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| **UČNI NAČRT PREDMETA / COURSE SYLLABUS** |
| **Predmet:** | **MATEMATIČNE METODE I** |
| **Course title:** | **MATHEMATICAL METHODS I** |
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| **Študijski program in stopnja****Study programme and level** | **Študijska smer****Study field** | **Letnik****Academic year** | **Semester****Semester** |
| ENERGETIKA, 1. stopnja |  | 1 | 1 |
| ENERGY TECHNOLOGY, 1.degree |  | 1 | 1 |
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| **Vrsta predmeta / Course type** | Obvezni/Obligatory |
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| **Univerzitetna koda predmeta / University course code:** | **V** |
|  |
| **Predavanja****Lectures** | **Seminar****Seminar** | **Vaje****Tutorial** | **Klinične vaje****work** | **Druge oblike študija** | **Samost. delo****Individ. work** |  | **ECTS** |
| **45** |  | **30** |  |  | **105** |  | **6** |
| **AV** | **LV** | **RV** |
| **30** |  |  |
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| **Nosilec predmeta / Lecturer:** | **BRIGITA FERČEC** |
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| **Jeziki /** **Languages:** | **Predavanja / Lectures:** | slovenski/Slovene |
| **Vaje / Tutorial:** | slovenski/Slovene |
| **Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:** |  | **Prerequisits:** |
| Ni pogojev. |  | None. |
| **Vsebina:**  |  | **Content (Syllabus outline):** |
| 1.Številske množice (naravna, cela, racionalna, realna, iracionalna, kompleksna števila, enačbe, neenačbe).2.Funkcije ene spremenljivke (osnovne elementarne funkcije, definicijsko območje, zaloga vrednosti, ničle, zveznost funkcij, limita funkcije).3.Odvod (definicija, ekstremalni problemi, ukrivljenost, višji odvodi, povezava s fiziko, Taylorjeva vrsta).4. Integral (nedoločeni in določeni integral, uporabnosti – ploščine, vrtenine, dolžina loka, težišča, vztrajnostni momenti, neskončne meje, Fourierova vrsta).5. Diferencialne enačbe (DE prvega reda, DE drugega reda s konstantnimi koeficienti, sistemi DE, Laplaceova transformacija, uporabnost v tehniki in fiziki).6. Funkcije več spremenljivk (parcialni odvodi, totalni diferencial, lokalni ekstremi, Taylorjeva vrsta funkcije dveh ali treh spremenljivk).7. Integrali funkcij več spremenljivk (dvojni in trojni integral, uvedba novih spremenljivk, uporaba-ploščine, prostornine, vztrajnostni momenti, težišča). |  | 1. Numerical sets (integer, rational, real, irational, complex numbers, equations, inequalities).2. Functions (basic elementary functions, zeros, continuity of funkction, limit of function).3. Derivative (definition, problems of extrems, curvature, higher derivations, connection with physics, Taylor series). 4. Integral (indefinite and definite integral, applications – surface, rotary body, length of the arc, moment of inertia, Fourier series).5. Differential equations (DE of 1st order, DE of 2nd order with the constant coefficients, systems of DE, Laplace transformation, applications in physics and engineering).6. Functions of more variables (partial derivatives, total diferential, local extrems, Taylor series of functions of two or three variables).7. Integrals of functions of more variables (double and triple integral, introduction of new variables, applications – surface, volume, moment of inertia, center of gravity). |

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| **Temeljni literatura in viri / Readings:** |
| E. Kreyszig, Advanced Engineering Mathematics, J. Wiley and Sons.I. Vidav, Višja Matematika, DMFA Slovenije. M. Mencinger, Zbirka rešenih nalog iz matematične analize in algebre, FG UM. R. Jamnik, Matematika, DMFA Slovenije. |
| **Cilji in kompetence:** |  | **Objectives and competences:** |
| Študent pridobi in utrdi znanje ter veščine s področja matematične analize, ki je potrebno, da opravi obveznosti pri drugih izpitih, ki jih mora opraviti v svojem študiju. |  | Student acquires and consolidates knowledge and skills in the field of mathematical analysis, which is required to perform the obligations in other exams that must be done in his/her study.  |
| **Predvideni študijski rezultati:** |  | **Intended learning outcomes:** |
| Znanje in razumevanje:Razumeti povezavo med matematiko, fiziko in mehaniko; razumeti aplikativno vrednost matematike. |  | Knowledge and understanding:Understanding the connection between mathematics, physics and mechanics; understanding the applied value of mathematics. |
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| **Metode poučevanja in učenja:** |  | **Learning and teaching methods:** |
| Klasična predavanja, seminarske vaje, domače naloge. |  | Lectures, practical work, homework. |
| **Načini ocenjevanja:** | Delež (v %) /Weight (in %) | **Assessment:** |
| Način (pisni izpit, ustno izpraševanje, naloge, projekt)* Praktični del izpita
* Teoretični del izpita
* Domača naloga
 | **60****30****10** | Type (examination, oral, coursework, project):* Practical part of exam
* Theoretical part of exam
* Homework
 |
| **Reference nosilca / Lecturer's references:**  |
| 1.MENCINGER, Matej, FERČEC, Brigita. The center and cyclicity problems for some analytic maps. *Applied mathematics and computation*, 2017, vol. 306, str. 73-85.2. MENCINGER, Matej, FERČEC, Brigita, OLIVEIRA, Regilene, PAGON, Dušan. Cyclicity of some analytic maps. *Applied mathematics and computation*, 2017, vol. 295, str. 114-125.3. SANG, Bo, FERČEC, Brigita, WANG, Qin-Long. Limit cycle bifurcated from a center in a three dimensional system. *Electronic journal of differential equations*, 2016, vol. 2016, no. 109, str. 1-11. 4. FERČEC, Brigita, GINÉ, Jaume, ROMANOVSKI, Valery, EDNERAL, Victor F. Integrability of complex planar systems withhomogeneous nonlinearities. *Journal of mathematical analysis and applications*, 2016, vol. 434, issue 1, str. 894-914,5. FERČEC, Brigita. On integrability conditions and limit cycle bifurcations for polynomial system. *Applied mathematics and computation*, 2015, vol. 263, str. 94-106, 6. FERČEC, Brigita, LEVANDOVSKYY, Viktor, ROMANOVSKI, Valery, SHAFER, Douglas. Bifurcation of critical periods of polynomial systems. *Journal of differential equations*, 2015, vol. 259, iss. 8, str. 3825-3853. 7. FERČEC, Brigita, MENCINGER, Matej. Integer programming and Gröbner bases = Celoštevilsko programiranje in Gröbnerjeve baze. *Journal of energy technology*, 2015, vol. 8, iss. 2, str. 43-58.8. AYBAR, Ilknur Kusbeyzi, AYBAR, Orhan Ozgur, FERČEC, Brigita, ROMANOVSKI, Valery, SWARUP SAMAL, Satya, WEBER, Andreas. Investigation of invariants of a chemical reaction system with algorithms of computer algebra. *MATCH Communications in Mathematical and in Computer Chemistry*, 2015, vol. 74, issue 3, str. 465-480.  |

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| **UČNI NAČRT PREDMETA / COURSE SYLLABUS** |
| **Predmet:** | **OSNOVE FIZIKE** |
| **Course title:** | **FUNDAMENTALS OF PHYSICS** |
|  |  |  |  |
| **Študijski program in stopnja****Study programme and level** | **Študijska smer****Study field** | **Letnik****Academic year** | **Semester****Semester** |
| ENERGETIKA, 1. stopnja |  | 1 | 1 |
| ENERGY TECHNOLOGY, 1.degree |  | 1 | 1 |
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| **Vrsta predmeta / Course type** | Obvezni / Obligatory  |
|  |  |
| **Univerzitetna koda predmeta / University course code:** | **V** |
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| **Predavanja****Lectures** | **Seminar****Seminar** | **Vaje****Tutorial** | **Klinične vaje****work** | **Druge oblike študija** | **Samost. delo****Individ. work** |  | **ECTS** |
| **45** |  | **30** |  |  | **105** |  | **6** |
| **AV** | **LV** | **RV** |
| **30** |  |  |
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| **Nosilec predmeta / Lecturer:** | **MARKO MARHL** |
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| **Jeziki /** **Languages:** | **Predavanja / Lectures:** | slovenski / slovene |
| **Vaje / Tutorial:** | slovenski / slovene |
| **Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:** |  | **Prerequisits:** |
| Ni pogojev. |  | None.  |
| **Vsebina:**  |  | **Content (Syllabus outline):** |
| * Fizikalne količine in merjenje.
* Gibanje v 1D in 2D.
* Sile in Newtonovi zakoni, gravitacija.
* Sile pri kroženju.
* Delo, energija, moč, izrek o kinetični energiji, izrek o kinetični in potencialni energiji.
* Gibalna količina, elastični in neelastični trki.
* Osnove vrtenja, energija pri vrtenju.
* Nihanje.
* Mehansko valovanje, zvok.
* Osnove EM valovanja, svetloba, geometrijska optika.
* Energijski tokovi in univerzalni pogled na energijo, povezovanje znanj iz toplote, elektrike in magnetizma iz drugih predmetov.
 |  | * Physical quantities and measurement.
* Movement in 1D and 2D.
* Forces and Newton's laws, gravity.
* Forces during circular motion.
* Work, energy, power, the kinetic energy theorem, the kinetic and potential energy theorem.
* Momentum, elastic and non-elastic collisions.
* Basics of rotation, energy during rotational movement.
* Oscillation.
* Mechanical waves, sound.
* Basics of EM wave, light, geometric optics.
* Energy flows and a universal view of energy, connecting knowledge of heat, electricity and magnetism from other subjects
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| **Temeljni literatura in viri / Readings:** |
| **Osnovni viri:**1) R. Kladnik: Osnove fizike. Del 1, Državna založba Slovenije, 1969.2) R. Kladnik: Osnove fizike. Del 2, Državna založba Slovenije, 1977.3) R. Serway: Physics for Scientists & Engineers, Saunders College Publishing, 2000.4) D. C. Giancoli: Physics. Principles with Applications, Upper Saddle River, N.J., 2005.5) L. A. Bloomfield: How things work, The Physics of everyday life, NJ: Wiley, 2006. |
| **Cilji in kompetence:** |  | **Objectives and competences:** |
| Seznanitev in razumevanje osnovnih fizikalnih pojavov na katerih so osnovani pomembni izvori energije, njihovih pojavnih oblik in pretvorb ter nekaterih vidikov praktične uporabe. |  | To get acquainted and to gain understanding of the basic laws of physics that lead to the important energy sources and their transformations in addition of brief description of their use for some practical purposes. |
| **Predvideni študijski rezultati:** |  | **Intended learning outcomes:** |
| Znanje in razumevanje:Študent razume in zna pojasniti osnovne fizikalne koncepte z obravnavanih področij - zna postaviti in ovrednotiti enostaven fizikalni model, po pisnih navodilih opravi eksperiment, izmeri in izračuna zahtevane fizikalne količine, oceni natančnost rezultatov. |  | Knowledge and Understanding:A student understands and can explain basic physical concepts in the respective fields - student can build and evaluate a simple physical model, student can perform an experiment using written instructions, measure and calculate the required physical quantities, estimate the uncertainty of the results. |
| Prenesljive/ključne spretnosti in drugi atributi:* Reševanje problemov z matematičnimi orodji in celosten pristop k reševanju problemov.
* Sposobnost prepoznati problem in ga teoretično obravnavati v okviru elementarne fizike.
 |  | Transferable/Key Skills and other attributes:* Problems solving with mathematical tools, an integral approach to solution of problems.
* They are able to identify the problem and describe it theoretically in the frame of elementary physics.
 |
| **Metode poučevanja in učenja:** |  | **Learning and teaching methods:** |
| * Predavanja v obliki razgovora in diskusij.
* Teoretične vaje.
 |  | • Lectures in the form of conversation and discussion.* Theoretical exercises.
 |
| **Načini ocenjevanja:** | Delež (v %) /Weight (in %) | **Assessment:** |
| **Domače naloge****Pisni izpit****Ustni izpit** | **30****30****40** | **Homeworks****Written examination****Oral examination** |
| **Reference nosilca / Lecturer's references:**  |
| MARKOVIČ, Rene, PELTAN, Julien, GOSAK, Marko, HORVAT, Denis, ŽALIK, Borut, SEGUY, Benjamin, CHAUVEL, Remi, MALANDAIN, Gregoire, COUFFINHAL, Thierry, DUPLÁA, Cécile, MARHL, Marko, ROUX, Etienne. Planar cell polarity genes frizzled4 and frizzled6 exert patterning influence on arterial vessel morphogenesis. PloS one, ISSN 1932-6203, 2017, vol. 12, iss. 3, str. 1-19, doi: 0.1371/journal.pone.0171033. [COBISS.SI-ID 22990856].GOSAK, Marko, STOŽER, Andraž, MARKOVIČ, Rene, DOLENŠEK, Jurij, MARHL, Marko, RUPNIK, Marjan, PERC, Matjaž. The relationship between node degree and dissipation rate in networks of diffusively coupled oscillators and its significance for pancreatic beta cells. Chaos, ISSN 1054-1500, July 2015, vol. 25, iss. 7, 073115-1-073115-8, doi: 10.1063/1.4926673. [COBISS.SI-ID 512523576]. GOSAK, Marko, DOLENŠEK, Jurij, MARKOVIČ, Rene, RUPNIK, Marjan, MARHL, Marko, STOŽER, Andraž. Multilayer network representation of membrane potential and cytosolic calcium concentration dynamics in beta cells. Chaos, solitons and fractals. [Print ed.], 2015, vol. 80, str. 76-82, ilustr. http://www.sciencedirect.com/science/article/pii/S0960077915001794, doi: 10.1016/j.chaos.2015.06.009. [COBISS.SI-ID 512513080].GOSAK, Marko, MARKOVIČ, Rene, FAJMUT, Aleš, MARHL, Marko, HAWLINA, Marko, ANDJELIĆ, Sofija. The analysis of intracellular and intercellular calcium signaling in human anterior lens capsule epithelial cells with regard to different types and stages of the cataract. PloS one, ISSN 1932-6203, 2015, vol. 10, iss. 12. http://dx.doi.org/10.1371/journal.pone.0143781, doi: 10.1371/journal.pone.0143781. [COBISS.SI-ID 2645676]. 5. MARKOVIČ, Rene, STOŽER, Andraž, GOSAK, Marko, DOLENŠEK, Jurij, MARHL, Marko, RUPNIK, Marjan. Progressive glucose stimulation of islet beta cells reveals a transition from segregated to integrated modular functional connectivity patterns. Scientific reports, ISSN 2045-2322, vol. 5, 2015, 10 str. http://www.nature.com/srep/2015/150119/srep07845/full/srep07845.html, doi: 10.1038/srep07845. [COBISS.SI-ID 512466488]. |

