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| **UČNI NAČRT PREDMETA / COURSE SYLLABUS** | | | | | | | | | | | | | | | | | | |
| **Predmet:** | | | Polprevodniška elektronika | | | | | | | | | | | | | | | |
| **Course title:** | | | Semiconductor Electronics | | | | | | | | | | | | | | | |
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| **Študijski program in stopnja**  **Study programme and level** | | | | | **Študijska smer**  **Study field** | | | | | | | | **Letnik**  **Academic year** | | **Semester**  **Semester** | | | |
| Univerzitetni študijski program prve stopnje Elektrotehnika | | | | | **Ni smeri** | | | | | | | | **2.** | | **letni** | | | |
| 1st cycle academic study programme Electrical Engineering | | | | | **/** | | | | | | | | **2.** | | **summer** | | | |
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| **Vrsta predmeta / Course type** | | | | | | | | | | | | Obvezni – strokovni/  compulsory professional | | | | | | |
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| **Univerzitetna koda predmeta / University course code:** | | | | | | | | | | | | 64118 | | | | | | |
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| **Predavanja**  **Lectures** | **Seminar**  **Seminar** | | | **Vaje**  **Tutorial** | | **Klinične vaje**  **work** | | | | | **Druge oblike študija** | | | **Samost. delo**  **Individ. work** | |  | **ECTS** | |
| **45** |  | | | **45** | |  | | | | |  | | | **85** | |  | **7** | |
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| **Nosilec predmeta / Lecturer:** | | | | | Franc Smole | | | | | | | | | | | | | |
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| **Jeziki /**  **Languages:** | | **Predavanja / Lectures:** | | | | slovenski/Slovenian | | | | | | | | | | | | |
| **Vaje / Tutorial:** | | | | slovenski/Slovenian | | | | | | | | | | | | |
| **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):** | | | | | | | | |
| Vrste in lastnosti polprevodnikov. Električni toki v polprevodniku. Generacije in rekombinacije.  Polprevodniška dioda s pn-spojem: idealna in realna tokovno-napetostna karakteristika, model diode pri krmiljenju z majhnimi signali, prebojna napetost, vzbujanje diode z velikimi signali, stikalne lastnosti diode. Druge diodne zgradbe: tunelska dioda, dioda kovina-polprevodnik (Schottky-jeva dioda), heterospojna dioda. Primeri uporabe diod.  Bipolarni tranzistor: tokovno-napetostne karakteristike, modeli bipolarnega tranzistorja pri majhnih in velikih signalih, visokofrekvenčne lastnosti tranzistorja, tranzistor kot stikalo, primeri uporabe bipolarnih tranzistorjev.  Spojni FET in MOST, tokovno-napetostne karakteristike, modeli unipolarnih tranzistorjev, primeri uporabe unipolarnih tranzistorjev, CMOS-invertor.  Močnostni polprevodniški elementi: pnpn-dioda, diak, tiristor, triak, IGBT.  Fotonski polprevodniški elementi: absorpcija svetlobe, svetleče diode, laserske diode, fotodetektorji: fotoupor, fotodioda, pin-fotodioda, plazovna fotodioda, fototranzistor, sončne celice.  Nanoelektronika in nanotehnologije: osnovne definicije, trendi na področju nanoznanosti, nanoprevodniki, transportne lastnosti polprevodniških nanostruktur, nanoelementi. | | | | | | |  | | Classifications of semiconductors. Carrier transport phenomena. Carrier generation and recombination.  The pn junction diode: ideal and nonideal current-voltage relationship, small-signal model of the pn junction, junction breakdown, diode transients. Special diode types: the tunnel diode, the Schottky barrier diode, hetero-junction diode. Examples of the use of diodes.  The bipolar transistor: current-voltage relationship, the modes of operation, amplification with bipolar transistors, equivalent circuit models, frequency limitations, large-signal switching, basic single-stage amplifier configurations, basic logic inverter.  The JFET and the MOSFET, current-voltage relationship, small-signal equivalent circuit, basic configurations of single-stage amplifiers, the CMOS digital logic inverter.  Semiconductor power devices: pnpn diode, diac, thyristor, triac, IGBT.  Optical devices: optical absorption, light emitting diodes, laser diodes, photodetectors: photoconductor, photodiode, pin photodiode, avalanche photodiode, phototransistor, solar cells.  Nanoelectronics and nanotechnology: basic definitions, trends in the field of nanoelectronics, nanoconductors, transport properties of semiconductor nanostructures, nanodevices. | | | | | | | | |

