjem stolpcu.  Dodatni pogoji pri načinu ocenjevanja:   * za pozitivno končno oceno mora študentka/študent pozitivno opraviti in pisni in ustni izpit * za pristop k ustnemu izpitu je potrebno pozitivno opraviti pisni izpit in hkrati uspešno opraviti vse laboratorijske vaje predmeta.   Ocene od 1 do vključno 5 so negativne, ocene od vključno 6 do 10 so pozitivne. | 40 % pisni /  written exam  60 % ustni /  oral exam | | | | Type: written exam, oral exam.  The final grade is determined based on the results of written exam and oral exam. The share of each contribution is defined in previous column.  Additional conditions:   * a condition for positive final grade is positive grade ofwritten exam and positive grade of oral exam * to take an oral exam there are two conditions: positive grade of the written exam and successfully finished all laboratory assignments   Negative grades: from 1 to 5, positive grades: from 6 to 10. |
| **Reference nosilca / Lecturer's references:** | | | | | |
| 1. KRČ, Janez, TOPIČ, Marko, SMOLE, Franc, OPARA KRAŠOVEC, Urša, LAVRENČIČ ŠTANGAR, Urška, OREL, Boris. Three-state regulator for electrochromic windows. *Solar energy materials and solar cells*, ISSN 0927-0248. [Print ed.], 2002, vol. 71, no. 3, str. 387-395. 2. KRČ, Janez, TOPIČ, Marko, SMOLE, Franc, OPARA KRAŠOVEC, Urša, LAVRENČIČ ŠTANGAR, Urška, OREL, Boris. Analog regulator for electrochromic windows = Analogni regulator za elektrokromna stekla. *Informacije MIDEM*, ISSN 0352-9045, 2000, vol. 30, no. 1, str. 32-36. 3. KRČ, Janez, JANKOVEC, Marko, TOPIČ, Marko. Elektronika na poti od detektorja do osrednjega dela sistema = Electronics on the way from a detector to the central system unit. *Informacije MIDEM*, ISSN 0352-9045, 2002, letn. 32, št. 4, str. 298-302. 4. TOPIČ, Marko (urednik), KRČ, Janez (urednik), ŠORLI, Iztok (urednik), 45th International Conference on Microelectronics, Devices and Materials and the Workshop on Advanced Photovoltaic Devices and Technologies, September 9 - September 11, 2009, Postojna, Slovenia,*. Proceedings*. Ljubljana: MIDEM - Society for Microelectronics, Electronic Components and Materials, 2009. XII, 396 str. 5. JANKOVEC, Marko, LIPOVŠEK, Benjamin, KRČ, Janez*. Elementi polprevodniške elektronike : delovno gradivo za laboratorijske vaje*. 1. izd. Ljubljana: Založba FE in FRI, 2013. | | | | | |