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| **UČNI NAČRT PREDMETA / COURSE SYLLABUS** |
| **Predmet:** | **MERILNA TEHNIKA V ENERGETIKI** |
| **Course title:** | **MEASURING TECHNICS IN ENERGETICS** |
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| **Študijski program in stopnja****Study programme and level** | **Študijska smer****Study field** | **Letnik****Academic year** | **Semester****Semester** |
| ENERGETIKA, 1. stopnja |  | 1 | 1 |
| ENERGY TECHNOLOGY, 1.degree |  | 1 | 1 |
|  |
| **Vrsta predmeta / Course type** | Obvezni/Obligatory |
|  |  |
| **Univerzitetna koda predmeta / University course code:** | V |
|  |
| **Predavanja****Lectures** | **Seminar****Seminar** | **Vaje****Tutorial** | **Klinične vaje****work** | **Druge oblike študija** | **Samost. delo****Individ. work** |  | **ECTS** |
| **45** |  | **30** |  |  | **105** |  | **6** |
| **AV** | **LV** | **RV** |  |
|  | **30** |  |  |
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| **Nosilec predmeta / Lecturer:** | **PETER VIRTIČ** |
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| **Jeziki / Languages:** | **Predavanja / Lectures:** | slovenski / Slovene  |
| **Vaje / Tutorial:** | slovenski / Slovene  |
| **Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:** |  | **Prerequisits:** |
| Ni pogojev. |  | None. |
| **Vsebina:**  |  | **Content (Syllabus outline):** |
| * merske enot in sitem SI
* merilne karakteristike (statične in dinamične karakteristike, merilna negotovost, standardi)
* meritve napetosti in tokov
* meritve prevodnosti/uporonosti
* meritve kapacitvnosti in induktivnosti
* meritve električnih in magnetnih polij
* meritve permeabilnosti, histereze in dielektrične konstante
* meritve električne moči in cos fi
* meritve fazne razlike
* meritve neelektričnih veličin
* meritve časa in frekvence
* spektralna analiza
* meritve popačenja
* merilni ojačevalniki
* analogno digitalna in digitalno analogna pretvorba
* reference in etaloni
* virtualna instrumentacija
* programska in strojna oprema za zajemanje podatkov
 |  | * measurement units and system SI
* measurement characteristics (static and dynamic characteristics, measurement uncertainty, standards)
* voltage and current measurements
* measurements of resistance/conductance
* measurements of magnetic fields
* measurement of permeability, hystersis and dielectric constants
* measurements of electrical power and cos fi
* measurements of phase difference
* measurements of non-electrical quantities
* measurements of time and frequency
* spectrum analysis
* measurements of distortions
* measurement amplifiers
* analog to digital and digital to analog conversion
* references and etalons
* virtual instrumentation
* software and hardware for data acquisition
 |
| **Temeljni literatura in viri / Readings:** |
| P.F. Dunn, Measurement and Data Analysis for Engineering and Science, CRC Press, 2010. |
| **Cilji in kompetence:** |  | **Objectives and competences:** |
| Spoznavanje osnov meritev fizikalnih veličin in instrumentacije. |  | Obtaining basic knowledge about the measurements of physical quantities and instrumentation. |
| **Predvideni študijski rezultati:** |  | **Intended learning outcomes:** |
| Znanje in razumevanje:Razumevanje in osvojitev osnov merjenja fizikalnih veličin. |  | Knowledge and understanding:Understanding and acquiring fundamentals of measurements of physical quantities. |
| Prenesljive/ključne spretnosti in drugi atributi:Razvoj veščin in spretnosti v uporabi znanja na svojem konkretnem strokovnem delovnem področju. |  | Transferable/Key Skills and other attributes:Development of skills and expertise in the use of knowledge in a specific technical working area. |
| **Metode poučevanja in učenja:** |  | **Learning and teaching methods:** |
| Predavanja, podprta s praktičnimi demonstracijami in eksperimenti.Vodene laboratorijske vaje.Samostojno praktično delo. |  | Lectures supported with practical demonstrators and experiments.Guided laboratory work.Independent practical work. |
| **Načini ocenjevanja:** | Delež (v %) /Weight (in %) | **Assessment:** |
| Način (pisni izpit, ustno izpraševanje, naloge, projekt)* pisni izpit
* zagovor vaj
* projekt
 | **50** **30** **20**  | Type (examination, oral, coursework, project):* written examination
* lab work defense
* project
 |
| **Reference nosilca / Lecturer's references:**  |
| PIŠEK, Peter, ŠTUMBERGER, Bojan, MARČIČ, Tine, VIRTIČ, Peter. Design analysis and experimental validation of a double rotor synchronous PM machine used for HEV. *IEEE trans. magn.*, Jan. 2013, vol. 49, no. 1, str. 152-155, doi: [10.1109/TMAG.2012.2220338](http://dx.doi.org/10.1109/TMAG.2012.2220338). [COBISS.SI-ID [1024117084](http://cobiss.izum.si/scripts/cobiss?command=DISPLAY&base=COBIB&RID=1024117084)] ŠLAMBERGER, Jan, VIRTIČ, Peter. Design of electrical machines by using conformal mapping = Konstruiranje električnih strojev z uporabo konformnih preslikav. *Journal of energy technology*, feb. 2013, vol. 6, iss. 1, str. 13-18. <http://www.fe.um.si/en/jet.html>. [COBISS.SI-ID [1024132444](http://cobiss.izum.si/scripts/cobiss?command=DISPLAY&base=COBIB&RID=1024132444)] VIRTIČ, Peter. Determining losses and efficiency of axial flux permanent magnet synchronous motor. *Prz. Elektrotech.*, 2013, r. 89, nr. 2b, str. 13-16. <http://pe.org.pl/articles/2013/2b/4.pdf>. [COBISS.SI-ID [1024123484](http://cobiss.izum.si/scripts/cobiss?command=DISPLAY&base=COBIB&RID=1024123484)] PRAUNSEIS, Zdravko, VIRTIČ, Peter. Evaluation of mechanical properties of soft magnetic materials for axial flux permanent magnet synchronous machines. *Prz. Elektrotech.*, 2013, r. 89, nr. 2b, str. 35-37. <http://www.red.pe.org.pl/articles/2013/2b/10.pdf>. [COBISS.SI-ID [1024122460](http://cobiss.izum.si/scripts/cobiss?command=DISPLAY&base=COBIB&RID=1024122460)] ŠLAMBERGER, Jan, VIRTIČ, Peter. Determining energy production of CdTe photovoltaic system. *Prz. Elektrotech.*, 2013, r. 89, nr. 2b, str. 84-87. <http://pe.org.pl/articles/2013/2b/23.pdf>. [COBISS.SI-ID [1024123740](http://cobiss.izum.si/scripts/cobiss?command=DISPLAY&base=COBIB&RID=1024123740)]  |