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| **Temeljni literatura in viri / Readings:** | | | | | |
| 1. Franc Smole, Polprevodniška elektronika, Založba FE in FRI, Ljubljana, 2013. 2. Smole F., Topič M., Elementi polprevodniške elektronike, Založba FE in FRI, Ljubljana, 2014. 3. Donald A. Neamen, Semiconductor Physics and Devices, University of New Mexico, McGraw-Hill, 2011. 4. S. M. Sze, Semiconductor Devices, John Wiley & Sons, Inc., 2006. 5. S. O. Kasap, Optoelectronics and Photonics, Prentice Hall, Inc., 2013. 6. William A. Goddard, Donald W. Brenner, Sergey Edward Lyshevski, Gerald J. Iafrate, Nanoscience, Engineering, and Technology, CRC Press LLC, 2012. 7. George W. Hanson, Fundamentals of Nanoelectronics, Pearson Prentice Hall, 2008. | | | | | |
| **Cilji in kompetence:** | |  | | **Objectives and competences:** | |
| Usvojiti zgradbe, delovanje in lastnosti polprevodniških elektronskih elementov ter na primeru osnovnih povezav elementov prikazati glavne namene uporabe.  Poznavanje polprevodniških elementov je pomembno za razumevanje analogne in digitalne elektronike, močnostne elektronike, optoelektronike, fotonike in razvijajoče se nanoelektronike. | |  | | To comprehend structures, basic principles of operation and properties of semiconductor devices and present the main purposes of applications on examples of basic configurations. Knowledge of semiconductor devices is important for the understanding of the analog and digital electronics, power electronics, optoelectronics, photonics and emerging nanoelectronics. | |
| **Predvideni študijski rezultati:** | | |  | **Intended learning outcomes:** | |
| Študent bo poznal in razumel zgradbo in delovanje polprevodniških elektronskih elementov, osnovne povezave elementov in glavne namene uporabe. | | |  | Student will comprehend the structure and functioning of semiconductor devices, basic configurations of elements and fundamental purposes of application. | |
| **Metode poučevanja in učenja:** | | |  | **Learning and teaching methods:** | |
| predavanja, avditorne vaje, laboratorijske vaje | | |  | lectures, auditory practice, laboratory assignments | |
| **Načini ocenjevanja:** | Delež (v %)  Weight (in %) | | | | **Assessment:** |
| Način: laboratorijske vaje, pisni izpit, ustni izpit. Opravljene laboratorijske vaje so pogoj za pristop h končnemu izpitu.  Ocene od 1 do vključno 5 so negativne, ocene od vključno 6 do 10 so pozitivne.  Prispevki k oceni:  pisni izpit  ustni izpit | 50%  50% | | | | Type: laboratory exercises, written exam, oral exam. Conducted laboratory assignments present a condition for undertaking the final exam.  Negative grades: from 1 to 5, positive grades: from 6 to 10.  Contributions to final grade:  written exam  oral examination |
| **Reference nosilca / Lecturer's references:** | | | | | |
| 1. SEIF, Johannes Peter, DESCOEUDRES, Antoine, FILIPIČ, Miha, SMOLE, Franc, TOPIČ, Marko, HOLMAN, Zachary Charles, DE WOLF, Stefaan, BALLIF, Christophe. Amorphous silicon oxide window layers for high-efficiency silicon heterojunction solar cells. Journal of applied physics, 2014, vol. 115, no. 2, str. 1-8.  2. FILIPIČ, Miha, HOLMAN, Zachary, SMOLE, Franc, DE WOLF, Stefaan, BALLIF, Christophe, TOPIČ, Marko. Analysis of lateral transport through the inversion layer in amorphous silicon/crystalline silicon heterojunction solar cells. Journal of applied physics, 2013, vol. 114, no. 7, str. 1-7.  3. HOLMAN, Zachary, FILIPIČ, Miha, LIPOVŠEK, Benjamin, DE WOLF, Stefaan, SMOLE, Franc, TOPIČ, Marko, BALLIF, Christophe. Parasitic absorption in the rear reflector of a silicon solar cell: simulation and measurement of the sub-bandgap reflectance for common dielectric/metal reflectors. Solar energy materials and solar cells, [Print ed.], Jan. 2014, vol. 120, part A, str. 426-430.  4. FILIPIČ, Miha, BERGINC, Marko, SMOLE, Franc, TOPIČ, Marko. Analysis of electron recombination in dye-sensitized solar cell. Current applied physics, Jan. 2012, vol. 12, no. 1, str. 238-246.  5. NERAT, Marko, SMOLE, Franc, TOPIČ, Marko. A simulation study of the effect of the diverse valence-band offset and the electronic activity at the grain boundaries on the performance of polycrystalline Cu(In,Ga)Se2 solar cells. Thin Solid Films, [Print ed.], 2011, vol. 519, no. 21, str. 7497-7502. | | | | | |