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| **UČNI NAČRT PREDMETA / COURSE SYLLABUS** |
| **Predmet:** | **ELEKTROTEHNIKA I** |
| **Course title:** | **ELECTRICAL ENGINEERING I** |
|  |  |  |  |
| **Študijski program in stopnja****Study programme and level** | **Študijska smer****Study field** | **Letnik****Academic year** | **Semester****Semester** |
| ENERGETIKA, 1. stopnja  |  | 1 | 1 |
| ENERGY TECHNOLOGY, 1.degree |  | 1 | 1 |
|  |
| **Vrsta predmeta / Course type** | Obvezni/Obligatory |
|  |  |
| **Univerzitetna koda predmeta / University course code:** | V |
|  |
| **Predavanja****Lectures** | **Seminar****Seminar** | **Vaje****Tutorial** | **Klinične vaje****work** | **Druge oblike študija** | **Samost. delo****Individ. work** |  | **ECTS** |
| **45** |  | **30** |  |  | **105** |  | **6** |
| **AV** | **LV** | **RV** |  |
| **30** |  |  |  |
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| **Nosilec predmeta / Lecturer:** | **MIRALEM HADŽISELIMOVIĆ** |
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| **Jeziki /** **Languages:** | **Predavanja / Lectures:** | slovenski / Slovene |
| **Vaje / Tutorial:** | slovenski / Slovene |
| **Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:** |  | **Prerequisits:** |
| Ni pogojev. |  | None. |
| **Vsebina:**  |  | **Content (Syllabus outline):** |
| • Uvod.• Stacionarno električno polje.• Elektrostatično polje, električna poljska jakost, računanje el. poljske jakosti. Definicija potenciala in napetosti-metoda zrcaljenja. Električno polje v dielektrikih. Kapacitivnost, analiza vezij s kapacitivnostmi, energija elektrostatičnega polja.• Električno polje enakomerno gibajočih se elektrin. Linearna vezja-pasivni in aktivni elementi, Kirchhoffova zakona.• Magnetno polje enakomerno gibajočih se elektrin. Magnetna poljska jakost (Amperov zakon), Biot-Savartov zakon.• Magnetni pretok in Maxwellova 4. enačba v integralni obliki. Magnetno polje v magnetnih materialih. Analiza magnetnih krogov.• Časovno spremenljiva polja: lastna induktivnost, medsebojna induktivnost. Energija magnetnega polja.• Izmenične (sinusne) veličine v realnem in kompleksnem prostoru.• Resonančni pojav, kompenzacija, realni elementi, transformator.• Polifazni sistemi, moč v trifaznih sistemih, vrtilno magnetno polje.  |  | • Introduction.• Electric field of stationary charges, electrostatic field, electric field strength, calculations of the electrostatic field. Definition of electric potential and voltage. Electrostatic field in dielectric materials transition. Capacitance, analysis of circuits with capacitors. Electrostatic field energy.• Electric field of evenly moving charges.Linear circuit analysis: passive and active elements of electric circuits, Kirchhoff’s first and second laws. Ohm’s and Joule’s law.• Magnetic field of evenly moving charges. Magnetic field strength (Ampere's law), Biot-Savart's law.• Magnetic flux and Maxwell’s 4 equation in integral form. Magnetic field in magnetic materials. Analysis of magnetic circuits. • Time varying fields: self inductance and mutual inductance. Magnetic field energy.• AC electric (sinusoidal) quantities in real and complex space.• Resonance phenomena, compensation, real elements, transformer.• Poly-phase systems, power in three-phase circuits, rotational magnetic field. |
| **Temeljni literatura in viri / Readings:** |
| I. Tičar,T. Zorič: Introduction to Electrical Engineering I, II, III (in Slovene).M. Hadžiselimović, S. Seme: Electrical Engineering – exercises (in Slovene). |
| **Cilji in kompetence:** |  | **Objectives and competences:** |
| Osnovno znanje elektromagnetike. |  | Basic knowledge of Electomagnetics. |
| **Predvideni študijski rezultati:** |  | **Intended learning outcomes:** |
| Znanje in razumevanje:* sposobnost uporabe pridobljenega teoretičnega znanja v praksi
* avtonomnost v svojem strokovnem delu in zavezanost profesionalni etiki
 |  | Knowledge and understanding:* ability to use theoretical knowledge in practice
* independence in professional work and obligation to professional ethics
 |
| Prenesljive/ključne spretnosti in drugi atributi:Razvoj veščin in spretnosti v uporabi znanja na svojem konkretnem strokovnem delovnem področju. |  | Transferable/Key Skills and other attributes:Development of skills and expertise in the use of knowledge in a specific technical working area. |
| **Metode poučevanja in učenja:** |  | **Learning and teaching methods:** |
| Predavanja.Seminarske vaje. |  | Lectures.Seminar exercises. |
| **Načini ocenjevanja:** | Delež (v %) /Weight (in %) | **Assessment:** |
| Način (pisni izpit, ustno izpraševanje, naloge, projekt)* računski del (pisni)
* teoretični del (pisni/ustni)
 | **60****40** | Type (examination, oral, coursework, project):* Computational part (written)
* Theoretical part (written/oral)
 |
| **Reference nosilca / Lecturer's references:**  |
| 1. SEME, Sebastijan, LUKAČ, Niko, ŠTUMBERGER, Bojan, HADŽISELIMOVIĆ, Miralem. Power quality experimental analysis of grid-connected photovoltaic systems in urban distribution networks. Energy, ISSN 0360-5442. [Print ed.], 2017, str. [1-6]. 2. SEME, Sebastijan, SRPČIČ, Gregor, KAVŠEK, Domen, BOŽIČNIK, Stanislav, LETNIK, Tomislav, PRAUNSEIS, Zdravko, ŠTUMBERGER, Bojan, HADŽISELIMOVIĆ, Miralem. Dual-axis photovoltaic tracking system : design and experimental investigation. Energy, ISSN 0360-5442. [Print ed.], maj 2017, str. [1-8].3. SEME, Sebastijan, ŠTUMBERGER, Bojan, HADŽISELIMOVIĆ, Miralem. A novel prediction algorithm for solar angles using second derivative of the energy for photovoltaic sun tracking purposes. Solar energy, ISSN 0038-092X. [Print ed.], nov. 2016, vol. 137, str. 201-211. 4. SEME, Sebastijan, POŽUN, Jože, ŠTUMBERGER, Bojan, HADŽISELIMOVIĆ, Miralem. Energy production of different types and orientations of photovoltaic systems under outdoor conditions. Journal of solar energy engineering : Transactions of the ASME, ISSN 0199-6231, 2015, vol. 137, issue 2, str. 021021-1 - 021021-10. 5. ŠTUMBERGER, Bojan, MARČIČ, Tine, HADŽISELIMOVIĆ, Miralem. Direct comparison of induction motor and line-start IPM synchronous motor characteristics for semi-hermetic compressor drives. IEEE transactions on industry applications, ISSN 1939-9367, 2012, vol. 48, no 6, str. 2310-2321. |

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| **UČNI NAČRT PREDMETA / COURSE SYLLABUS** |
| **Predmet:** | **RAČUNALNIŠTVO**  |
| **Course title:** | **COMPUTER SCIENCE**  |
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| **Študijski program in stopnja****Study programme and level** | **Študijska smer****Study field** | **Letnik****Academic year** | **Semester****Semester** |
| ENERGETIKA, 1. stopnja |  | 1 | 1 |
| ENERGY TECHNOLOGY, 1.degree |  | 1 | 1 |
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| **Vrsta predmeta / Course type** | Obvezni/Obligatory |
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| **Univerzitetna koda predmeta / University course code:** | V |
|  |
| **Predavanja****Lectures** | **Seminar****Seminar** | **Vaje****Tutorial** | **Klinične vaje****work** | **Druge oblike študija** | **Samost. delo****Individ. work** |  | **ECTS** |
| **45** |  | **30** |  |  | **105** |  | **6** |
| **AV** | **LV** | **RV** |  |
|  |  | **30** |  |
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| **Nosilec predmeta / Lecturer:** | **GORAZD HREN** |
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| **Jeziki /** **Languages:** | **Predavanja / Lectures:** | slovenski / Slovene |
| **Vaje / Tutorial:** | slovenski / Slovene |
| **Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:** |  | **Prerequisits:** |
| Ni pogojev. |  | None. |
| **Vsebina:**  |  | **Content (Syllabus outline):** |
| * Osnovni pojmi računalništva in informatike
* Pregled razvoja računalnikov
* Strojna oprema
* Programska oprema (sistemska, aplikativna)
* Računalniška omrežja in varnost
* Algoritmi in diagrami poteka
* Programski jeziki in programiranje
* Programska orodja
* Semantika in sintaksa programskih jezikov,

Označevalni jeziki |  | * Basic concepts of computer science and informatics
* History of computer development
* Hardware
* Software (operating, applicative)
* Computer networks and security
* Algorithms and flowcharts
* Programming languages and programming
* Programming tools
* Semantics and syntax of programming languages,
* Mark-up languages
 |
| **Temeljni literatura in viri / Readings:** |
| Ljubomir Kostrevc: Računalništvo in informatika, Pasadena, Ljubljana, 2002.Larry Long, Nancy Long: Computers, Prentice Hall, 2005.[G. Michael Schneider](http://www.google.com/search?hl=sl&tbo=p&tbm=bks&q=inauthor:%22G.+Michael+Schneider%22), [Judith L. Gersting](http://www.google.com/search?hl=sl&tbo=p&tbm=bks&q=inauthor:%22Judith+L.+Gersting%22): Invitation to Computer Science, 2010Brian D. Hahn, [Dan Valentine](http://www.amazon.com/s/ref%3Dntt_athr_dp_sr_2?_encoding=UTF8&sort=relevancerank&search-alias=books&field-author=Dan%20Valentine): Essential MATLAB for Engineers and Scientists, Third Edition, Elsevier 2007Jože Petrišič :Uvod v MATLAB za inženirje, Ljubljana : Fakulteta za strojništvo, 2011David C. Kuncicky: Matlab Programming, Pearson Prentice Hall, 2004 |
| **Cilji in kompetence:** |  | **Objectives and competences:** |
| Predavanja o računalništvu so namenjena poglabljanju znanja o sestavi in uporabi računalnika in programske opreme. Namenjena so spoznavanju informacijske in komunikacijske tehnologije s ciljem, da si študentje pridobijo teoretične osnove in praktične izkušnje pri uporabi računalniških sistemov in programskih orodij. S pomočjo samostojnega programiranja se študentje seznanijo s sintakso in semantiko programskih jezikov, ki jih potrebujejo pri študiju.  |  | The lectures on computer science and are intended for deepening the knowledge about the structure and use of computer hardware and software. Moreover, they are intended for introducing the information and communication technologies. The goal is the students gaining theoretical bases and practical experiences with the use of computers and programming tools. With the aid of independent programming the students are introduced to syntax and semantics of same programming languages needed for study.  |
| **Predvideni študijski rezultati:** |  | **Intended learning outcomes:** |
| Znanje in razumevanje:Študentje bodo po predavanjih sposobni: * razpoznati in razčleniti komponente računalnika in določiti vrste informacijskih sistemov
* razumeti vlogo in pomen informatike
* uporabiti multimedijske komponente v informacijskih sistemih
* demonstrirati svoje znanje za področje komunikacije človek-stroj
* delati v virtualni skupini
* urediti potrebno za varovanje podatkov na računalniku in v omrežju
* skupinskega dela v programskih okoljih
 |  | Knowledge and understanding:Students will be able to:* distinguish and analyse computer components, as well as define different types of information systems
* comprehend the role and meaning of informatics
* use multimedia components in information systems
* demonstrate their knowledge in the field of human-machine interaction
* work in a virtual group
* organize (arrange) that is required for computer and network data protection
* recognize and use tools for computer-supported collaborative work
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| **Metode poučevanja in učenja:** |  | **Learning and teaching methods:** |
| * frontalno učenje
* e-učenje
* Praktično delo v računalniški učilnici
 |  | * frontal learning
* e-learning
* Practical work in computer room
 |
| **Načini ocenjevanja:** | Delež (v %) /Weight (in %) | **Assessment:** |
| Način (pisni izpit, ustno izpraševanje, naloge, projekt)* Oddane domače naloge

 (pogoj za pristop k izpitu)* pisni izpit
* ustni izpit ali e-kviz
 | **15****45****40** | Type (examination, oral, coursework, project):* completed homework

 (required before examination)* written examination
* oral examination or e-quiz
 |
| **Reference nosilca / Lecturer's references:**  |
| HREN, Gorazd. Web-based environment for mechanism simulation integrated with CAD system. Eng. comput., 2010, vol. 26, no. 2, str. 137-148, JCR HREN, Gorazd, JEZERNIK, Anton. A framework for collaborative product review. Int. j. adv. manuf. technol., June 2009, vol. 42, no 7/8, str. 822-830, JCRKRIVOGRAD, Sebastian, HREN, Gorazd, ŽALIK, Borut, JEZERNIK, Anton. Hiter algoritem za poenostavljanje in obnovitev trikotniških mrež za prenos rezultatov MKE preko svetovnega spleta = A fast triangular-mesh decimation-and-undecimation algorithm for transferring FEM results via the Web. Stroj. vestn., 2003, letn. 49, št. 11, str. 524-537. JCR |

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| **UČNI NAČRT PREDMETA / COURSE SYLLABUS** |
| **Predmet:** | **MATEMATIČNE METODE II** |
| **Course title:** | **MATHEMATICAL METHODS II** |
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| **Študijski program in stopnja****Study programme and level** | **Študijska smer****Study field** | **Letnik****Academic year** | **Semester****Semester** |
| ENERGETIKA, 1. stopnja |  | 1 | 2 |
| ENERGY TECHNOLOGY, 1.degree |  | 1 | 2 |
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| **Vrsta predmeta / Course type** | Obvezni/Obligatory |
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| **Univerzitetna koda predmeta / University course code:** | **V** |
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| **Predavanja****Lectures** | **Seminar****Seminar** | **Vaje****Tutorial** | **Klinične vaje****work** | **Druge oblike študija** | **Samost. delo****Individ. work** |  | **ECTS** |
| **30** |  | **30** |  |  | **90** |  | **5** |
| **AV** | **LV** | **RV** |
| **30** |  |  |
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| **Nosilec predmeta / Lecturer:** | **BRIGITA FERČEC** |
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| **Jeziki /** **Languages:** | **Predavanja / Lectures:** | slovenski/Slovene |
| **Vaje / Tutorial:** | slovenski/Slovene |
| **Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:** |  | **Prerequisits:** |
| Ni pogojev. |  | None. |
| **Vsebina:**  |  | **Content (Syllabus outline):** |
| 1.Vektorji v prostoru (definicija, geometrijska interpretacija, osnovne operacije, skalarni produkt, vektorski produkt, mešani produkt, analitična geometrija v prostoru-premice in ravnine, povezava s fiziko).2. Matrike (računske operacije, različne vrste matrik, matrike preslikav, determinanta, vektorski prostori R^n in linearne preslikave, rotacije, projekcije, zrcaljenja, lastne vrednosti in lastni vektorji matrik, spektralni razcep in Jordanova forma, uporaba spektralne analize).3. Vektorska analiza (skalarna in vektorska polja, gradient, rotor, divergenca, operator nabla, smerni odvod). |  | 1. Vectors in space (definition, geometrical interpretation, basic operations, scalar product, vector product, mixed product, analitical geometry in space – straightlines and planes, connection with physics).2. Matrices (operations, different kinds of matrices, mapping matrices, determinant, vector spaces R^n and linear maps, rotations, mirroring, projections, eigenvalues and eigenvectors of matrix, spectral theory). 3. Vector analysis (scalar and vector fields, gradient, rotor, divergence, operator nabla, directional derivative). |

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| **Temeljni literatura in viri / Readings:** |
| E. Kreyszig, Advanced Engineering Mathematics, J. Wiley and Sons.I. Vidav, Višja Matematika, DMFA Slovenije. M. Mencinger, Zbirka rešenih nalog iz matematične analize in algebre, FG UM. R. Jamnik, Matematika, DMFA Slovenije. |
| **Cilji in kompetence:** |  | **Objectives and competences:** |
| Študent pridobi in utrdi znanje ter veščine s področja matematične algebre, ki je potrebno, da opravi obveznosti pri drugih izpitih, ki jih mora opraviti v svojem študiju. |  | Student acquires and consolidates knowledge and skills in the field of algebra, which is required to perform the obligations in other exams that must be done in his/her study. |
| **Predvideni študijski rezultati:** |  | **Intended learning outcomes:** |
| Znanje in razumevanje:Razumeti povezavo med matematiko, fiziko in mehaniko; razumeti aplikativno vrednost matematike. |  | Knowledge and understanding:Understanding the connection between mathematics, physics and mechanics; understanding the applied value of mathematics. |
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| **Metode poučevanja in učenja:** |  | **Learning and teaching methods:** |
| Klasična predavanja, seminarske vaje, domače naloge. |  | Lectures, practical work, homework. |
| **Načini ocenjevanja:** | Delež (v %) /Weight (in %) | **Assessment:** |
| Način (pisni izpit, ustno izpraševanje, naloge, projekt)* Praktični del izpita
* Teoretični del izpita
* Domača naloga
 | 603010 | Type (examination, oral, coursework, project):* Practical part of exam
* Theoretical part of exam
* Homework
 |
| **Reference nosilca / Lecturer's references:**  |
| 1.MENCINGER, Matej, FERČEC, Brigita. The center and cyclicity problems for some analytic maps. *Applied mathematics and computation*, 2017, vol. 306, str. 73-85.2. MENCINGER, Matej, FERČEC, Brigita, OLIVEIRA, Regilene, PAGON, Dušan. Cyclicity of some analytic maps. *Applied mathematics and computation*, 2017, vol. 295, str. 114-125.3. SANG, Bo, FERČEC, Brigita, WANG, Qin-Long. Limit cycle bifurcated from a center in a three dimensional system. *Electronic journal of differential equations*, 2016, vol. 2016, no. 109, str. 1-11. 4. FERČEC, Brigita, GINÉ, Jaume, ROMANOVSKI, Valery, EDNERAL, Victor F. Integrability of complex planar systems withhomogeneous nonlinearities. *Journal of mathematical analysis and applications*, 2016, vol. 434, issue 1, str. 894-914,5. FERČEC, Brigita. On integrability conditions and limit cycle bifurcations for polynomial system. *Applied mathematics and computation*, 2015, vol. 263, str. 94-106, 6. FERČEC, Brigita, LEVANDOVSKYY, Viktor, ROMANOVSKI, Valery, SHAFER, Douglas. Bifurcation of critical periods of polynomial systems. *Journal of differential equations*, 2015, vol. 259, iss. 8, str. 3825-3853. 7. FERČEC, Brigita, MENCINGER, Matej. Integer programming and Gröbner bases = Celoštevilsko programiranje in Gröbnerjeve baze. *Journal of energy technology*, 2015, vol. 8, iss. 2, str. 43-58.8. AYBAR, Ilknur Kusbeyzi, AYBAR, Orhan Ozgur, FERČEC, Brigita, ROMANOVSKI, Valery, SWARUP SAMAL, Satya, WEBER, Andreas. Investigation of invariants of a chemical reaction system with algorithms of computer algebra. *MATCH Communications in Mathematical and in Computer Chemistry*, 2015, vol. 74, issue 3, str. 465-480.  |

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| **UČNI NAČRT PREDMETA / COURSE SYLLABUS** |
| **Predmet:** | **ELEKTRONIKA V ENERGETIKI** |
| **Course title:** | **ELECTRONICS FOR ENERGY TECHNOLOGY** |
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| **Študijski program in stopnja****Study programme and level** | **Študijska smer****Study field** | **Letnik****Academic year** | **Semester****Semester** |
| ENERGETIKA, 1. stopnja  |  | 1 | 2 |
| ENERGY TECHNOLOGY, 1.degree |  | 1 | 2 |
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| **Vrsta predmeta / Course type** | Obvezni/Obligatory |
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| **Univerzitetna koda predmeta / University course code:** | V |
|  |
| **Predavanja****Lectures** | **Seminar****Seminar** | **Vaje****Tutorial** | **Klinične vaje****work** | **Druge oblike študija** | **Samost. delo****Individ. work** |  | **ECTS** |
| **30** |  | **30** |  |  | **90** |  | **5** |
| **AV** | **LV** | **RV** |  |
|  | **30** |  |  |
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| **Nosilec predmeta / Lecturer:** | **SEBASTIJAN SEME** |
|  |
| **Jeziki /** **Languages:** | **Predavanja / Lectures:** | slovenski / Slovene |
| **Vaje / Tutorial:** | slovenski / Slovene |
| **Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:** |  | **Prerequisits:** |
| Ni pogojev. |  | None. |
| **Vsebina:**  |  | **Content (Syllabus outline):** |
| a) Osnove električnih vezij med katere spadata Kirchoffova zakona, idealni in realni elementi, analiza vezij, delilniki napetosti in toka.b) Osnove operacijskih ojačevalnikov, definicija ojačanja idealnega in realnega operacijskega ojačevalnika in osnovna vezja ojačevalnikov.c) Seznanitev z obratovalnimi lastnostmi in karakteristikami komponent energetske elektronike, kot so: diode, tiristorji, GTO v vezjih z ohmskim in ohmsko induktivnim bremenom, bipolarni tranzistor, MOSFET, IGBT, IGCT.d) Diodna usmerniška vezja in omrežno vodeni usmerniki.e) DC-DC pretvorniki - obravnava osnovnih vezij (pretvornik navzdol, pretvornik navzgor, pretvornik navzdol-navzgor in Ćukov pretvornik). Modeli pretvornikov pri zveznem in nezveznem področju delovanja.f) DC-AC razsmerniki. Enofazna in trifazna razsmerniška vezja. Uporaba razsmernikov v izmeničnih motornih pogonih in sončnih elektrarnah.  |  | a) The basics of electrical circuits, which include Kirchoff's law, ideal and real elements, circuit analysis, voltage and current divider.b) Operational amplifier basics, definition of amplification of ideal and real operating amplifier and basic circuit amplifiers.c) Learning about the operating properties and characteristics of components of power electronics, such as: diodes, thyristors, GTO in circuits with ohmic and ohmic inductive loads, bipolar transistor, MOSFET, IGBT, IGCT.d) Diode rectifiers and network rectifiers.e) DC-DC converters - basic circuits (buck converter, boost converter, buck-boost converter, and Ćuk converter). Models of converters in a continuous and discontinuous field of operation.f) DC-AC inverters. Single-phase and three-phase inverter circuits. Using inverters in motor drives and photovoltaic systems. |
| **Temeljni literatura in viri / Readings:** |
| Priporočeni študijski viri: N. Mohan: Power Electronics, A First Course, Wiley, 2012.B. M.Wilamowski, J.D. Irvin: The Industrial Electronics Handbook, Fundamentals of Industrial Electronics, CRC Press, 2011.F. Mihalič: Energetska elektronika (Zbirka rešenih vaj), FERI, Maribor, 2008.M. Milanovič: Močnostna elektronika, FERI, Maribor, 2007.M. H. Rashid: Power Electronics Handbook, Devices, Circuits and Applications, Elsevier, 2007.R. Shaffer: Fundamentals of Power Electronics with MATLAB, Charles River Media, 2007.J. Nastran: Močnostna elektronika-interna skripta, Univerza v Ljubljani, Fakulteta za elektrotehniko, Ljubljana, 2006.B. Bose: Power Electronics and Motor Drives, Advances andTrends, Elsevier, 2006.F. L. Luo, H. Ye: Advanced DC/DC Converters, CRC Press, 2004.T. Skvarenina: Power electronics handbook, CRC Press, New York, 2002.R. Cajhen: Tiristorski pretvorniki, Univerza v Ljubljani, Fakulteta za elektrotehniko, Ljubljana, 1990.N. Mohan, T. M. Undeland, W. P. Robbins: Power Electronics: Converters, Applications and Design, John Wiley & Sons, New York, 1989. |
| **Cilji in kompetence:** |  | **Objectives and competences:** |
| Cilj predmeta je pridobiti poglobljena teoretična znanja in funkcionalno razumevanje delovanja ter načrtovanja naprav energetske elektronike. Specifični pregled klasičnih in sodobnih pretvorniških naprav za pretvorbo električne energije v nizko in visokonapetostnih napajalnih sistemih. Posredovati temeljna znanja o energetskih stikalih, delovanju in obratovalnih karakteristikah pretvornikov. Usposobiti študenta za samostojno analizo delovanja in obratovalnih lastnosti pretvorniških naprav.Razviti sposobnosti samostojnega in kreativnega reševanja inženirskih problemov. |  | The objective of the course is to gain theoretical knowledge and functional understanding of the operation and design of power electronics devices. A specific overview of conventional and modern converters for converting electrical power into low and high voltage power systems. Provide basic knowledge of power switches, performance and operating characteristics of converters. Qualify the student for independent analysis of the operation and operating properties of the conversion devices.Develop the capabilities of independent and creative solving of engineering problems. |
| **Predvideni študijski rezultati:** |  | **Intended learning outcomes:** |
| Znanje in razumevanje:Znanje s področja komponent energetske elektronike in razumevanje delovanja usmerniških vezij, DC-DC pretvornikov in DC-AC razsmernikov. |  | Knowledge and Understanding:Knowledge in the field of power electronics components and understanding the functioning of rectifier circuits, DC-DC converters and DC-AC inverters. |
| Prenesljive/ključne spretnosti in drugi atributi:Samostojno načrtovanje DC-DC pretvornikov in DC-AC razsmernikov za električne motorne pogone. |  | Transferable/Key Skills and other attributes:Independent design of DC-DC converters and DC-AC inverters for electric motor drives. |
| **Metode poučevanja in učenja:** |  | **Learning and teaching methods:** |
| Predavanja.Laboratorijske vaje.Samostojno delo. |  | Lectures.Practical exercises.Individual work. |
| **Načini ocenjevanja:** | Delež (v %) /Weight (in %) | **Assessment:** |
| Opravljene laboratorijske vaje.Pisni izpit. | **35****65** | Completed lab work.Written examination. |
| **Reference nosilca / Lecturer's references:**  |
| SEME, Sebastijan, ŠTUMBERGER, Gorazd, VORŠIČ, Jože. Maximum efficiency trajectories of a two-axis sun tracking system determined considering tracking system consumption. IEEE transactions on power electronics, ISSN 0885-8993, apr. 2011, vol. 26, no. 4, str. 1280-1290, doi: 10.1109/TPEL.2011.2105506. [COBISS.SI-ID 14971926], [JCR, SNIP, WoS do 20. 8. 2017: št. citatov (TC): 36, čistih citatov (CI): 36, Scopus do 24. 8. 2017: št. citatov (TC): 49, čistih citatov (CI): 49]SEME, Sebastijan, ŠTUMBERGER, Gorazd. The energy consumption of the permanent magnet DC motors in the dual axis tracking system. V: CVETKOVSKI, Goga (ur.), PETKOVSKA, Lidija (ur.). ISEF 2013 : conference proceedings, 16. International Symposium on Electromagnetic Fields in Mechatronics, Electrical and Electronic Engineering, 12-14 Septmeber 2013, Ohrid, Macedonia. Ohrid: ISEF International Steering Committee. 2013, str. 056-1 - 056-4. [COBISS.SI-ID 76480257]ŠTUMBERGER, Gorazd, SEME, Sebastijan, DEŽELAK, Klemen, POLAJŽER, Boštjan, TOMAN, Matej, DOLINAR, Drago. The impact of magnetically nonlinear iron core characteristics on reponses of a three-phase power transformer dynamic model. V: KRAWCZYK, Andrzej (ur.), WIAK, Sławomir (ur.), LÓPEZ-FERNÁNDEZ, Xose M. (ur.). Electromagnetic fields in mechatronics, electrical and electronic engineering : proceedings of ISEF'05, (Studies in applied electromagnetics and mechanics, ISSN 1383-7281, vol. 27). Amsterdam [etc.]: IOS Press. cop. 2006, str. 503-508. [COBISS.SI-ID 10699030]ŠTUMBERGER, Gorazd, SEME, Sebastijan, DEŽELAK, Klemen, POLAJŽER, Boštjan, TOMAN, Matej, DOLINAR, Drago. The impact of magnetically nonlinear iron core characteristics on responses of a three-phase power transformer dynamic model. V: LÓPEZ-FERNÁNDEZ, Xose M. (ur.), WIAK, Sławomir (ur.), KRAWCZYK, Andrzej (ur.). Proceedings, XII International Symposium on Electromagnetic Fields in Mechatronics, Electrical and Electronic Engineering, 15-17 September, 2005, Baiona, Spain. Vigo: University. 2005, 6 str. [COBISS.SI-ID 9828886] |

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| **UČNI NAČRT PREDMETA / COURSE SYLLABUS** |
| **Predmet:** | **GRADNIKI V ENERGETIKI** |
| **Course title:** | **MATERIALS IN ENERGETICS** |
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| **Študijski program in stopnja****Study programme and level** | **Študijska smer****Study field** | **Letnik****Academic year** | **Semester****Semester** |
| ENERGETIKA, 1. Stopnja |  | 1 | 2 |
| ENERGY TECHNOLOGY, 1.degree |  | 1 | 2 |
|  |
| **Vrsta predmeta / Course type** | Obvezni/Obligatory |
|  |  |
| **Univerzitetna koda predmeta / University course code:** | V |
|  |
| **Predavanja****Lectures** | **Seminar****Seminar** | **Vaje****Tutorial** | **Klinične vaje****work** | **Druge oblike študija** | **Samost. delo****Individ. work** |  | **ECTS** |
|  **30** |  | **30** |  |  |  **90** |  |  **5** |
| **AV** | **LV** | **RV** |  |
|  | **30** |  |
|  |
| **Nosilec predmeta / Lecturer:** | **ZDRAVKO PRAUNSEIS** |
|  |
| **Jeziki / Languages:** | **Predavanja / Lectures:** | slovenski / Slovene |
| **Vaje / Tutorial:** | slovenski / Slovene, |
| **Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:** |  | **Prerequisits:** |
| Ni pogojev. |  | None. |
| **Vsebina:**  |  | **Content (Syllabus outline):** |
| Predavanja:Podane so osnove notranje zgradbe materialov in namenska uporaba materialov glede na njihovo mikrostrukturo in mehanske lastnosti. Kovinski in nekovinski materiali, ki se najpogosteje uporabljajo v gradnji energetskih sistemov. Preizkušanje materialov z osnovnimi mehanskimi preizkusi. Določitev mehanskega obnašanja materialov pri različnih obremenitvah (statičnih in dinamičnih) in ekstremnih temperaturah (nizkih in visokih) obratovanja. Osnove spajanja materijalov in standardno označevanje materijalov ter njihova uporaba v konstrukcijski praksi.Podane so osnove konstruiranja procesne opreme. Predstavljeni so moderni postopki spajanja materialov in kompozitov s posebnim ozirom na reševanje problematike spajanja jekel: ogljičnih nelegiranih jekel, konstrukcijskih nelegiranih ogljikovih jekel, finozrnatih - mikrolegiranih, termomehansko obdelanih in poboljšanih konstrukcijskih jekel za obratovanje pri nizkih temperaturah, nizko legiranih poboljšanih jekel za strojegradnjo, jekel odpornim proti povišanim temperaturam za procesno opremo (parne kotle, turbine, tlačne posode in komore, itd..), nerjavna, kislinsko odporna in visokokorozijsko odporna in ognjeodporna jekla. Predstavljene so tlačne posode in elementi za cevni transport (cevi, oprema cevovodov in postrojenj, itd.), gonil in prenosnikov. Osnove ležajev, gredi, osi in cevnih prirobnic.Osnovno eksperimentalno preizkušanje materialov s pomočjo lomne mehanike. Neporušne metode odkrivanja napak v materialih in spojih, ki se pojavijo tekom obratovanja in ukrepi za njihovo varno obratovanje.Vaje:Določevanje mehanskega obnašanja homogenih in heterogenih materialov pri obratovanju in njihova uporaba pri konstruiranju procesne opreme. |  | Lectures:Basic features of internal structures of materials and proper application of materials in regard to their microstructure and mechanical properties are presented. Metal and non-metal materials are treated, which are often used for construction of energy systems. esting of materials with using basic mechanical tests. Mechanical behaviour determination of materials at different loadings (statics or dynamics) and extreme temperature (low or high) operation. Basic features of jointed materials and standard marked materials and their application at the design practical work. Basic features of process equipment design are treated. The modern joined material and composite processes are presented in regard about solution problems of joined steels: low alloy carbon steels, carbon steels, fine grained microalloyed steels, TMT steels and Q&T steels Off Shore structures steels for operation at extremely low temperatures, low alloyed Q&T steels, high temperature resistance steels for process equipment (steam boilers, turbines, pressure vessels, chambers, etc..), stainless steels, austenitic (inox), acid resistance and high corrosion resistance and temperature resistance steels. Presure vessels design and parts for pipeline transport ( pipes, pipelines equipment and devices, etc..), driving gears and machine belts are presented.Basic fracture mechanics experimental testing of materials. Basic features of bearings, shafts, axles and pipe flanges are treated.Nondestructive method of detecting defects at materials and joints which appears during loading operation and preventive measure for their safe operation.Tutorial and seminar work:Mechanical behaviour determination of homogeneous and heterogeneous materials at operation and their application at process equipment design. |
| **Temeljna literatura in viri / Readings:** |
| S.Allen, E.L. Thomas: The structure of Materials, John Willey&Sons, Inc, 1999Metalurški priročnik, Tehniška založba Slovenije, Ljubljana 1972D. Zupančič: Označevanje materialov, Fakulteta za strojništvo,Ljubljana 1998K. Easterling: Introduction to the Physical Metallurgy of Welding, Butterworths, London etc.,1983G.A. Webster: High Temperature Component Life Assessment, Chapman&Hall, London, 1994N. E. Dowling: Mechanical Behaviour of Materials, 2003.B. Kraut: Strojniški priročnik, Tehniška založba, Ljubljana 2002. J. E. Shigley, C. R. Mishke: Mechanical Engineering Design, 2004.ASTM Standards: Steel-Structural, Reinforcing, Pressure Vessel, Railway, Vol. 01.04, 2005.API 579, Fitness–for-service, The Equity Engineering Group, Inc., Cleveland, Ohio, 2005.BS 7910, Guide on methods for assessing the acceptability of flaws in fusion welded structures, British Standard, TWI-Abingtonhall 1999.Z. Praunseis.: Gradniki v energetiki, Univerzitetni učbenik, Univerza v Mariboru, 2011 |
| **Cilji in kompetence:** |  | **Objectives and competences:** |
| * podati osnovno znanje o mehanskem obnašanju materialov glede na obratovalne pogoje konstrukcije
* podati osnove spajanja materialov, ki so uporabljene za konstruiranje opreme
* pridobiti praktična znanja, ki so potrebna za konstruiranje procesne opreme
* podati osnovno znanje o konstruiranju komponent in tehniški specifikaciji za konstruiranje naprav v procesni opremi
* uporabiti klasične analitične metode za izrazito zmanjšanje verjetnosti odpovedi ali ustavitve obratovanja
* pridobiti praktična znanja, ki so potrebna za konstruiranje opreme
* določiti dejanske mehanske lastnosti materialov
* ocenitev napak v materialih
 |  | * to provide the basic knowledge about mechanical behaviour of materials in regard to the operation condition of construction.
* to provide the basic knowledge of joined materials which are used for equipment design.
* to provide necessary practical application for process equipment design
* to provide the basic knowledge about components design and technical specification of process equipment devices design.
* to apply classical analysis methods for drastically reduced the likelihood of equipment failure and plant downtime
* practical application of process equipment design
* to determine the real mechanical properties of materials
* defects estimation of materials
 |
| **Predvideni študijski rezultati:** |  | **Intended learning outcomes:** |
| Znanje in razumevanje:* spoznavanje osnov o namenski uporabi materialov za konstruiranje energetskih sistemov
* spoznavanje osnovnih postopkov spajanja materialov za konstruiranje nestandardnih energetskih komponent in elementov
* razumevanje osnovnih značilnosti procesne opreme in pogojev obratovanja
 |  | Knowledge and understanding:* basic knowledge about selection and application of materials for process equipment
* introduction of basic rules and standards for dimensioning of standard and nonstandard structure’s parts and elements
* understanding of features and operation coditions of process equipment
* detecting of defects at materials and joints
 |
| Prenesljive/ključne spretnosti in drugi atributi:Uporaba standardov in tehniškega znanja za projektiranje energetskih komponent in elementov |  | Transferable/Key Skills and other attributes:Combined use of different standards, technical knowledge for dimensioning and software for design of process equipment. |
| **Metode poučevanja in učenja:** |  | **Learning and teaching methods:** |
| Frontalna predavanja.Reševanje domačih nalog.Praktično delo pri laboratorijskih vajah. |  | Frontal lectures.Coursework.Practical work at laboratory exercises. |
| **Načini ocenjevanja:** | Delež (v %) /Weight (in %) | **Assessment:** |
| Način (pisni izpit, ustno izpraševanje, naloge, projekt)* domače naloge
* praktični del izpita v obliki pisnega reševanja izvedbe konstrukcijskega elementa v napravah procesne opreme
* teoretični del pisnega izpita v obliki dopolnjevanja dokumentacije in preračunov za procesno opremo
 | **10****45****45** | Type (examination, oral, coursework, project):* completed coursework
* written examination in the form of practical solution for structural parts of process equipment
* theoretical examination in the form of completing technical documentation and calculations of process equipment components
 |
| **Reference nosilca / Lecturer's references:**  |
| PRAUNSEIS, Zdravko, AVSEC, Jurij*. Gradniki v energetiki*. Krško: Fakulteta za energetiko, Univerzitetni učbenik z recenzijo,2012. XII, 174 str., graf. prikazi. ISBN 978-961-6800-09-9. [COBISS.SI-ID [70057473](http://cobiss.izum.si/scripts/cobiss?command=DISPLAY&base=COBIB&RID=70057473)]PRAUNSEIS, Zdravko. Fracture evaluation of energy components with local brittle zones = Vrednotenje loma v energetskih komponentah z lokalnimi krhkimi področji. *Journal of energy technology*, feb. 2013, vol. 6, iss. 1, str. 51-60. <http://www.fe.um.si/en/jet.html>. [COBISS.SI-ID [1024133212](http://cobiss.izum.si/scripts/cobiss?command=DISPLAY&base=COBIB&RID=1024133212)] PRAUNSEIS, Zdravko. Evaluation of mechanical properties of soft magnetic materials for axial flux permanent magnet synchronous machines. *Prz. Elektrotech.*, 2013, r. 89, nr. 2b, str. 35-37. <http://www.red.pe.org.pl/articles/2013/2b/10.pdf>. [COBISS.SI-ID [1024122460](http://cobiss.izum.si/scripts/cobiss?command=DISPLAY&base=COBIB&RID=1024122460)], [[JCR](http://www.cobiss.si/scripts/cobiss?command=SEARCH&base=jcr&select=(sc=0033-2097+and+PY=2011))] PRAUNSEIS, Zdravko. Numerical evaluation of the crack-driving force in heterogeneous regions = Numerična določitev sile razvoja razpoke v heterogenih področjih. *Journal of energy technology*, Nov. 2012, vol. 5, iss. 4, str. 51-58. <http://www.fe.uni-mb.si/images/stories/jet/e-jet/revija_jet_-_volume_5_-_issue_4_-_november_-_za_internet.pdf>. [COBISS.SI-ID [1024118364](http://cobiss.izum.si/scripts/cobiss?command=DISPLAY&base=COBIB&RID=1024118364)PRAUNSEIS, Zdravko, AVSEC, Jurij, STROJKO, Renato. Application and testing of steels for the energy process industry = Uporaba in preizkušanje jekel za energetsko procesno industrijo. *Journal of energy technology*, ISSN 1855-5748. [Tiskana izd.], Aug. 2013, vol. 6, iss. 3, str. 25-34, ilustr. <http://www.fe.um.si/en/jet.html>. [COBISS.SI-ID [1024154716](https://plus.si.cobiss.net/opac7/bib/1024154716?lang=en)] |

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| **UČNI NAČRT PREDMETA / COURSE SYLLABUS** |
| **Predmet:** | **MEHANOENERGETIKA STROJEV IN NAPRAV** |
| **Course title:** | **MEHANOENERGETICS OF ENGINES AND DEVICES** |
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| **Študijski program in stopnja****Study programme and level** | **Študijska smer****Study field** | **Letnik****Academic year** | **Semester****Semester** |
| ENERGETIKA, 1. Stopnja |  | 1 | 2 |
| ENERGY TECHNOLOGY, 1.degree |  | 1 | 2 |
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| **Vrsta predmeta / Course type** | Obvezni/Obligatory |
|  |  |
| **Univerzitetna koda predmeta / University course code:** | **V** |
|  |
| **Predavanja****Lectures** | **Seminar****Seminar** | **Vaje****Tutorial** | **Klinične vaje****work** | **Druge oblike študija** | **Samost. delo****Individ. work** |  | **ECTS** |
| **30** |  | **30** |  |  | **90** |  | **5** |
| **AV** | **LV** | **RV** |  |
| **25** | **5** |  |  |
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| **Nosilec predmeta / Lecturer:** | **JURIJ AVSEC** |
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| **Jeziki / Languages:** | **Predavanja / Lectures:** | slovenski / Slovene |
| **Vaje / Tutorial:** | Slovenski / Slovene |
| **Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:** |  | **Prerequisits:** |
| Zahtevano predhodno znanje iz matematike in fizike.  |  | Completed courses in the following subjects: Mathematics and Physics. |
| **Vsebina:**  |  | **Content (Syllabus outline):** |
| 1.KinematikaKinematične enačbe v polarnem in cilindričnem koordinatnem sistemu, relativno gibanje, ravninsko gibanje togega telesa. 2. DinamikaDinamika sistemov delcev, gibalne in vrtilne količine, vztrajnostni tenzor. Lastna nedušena in dušena nihanja, vsiljeno nihanje, resonanca. Dinamika vrtenja togega telesa okoli osi. Osnove analitične mehanike.3. Statika in TrdnostOsnovni principi, ravnotežje sil za toga telesa, dvojice sil, strukturna analiza, težišča. Okvirji, paličja, vrvi. Uvod v elastičnost in plastičnost. Osnovni zakoni trdnosti, osnovne obremenitve, porušne hipoteze, kombinirane obremenitve, transformacije pomikov, transformacije napetosti, dimenzioniranje nosilcev in gredi, uklon palic, energijske metode, paličja, okvirji, plošče in lupine. 4. HidromehanikaOsnovne lastnosti tekočin, tlak, viskoznost, stisljivost tekočin, statične sile na ukrivljene in ravne ploskve,vzgon in plavanje, strujanje tekočin.Kontinuitetna enačba, Bernoullijeva enačba za stisljive in nestisljive tekočine, energijska enačba in moč, laminarni in turbulentni tok v cevi, tok okoli teles, osnove toka v odprtih kanalih. 5. Energetski stroji in naprave**:**Mehanika zračnih plovil, vodnih plovil, vlakov in cestnih vozil. Mehanika rotorjev in turbin. Vpliv termičnih napetosti na mehaniko energetskih naprav. Dinamika motorjev z notranjim zgorevanjem.6. Mikromehanika in nanomehanika v energetiki-osnove |  | 1.KinematicsKinematic equations in polar and spherical coordinate systems, relative motion, planar motion of rigid body.2. Dynamics Dynamics of system of particles, momentum and angular momentum, moment of inertia. Dynamics of rotation of rigid body around center of axis. Fundamentals of analytical mechanics. Non-damped and damped free oscillations, forced oscillations, resonance.3. Statics and Mechanics of materials General principles**,** equilibrium of a rigid body, couple of forces, structural analysis, centers of gravity. Cables, frames, trusses. Fundamental laws of mechanics of materials, fundamental loads, failure criterions, combined loadings, stress transformations, strain transformations, design of beams and shafts, deflection of beams and shafts, buckling of columns, energy methods, trusses, frames, plates and shells. Introduction of elasticity and plasticity. 4.Hydromechanics: Fundamental properties of fluids, pressure, viscosity, compressibility of fluids, static forces on plane and curved surfaces, buoyancy and stability of floating bodies, flow of fluids. Continuity equation, Bernoulli equation for compressible and uncompressible fluids, energy equation and power, laminar and turbulent flow in pipes, flow around the bodies, fundamentals of flow in open channels. Energetic machines and devices**:**Mechanics of airplanes, rockets, ships, trains and road vehicles. Mechanics of shafts and rotors. Influence of thermal strengths on mechanics of energetic processes. Dynamics of IC engines.6.Micromechanics and nanomechanics in energetic-fundamentals |
| **Temeljni literatura in viri / Readings:** |
| J.M. Gere, B.J. Goodno, Mechanics of Materials, CL Engineering, 2012R.C. Hibbeler, Mechanics of Materials, 2008, Prentice HallR.C. Hibbeler, Statics, 2013, Prentice HallR.C. Hibbeler, Dynamics, 2013, Prentice HallG.R. Fowler, G.L. Cassiday, Analytical mechanis, 2005, ThomsonD. Inman, Engineering Vibration, 2008, Prentice <hallS. Rao, Mechanical Vibration, 2005, Prentice HallM. H. Sadd Elasticity, 2005, ElsevierB.A. Boley, J.H. Wenier, Thermal Sresses, 2005, DoverA.N. Cleland, Foundations of Nanomechanics, 2002, SpringerR.L. Street, G.Z. Watters, J.K. Vennard, Elementary Fluid Mechanics, 7th edition, 1996, WileyJ.F. Douglas, J.M. Gasiorek, J.A. Swaffield, L.B. Jack, Fluid Mechanics, 6th Edition, Pearson, 2005C.T. Crowe, D.F. Elger, J.A. Roberson, Engineering Fluid Mechanics, 8th Edition, 20011, John Willey,F.M. White, Fluid Mechanics, 7th Edition, McGraw Hill, 2012.J.A. Fox, Hydraulic analysis of unsteady flow in pipe networks,MacMillan, 1977,P.A, Davidson, An introduction to magnetohydrodynamics, 2001, Cambridge Press.L. Böswirth, Technishe Strömungslehre, 2010, Vieweg Taubner |
| **Cilji in kompetence:** |  | **Objectives and competences:** |
| Študentje spoznajo osnovne zakone mehanoenergetike in spoznajo osnovne pricipe energetskih strojev in naprav.  |  | Students learn about fundamental principles in mechanoenergetics focused on mechanics energetic machines and devices. |
| **Predvideni študijski rezultati:** |  | **Intended learning outcomes:** |
| Znanje in razumevanje:* poznavanje osnovnih metod in fizikalnih principov;
 |  | Knowledge and understanding:* knowledge of basic methods and physical principles in modern mechanics;
 |
| Prenesljive/ključne spretnosti in drugi atributi:kombinirana uporaba različnih osnovnih znanj za reševanje inženirskih problemov; |  | Transferable/Key skills and other attributes:combined use of different fundamental skills for solution of engineering problems; |
| **Metode poučevanja in učenja:** |  | **Learning and teaching methods:** |
| 1. Avditorna predavanja, 2. Praktično delo pri avditornih vajah3. Laboratorijske vaje |  | 1. Lectures, 2. Practical work at tutorials,3. Lab tests |
| **Načini ocenjevanja:** | Delež (v %) /Weight (in %) | **Assessment:** |
| Način (pisni izpit, ustno izpraševanje, naloge, projekt)* Pisni izpit
* ustni izpit
 | **50****50** | Type (examination, oral, coursework, project):* Written examinnations
* Oral examination
 |
| **Reference nosilca / Lecturer's references:**  |
| AVSEC, Jurij. Vibration of beams and rotating shafts under thermal effects. J. Vibroeng. (Vilnius), Dec. 2009, vol. 11, iss. 4, str. 665-675. AVSEC, Jurij. The vibrations of microbeams and nanotubes. J. Vibroeng. (Vilnius), Dec. 2011, vol. 13, iss. 4, str. 638-645. <http://www.jve.lt/Vibro/JVE-2011-13-4/JVE-2011-13-4-675-Avsec.pdf.pdf>. AVSEC, Jurij, PRAUNSEIS, Zdravko, MARČIČ, Milan. Nonlinear vibrational analysis of diesel valve gear. J. Vibroeng. (Vilnius), Dec. 2011, vol. 13, iss. 4, str. 646-653. AVSEC, Jurij. The development of model for determination of speed of sound and thermal conductivity for nanofluids containing nanoparticles and carbon nanotubes. V: 37th Solid Mechanics Conference, Warsaw, Poland, September 6-10, 2010. 37th SolMech 2010 : book of abstracts of the 37th Solid Mechanics Conference, Warsaw, Poland, September 6-10, 2010. Warszaw: Polish Academy of Sciences, Institute of Fundamental Technological Research, 2010, str. 20-21. [AVSEC, Jurij, MEDVED, Igor. Influence of electromagnetic intermolecular forces on thermodynamic properties. Acta tech. Jaurinensis, 2013, vol. 6, no. 1, str. 3-9.*Conference, Warsaw, Poland, September 6-10, 2010*. Warszaw: Polish Academy of Sciences, Institute of Fundamental Technological Research, 2010, str. 20-21. [AVSEC, Jurij, MEDVED, Igor. Influence of electromagnetic intermolecular forces on thermodynamic properties. *Acta tech. Jaurinensis*, 2013, vol. 6, no. 1, str. 3-9.  |

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| **UČNI NAČRT PREDMETA / COURSE SYLLABUS** |
| **Predmet:** | **ELEKTROTEHNIKA II** |
| **Course title:** | **ELECTRICAL ENGINEERING II** |
|  |  |  |  |
| **Študijski program in stopnja****Study programme and level** | **Študijska smer****Study field** | **Letnik****Academic year** | **Semester****Semester** |
| ENERGETIKA, 1. stopnja  |  | 1 | 2 |
| ENERGY TECHNOLOGY, 1.degree |  | 1 | 2 |
|  |
| **Vrsta predmeta / Course type** | Obvezni/Obligatory |
|  |  |
| **Univerzitetna koda predmeta / University course code:** | V |
|  |
| **Predavanja****Lectures** | **Seminar****Seminar** | **Vaje****Tutorial** | **Klinične vaje****work** | **Druge oblike študija** | **Samost. delo****Individ. work** |  | **ECTS** |
| **30** |  | **30** |  |  | **90** |  | **5** |
| **AV** | **LV** | **RV** |  |
|  | **30** |  |  |
|  |
| **Nosilec predmeta / Lecturer:** | **MIRALEM HADŽISELIMOVIĆ** |
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| **Jeziki /** **Languages:** | **Predavanja / Lectures:** | slovenski / Slovene |
| **Vaje / Tutorial:** | slovenski / Slovene |
| **Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:** |  | **Prerequisits:** |
| Ni pogojev. |  | None. |
| **Vsebina:**  |  | **Content (Syllabus outline):** |
| * Uvod.
* Razdelitev materialov za aplikacije v elektroenergetiki, definicija lastnosti.
* Prevodni materiali: lastnosti, prevodnost, baker, aluminij, železo, kontaktni materiali.
* Polprevodni materiali: lastnosti, tehnologija izdelave, monolitna in plastna tehnologija.
* Izolacijski materiali: lastnosti, dielektričnost in prebojna trdnost, toplotni razredi.
* Magnetni materiali: lastnosti, mehkomagnetni in trdomagnetni materiali.
* Fizikalni principi delovanja detektorjev v elektroenergetiki: uporovni, kapacitivni, induktivni, piezoelektrični, piroelektrični, foto električni, elektrodinamični…
* Aplikativna uporaba in delovanje osnovnih elementov v elektroenergetiki.
* Napetost, tok, moč in energija osnovnih elementov.
* Enofazni in trifazni električni sistem, prednosti slabosti.
* Prehodni pojavi.
 |  | * Introduction.
* Division of materials for application in electrical engineering, definition of material properties.
* Conductor materials: properties, conductivity, copper, aluminum, iron, materials for contacts.
* Semiconductor materials: properties, monolithic and multilayer technology.
* Insulation materials: properties, permittivity and dielectric strength, thermal classification.
* Magnetic materials: properties, soft magnetic and hard magnetic materials.
* Physical principles for the operation of detectors in electrical engineering: resistive, capacitive, inductive, piezoelectric, pyroelectric, photo electric, electrodynamics...
* Applicative use and operation of basic elements in electrical engineering.
* Voltage, current, power and energy of basic elements in electrical engineering.
* One phase and three phase electric power system, advantages and disadvantages.
* Transient phenomena.
 |
| **Temeljni literatura in viri / Readings:** |
| I. Tičar, T. Zorič: Introduction to Electrical Engineering I, II, III (in Slovene).A. Hamler, B. Hribernik: Materials in Electrical engineering (in Slovene). |
| **Cilji in kompetence:** |  | **Objectives and competences:** |
| Osnovno znanje o materialih v elektroenergetiki, fizikalni principi delovanja detektorjev in osnovnih elementov v elektroenergetiki.  |  | Basic knowledge of electrical engineering materials, physical principles for the operation of detectors and applicative use and operation of basic elements in electrical engineering. |
| **Predvideni študijski rezultati:** |  | **Intended learning outcomes:** |
| Znanje in razumevanje:* sposobnost uporabe pridobljenega teoretičnega znanja o elektromagnetiki v praksi
* razumevanje materialov, ki se uporabljajo v elektrotehniki
 |  | Knowledge and understanding:* the ability to use the acquired theoretical knowledge of electromagnetics in practice
* understanding the properties of materials used in electrical engineering
 |
| Prenesljive/ključne spretnosti in drugi atributi:Razvoj veščin in spretnosti v uporabi znanja na svojem konkretnem strokovnem delovnem področju. |  | Transferable/Key Skills and other attributes:Development of skills and expertise in the use of knowledge in a specific technical working area. |
| **Metode poučevanja in učenja:** |  | **Learning and teaching methods:** |
| Predavanja.Laboratorijske vaje.Samostojno delo. |  | Lectures.Practical exercises.Individual work. |
| **Načini ocenjevanja:** | Delež (v %) /Weight (in %) | **Assessment:** |
| Opravljene laboratorijske vaje.Pisni izpit. | **35****65** | Completed lab work.Written examination. |
| **Reference nosilca / Lecturer's references:**  |
| 1. SEME, Sebastijan, LUKAČ, Niko, ŠTUMBERGER, Bojan, HADŽISELIMOVIĆ, Miralem. Power quality experimental analysis of grid-connected photovoltaic systems in urban distribution networks. Energy, ISSN 0360-5442. [Print ed.], 2017, str. [1-6].2. SEME, Sebastijan, SRPČIČ, Gregor, KAVŠEK, Domen, BOŽIČNIK, Stanislav, LETNIK, Tomislav, PRAUNSEIS, Zdravko, ŠTUMBERGER, Bojan, HADŽISELIMOVIĆ, Miralem. Dual-axis photovoltaic tracking system : design and experimental investigation. Energy, ISSN 0360-5442. [Print ed.], maj 2017, str. [1-8]. 3. HADŽISELIMOVIĆ, Miralem, MARČIČ, Tine, ŠTUMBERGER, Bojan, ZAGRADIŠNIK, Ivan. Winding type influence on efficiency of an induction motor. Przeglęad Elektrotechniczny, ISSN 0033-2097, 2011, vol. 87, iss. 3, str. 61-64.4. HADŽISELIMOVIĆ, Miralem, ŠTUMBERGER, Gorazd, ŠTUMBERGER, Bojan, ZAGRADIŠNIK, Ivan. Magnetically nonlinear dynamic model of synchronous motor with permanent magnets. Journal of Magnetism and Magnetic Materials, ISSN 0304-8853. [Print ed.], 2007, vol. 316, iss. 2, str. e257-e260. 5. HADŽISELIMOVIĆ, Miralem, VIRTIČ, Peter, ŠTUMBERGER, Gorazd, MARČIČ, Tine, ŠTUMBERGER, Bojan. Determining force characteristics of an electromagnetic brake using co-energy. Journal of Magnetism and Magnetic Materials, ISSN 0304-8853. [Print ed.], Oct. 2008, vol. 320, iss. 20, str. e556-e561. |

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| **UČNI NAČRT PREDMETA / COURSE SYLLABUS** |
| **Predmet:** | **AVTOMATIKA V ENERGETIKI** |
| **Course title:** | **AUTOMATION IN ENERGETICS** |
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| **Študijski program in stopnja****Study programme and level** | **Študijska smer****Study field** | **Letnik****Academic year** | **Semester****Semester** |
| ENERGETIKA, 1. stopnja  |  | 1 | 2 |
| ENERGY TECHNOLOGY, 1.degree |  | 1 | 2 |
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| **Vrsta predmeta / Course type** | Obvezni/Obligatory |
|  |  |
| **Univerzitetna koda predmeta / University course code:** | V |
|  |
| **Predavanja****Lectures** | **Seminar****Seminar** | **Vaje****Tutorial** | **Klinične vaje****work** | **Druge oblike študija** | **Samost. delo****Individ. work** |  | **ECTS** |
| **30** |  | **30** |  |  | **90** |  | **5** |
| **AV** | **LV** | **RV** |  |
| **5** |  | **25** |  |
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| **Nosilec predmeta / Lecturer:** | **BOJAN ŠTUMBERGER** |
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| **Jeziki /** **Languages:** | **Predavanja / Lectures:** | slovenski / Slovene |
| **Vaje / Tutorial:** | slovenski / Slovene |
| **Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:** |  | **Prerequisits:** |
| Ni pogojev. |  | None. |
| **Vsebina:**  |  | **Content (Syllabus outline):** |
| * Uvod in osnovni pojmi avtomatizacije
* Matematični modeli fizikalnih sistemov
* Laplace-ova transformacija
* Vhodno-izhodni modeli sistemov, prenosne funkcije, blokovni diagrami
* Analiza sistemov v časovnem področju, razvrstitev sistemov, korekcijski členi
* Matematični model fizikalnega sistema v prostoru stanj, izbira spremenljivk stanja
* Povezava med zapisom v prostoru stanj in prenosno funkcijo
* Analiza sistemov v frekvenčnem področju
* Kriteriji stabilnosti zaprtozančnih sistemov
* Sinteza zaprtozančnih sistemov s pomočjo frekvenčnih karakteristik
* Časovno diskretni regulacijski sistemi
 |  | * Introduction to control systems and basic expressions used in control systems
* Mathematical models of physical systems
* The Laplace transformation
* Input-output models, transfer functions, block diagrams
* System analysis in the time domain, systems classification, different controllers types
* State-space mathematical model of physical system, selection of state variables
* Connection between the state-space model and the transfer function
* System analysis in the frequency domain
* Stability of closed-loop control systems
* Synthesis of closed-loop control systems in the frequency domain
* Time-discrete control systems
 |
| **Temeljni literatura in viri / Readings:** |
| Z. Vukić, L. Kuljača: Automatsko upravljanje, FER Zagreb 2005.B. Zupančič: Zvezni regulacijski sistemi, FE Ljubljana 1995.B. Liptak: Process control, Instrument Eng. Handbook, Chilten book Comp. New York 1995.K. Breckner: Regl-und Rechenschaltungen in der Processautomatisierun, Oldenbourg Wien1999.Programska oprema/Software: Matlab, Simulink.B. M. Wiliamowski, J. D. Irwin: The Industrial Electronics Handbook, Control and Mechatronics, CRC Press, 2011.R. C.Dorf, R. H. Bishop: Modern Control Systems, Pearson Prentice Hall, 2008. |
| **Cilji in kompetence:** |  | **Objectives and competences:** |
| Naučiti študenta osnovnih pojmov iz avtomatike in ga usposobiti, da bo znal izdelati avtomatizacijo enostavnega procesa. Osvojiti metodologijo in pristope k avtomatizaciji objekta z uporabo sodobnih orodij in znanj. |  | To teach students the basics of automation and qualify them to be able to realize automation project of simple process. To learn the methodology and concepts of automation on object by the use of modern tools and knowledge. |
| **Predvideni študijski rezultati:** |  | **Intended learning outcomes:** |
| Znanje in razumevanje:Študent dobi temeljno znanje o problemih in načrtovanju avtomatizacije objekta s poudarkom na osnovnem nivoju, to je regulacijska zanka. |  | Knowledge and understanding:Students gain basic knowledge on design issues of automated process where the stress is on the control loop. |
| Prenesljive/ključne spretnosti in drugi atributi:Pridobljeno znanje bo znal aplicirati na poljuben objekt iz področja energetike. |  | Transferable/Key Skills and other attributes:The students’ knowledge will be applicable in many objects in the field of power systems. |
| **Metode poučevanja in učenja:** |  | **Learning and teaching methods:** |
| Predavanja z uporabo računalniške projekcije in tableAvditorne vaje.Računalniške vaje. |  | Lectures by using powerpoint slides and whiteboard.Auditorium exercises.Computer exercises. |
| **Načini ocenjevanja:** | Delež (v %) /Weight (in %) | **Assessment:** |
| Način (pisni izpit, ustno izpraševanje, računalniške vaje):* pisni izpit
* ustni izpit
* računalniške vaje
 | **50****40****10** | Type ( written and oral examination, computer exercises):* written exam
* oral exam
* computer exercises
 |
| **Reference nosilca / Lecturer's references:**  |
| IGREC, Dalibor, ŠTUMBERGER, Bojan, CHOWDHURY, Amor, HADŽISELIMOVIĆ, Miralem. Impact of saturation modelling on the losses of electric drive controlled by QFT. *Prz. Elektrotech.*, 2013, r. 89, nr. 2b, str. 92-95. <http://pe.org.pl/articles/2013/2b/25.pdf>. [COBISS.SI-ID [1024125276](http://cobiss.izum.si/scripts/cobiss?command=DISPLAY&base=COBIB&RID=1024125276)], ŠTUMBERGER, Gorazd, PLANTIĆ, Željko, ŠTUMBERGER, Bojan, MARČIČ, Tine. Impact of static and dynamic inductance on calculated time response. *Prz. Elektrotech.*, 2011, vol. 87, iss. 3, str. 190-193. [COBISS.SI-ID [14884630](http://cobiss.izum.si/scripts/cobiss?command=DISPLAY&base=COBIB&RID=14884630)], GORIČAN, Viktor, HAMLER, Anton, JESENIK, Marko, ŠTUMBERGER, Bojan, TRLEP, Mladen. Interaction of z component of magnetic field between two samples of GO material in the round rotational single sheet tester (RRSST). *J. magn. magn. mater.*. [Print ed.], 2006, vol. 304, iss. 2, str. e558-e560.<http://dx.doi.org/10.1016/j.jmmm.2006.02.174>. [COBISS.SI-ID [10816790](http://cobiss.izum.si/scripts/cobiss?command=DISPLAY&base=COBIB&RID=10816790)GORIČAN, Viktor, HAMLER, Anton, JESENIK, Marko, ŠTUMBERGER, Bojan, TRLEP, Mladen. Measurement of alternating magnetic properties of grain-oriented materials using a round rotation single sheet tester. *Phys., B Condens. matter*. [Print ed.], 2006, no. 372, str. 194-197. [COBISS.SI-ID[10151446](http://cobiss.izum.si/scripts/cobiss?command=DISPLAY&base=COBIB&RID=10151446)]SEME, Sebastijan, SRPČIČ, Gregor, KAVŠEK, Domen, BOŽIČNIK, Stanislav, LETNIK, Tomislav, PRAUNSEIS, Zdravko, ŠTUMBERGER, Bojan, HADŽISELIMOVIĆ, Miralem. Dual-axis photovoltaic tracking system : design and experimental investigation. *Energy*, ISSN 0360-5442. [Print ed.], maj 2017, str. [1-8], graf. prikazi, doi: [10.1016/j.energy.2017.05.153](https://doi.org/10.1016/j.energy.2017.05.153). [COBISS.SI-ID [1024270172](https://plus.si.cobiss.net/opac7/bib/1024270172?lang=sl)] |

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| **UČNI NAČRT PREDMETA / COURSE SYLLABUS** |
| **Predmet:** | **TOPLOTNI STROJI IN MOTORJI V ENERGETIKI** |
| **Course title:** | **HEAT ENGINES AND INTERNAL COMBUSTION ENGINES IN ENERGY TECHNOLOGY** |
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| **Študijski program in stopnja****Study programme and level** | **Študijska smer****Study field** | **Letnik****Academic year** | **Semester****Semester** |
| ENERGETIKA, 1. Stopnja |  | 2 | 1 |
| ENERGY TECHNOLOGY, 1.degree |  | 2 | 1 |
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| **Vrsta predmeta / Course type** | Obvezni/obligatory |
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| **Univerzitetna koda predmeta / University course code:** | V |
|  |
| **Predavanja****Lectures** | **Seminar****Seminar** | **Vaje****Tutorial** | **Klinične vaje****work** | **Druge oblike študija** | **Samost. delo****Individ. work** |  | **ECTS** |
| **45** |  | **30** |  |  | **105** |  | **6** |
| **AV** | **LV** | **RV** |
| **30** |  |  |
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| **Nosilec predmeta / Lecturer:** | **MILAN MARČIČ** |
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| **Jeziki /** **Languages:** | **Predavanja / Lectures:** | Slovenski in angleški jezik ; Slovene and English |
| **Vaje / Tutorial:** | Slovenski in angleški jezik ; Slovene and English |
| **Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:** |  | **Prerequisits:** |
| Zahtevano predhodno znanje iz matematike, mehanike in termodinamike |  | Completed courses in the following subjects: Mathematics, Mechanics, Thermodynamics |
| **Vsebina:**  |  | **Content (Syllabus outline):** |
| Vsebina predmeta obsega sledeča poglavja:1. Šobe in difuzorji.
2. Ottov krožni process.
3. Dieslov in Sabathe-Seilingerjev krožni proces
4. Delovanje dvo in štiritaknega motorja
5. Indikatorski diagram dvo in štiritaktnega motorja
6. Krmiljenje ventilov štiritaktnih motorjev
7. Goriva za toplotne stroje
8. Zgorevalni procesi toplotnih strojev
9. Mazanje motorjev
10. Dinamika ročičnega mehanizma
11. Proces plinske turbine
12. Dinamika toka skozi plinske turbine
13. Zgorevanje in gorilniki plinskih turbin
14. Industrijske plinske turbine
15. Termodinamični procesi parnih turbin
16. Curtisova turbine
17. Enakotlačne, nadtlačne,kombinirane in kondenzacijske turbine.
 |  | Content of the Subject:1. Nozzles and difusors.
2. Otto cycle.
3. Diesel and Sabathe-Seilinger cycle.
4. Two and four stroke engines.
5. Idicator diagram of two and four stroke engines.
6. Valve timing diagram of four stroke engines.
7. Fuels for heat engines.
8. Combustion process of heat engines.
9. Lubrication of engines.
10. Dynamics of crankshaft.
11. Gas turbine process.
12. Fluid dynamics of gas turbines.
13. Combustion and combustors of gas turbines
14. Industrial gas turbines.
15. Thermodynamics process of steam turbines.
16. Curtis turbine.
17. Action, impulse, combined and condensation turbines.
 |
| **Temeljni literatura in viri / Readings:** |
| Max Bohner, Rolf Gscheidle,….., Motorno vozilo, ISBN 86-365-0206-3C.F. Taylor, The Internal-Combustion Engine in Theory and Practice, 1985, M.I.T. Press |
| **Cilji in kompetence:** |  | **Objectives and competences:** |
| Podat osnove o sodobnih parnih strojih in turbinah, industrijskih plinskih turbinah, industrijskih Otto in Diesel motorjih, ter plinskih motorjev. |  | Basic knowledge of modern Steam Engines and Turbines, Industrial Gas Turbines, Industrial Spark Ignition and Diesel Engines and Gas Engines. |
| **Predvideni študijski rezultati:** |  | **Intended learning outcomes:** |
| Znanje in razumevanje:Študent si pridobi osnovna znanja o sodobnih parnih strojih in turbinah, industrijskih plinskih turbinah, industrijskih Otto in Diesel motorjih, ter plinskih motorjevPrenesljive/ključne spretnosti in drugi atributi:kombinirana uporaba različnih toplotnih strojev v energetiki |  | Knowledge and understanding:Knowledge and Understanding:Student acquires the fundamentals of of modern Steam Engines and Turbines, Industrial Gas Turbines, Industrial Spark Ignition and Diesel Engines and Gas Engines.Transferable/Key Skills and other attributes:combined use of different heat engines at energy plant |
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| **Metode poučevanja in učenja:** |  | **Learning and teaching methods:** |
| 1. Avditorna predavanja, 2. Praktično delo pri avditornih vajah |  | 1. Lectures, 2. Practical work at tutorials, |
| **Načini ocenjevanja:** | Delež (v %) /Weight (in %) | **Assessment:** |
| Način (pisni izpit, ustno izpraševanje, naloge, projekt)1. Praktični del izpita v obliki pisnega reševanja nalog.2. Teoretični del izpita. | **40****60** | Type (examination, oral, coursework, project):1. Written examination in the form of practical application. 2. Theoretical examination |
| **Reference nosilca / Lecturer's references:**  |
| **1.** STRUŠNIK, Dušan, MARČIČ, Milan, GOLOB, Marjan, HRIBERNIK, Aleš, ŽIVIĆ, Marija, AVSEC, Jurij. Energy efficiency analysis of steam ejector and electric vacuum pump for a turbine condenser air extraction system based on supervised machine learning modelling. *Applied energy*, ISSN 0306-2619, jul. 2016, vol. 173, str. 386-405 **2.** MARČIČ, Simon, MARČIČ, Milan, PRAUNSEIS, Zdravko. Computer simulation of the common rail accumulator fuel-injection system. *Journal of mechanical and automobile engineering*, ISSN 2472-6281, Jan. 2016, vol. 1, iss. 1, str. 1-15. **3.** MARČIČ, Simon, MARČIČ, Milan, PRAUNSEIS, Zdravko. Electricity and heat production by biomass. *Natural resources*, ISSN 2158-706X, November 2016, vol. 7, no. 11, str. 666-675. **4.** MARČIČ, Simon, MARČIČ, Milan, PRAUNSEIS, Zdravko. Mathematical model for the injector of a common rail fuel-injection system. *Engineering*, ISSN 1947-3931. [Print ed.], June 2015, vol. 7, no. 6, str. 307-321. **5.** STRUŠNIK, Dušan, MARČIČ, Milan, AVSEC, Jurij. Turbine sealing steam heat recovery with dynamic Stirling engines = Izraba toplote tesnilne pare turbine z dinamičnimi Stirling motorji. *Journal of energy technology*, ISSN 1855-5748. [Tiskana izd.], Aug. 2014, vol. 7, iss. 3, str. 17-34, ilustr.  |

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| **UČNI NAČRT PREDMETA / COURSE SYLLABUS** |
| **Predmet:** | **OSNOVE TERMODINAMIKE** |
| **Course title:** | **FUNDAMENTALS OF THERMODYNAMICS** |
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| **Študijski program in stopnja****Study programme and level** | **Študijska smer****Study field** | **Letnik****Academic year** | **Semester****Semester** |
| ENERGETIKA, 1. Stopnja |  | 2 | 1 |
| ENERGY TECHNOLOGY, 1.degree |  | 2 | 1 |
|  |
| **Vrsta predmeta / Course type** | Obvezni/Obligatory |
|  |  |
| **Univerzitetna koda predmeta / University course code:** | V |
|  |
| **Predavanja****Lectures** | **Seminar****Seminar** | **Vaje****Tutorial** | **Klinične vaje****work** | **Druge oblike študija** | **Samost. delo****Individ. work** |  | **ECTS** |
| **45** |  | **30** |  |  | **105** |  | **6** |
| **AV** | **LV** | **RV** |  |
| **25** | **5** |  |  |
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| **Nosilec predmeta / Lecturer:** | **JURIJ AVSEC** |
|  |
| **Jeziki /** **Languages:** | **Predavanja / Lectures:** | slovenski / Slovene |
| **Vaje / Tutorial:** | slovenski / Slovene |
| **Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:** |  | **Prerequisits:** |
| Ni pogojev. |  | None. |
| **Vsebina:**  |  | **Content (Syllabus outline):** |
| 1. Osnove termodinamike.2. Prvi glavni zakon termodinamike, termična enačba, kalorična enačba, preobrazbe.3. Drugi glavni zakon termodinamike, entropija, eksergija.4. Latnosti realnih snovi.5. Šobe in difuzorji-osnove.6. Termodinamika zmesi.7. Termodinamika zgorevanja.8. Delovni procesi.9. Grelni in hladilni procesi. 10. Alternativni sistemi ogrevanja in hlajenja.11. Sistemi ogrevanja z obnovljivimi viri.12. Osnove prenosa toplote.13. Dvodimenzijski stacionarni prevod toplote.14. Nestacionarni prevod toplote.15. Konvekcija.16. Naravna konvekcija.17. Vrenje in kondenzacija.18. Sevanje.19. Prenos snovi.20. Rekukerativni toplotni izmenjevalci, sotočni, protitočni, križni, izkoristek NTU metoda, konstrukcija.21. Regenerativni prenosniki toplote.22. Toplotni izmenjevalci, vrste, konstrukcija, energijski preračun.23. Uparjalniki in kondenzatorji.24. Kompaktni toplotni izmenjevalci.25. Snovni prenosniki toplote |  | 1. Fundamentals of the engineering thermodynamics.2. First law of thermodynamics, thermal equation of state, caloric equation of state.3. Second law of thermodynamics, entropy, exergy.4.Thermodynamic properties opf real substances.5. Nozzles and diffusors-fundamentals. 6. Thermodynamics of mixtures.7. Thermodynamics of combustion.8. Working processes.9. Heating and refrigerration processes.10. Alternative systems of heating and refrigeration.11. Systems of heating with renewable sources.12. Fundamentals of heat transfer.13. Two dimensional dteady state conduction.14. Transient conduction.15. Convection.16. Free convection.17. Boiling and condensation.18. Radiation.19. Mass transfer20. Recuperative heat exchangers, parallel flow, counterflow, crossflow, effectiveness NTU method, construction.21. Regenerative heat exchangers.22. Heat exchangers, construction, energy calculation. 23. Boilers and condensers.24. Compact heat exchangers.25. Mass exchangers. |
| **Temeljni literatura in viri / Readings:** |
| Milan Marčič, Jurij Avsec, Hladilna tehnika, Fakulteta za strojništvo, Univerza v Mariboru, 2003.Miran Oprešnik, Termodinamika, Fakulteta za strojništvo, Univerza v Ljubljani, 1987.Faye McQuiston, Jerald Parker, Jefrey Spitler, Heating, Ventilating and Air-Conditioning, John Wiley&Sons 2000.C.J. Erickson, Handbook of electrical heating for industry, IEEE Press, 1995D.Y. Goswami, F. Keith, Energy conversion, 2008, CRC PressA. Kitanowski, A. Poredoš, Daljinsko hlajenje, SDHK, 2001B. Liptak, Post-oil technology, CRC press, 2009F.P. Incropera, D.P. DeWitt, Heat and Mass Transfer, John Wiley, Fifth Edition, 2002.F.M. White, Heat and Mass Transfer, Addison Wesley, 1991.W. Kays, A.L. London, Compact Heat Exchangers, Mc-Graw Hill.H.D. Baehr, K. Stephan, Wärme und Stoff Übertragung, Springer, 1996, 2. Auflage.R.K. Shah, D. P. Sekulić, Fundamentals of heat exchanger design, 2003, Wiley.S. kakac, Heat exchangers, , CRC, Wiley. |
| **Cilji in kompetence:** |  | **Objectives and competences:** |
| Študent se spozna z osnovami termodinamike in prenosa toplote, ter ogrevalnimi in hladilnimi sistemi.  |  | Student acquires the fundamentals of thermodynamics and heat transfer, which is necessary for understanding and designing of heating and cooling systems. |
| **Predvideni študijski rezultati:** |  | **Intended learning outcomes:** |
| Znanje in razumevanje:* razumevanje termodinamike in prenosa toplote
* sposobnost projektiranja toplotnih in snovnih prenosnikov
 |  | Knowledge and understanding:* knowledge of thermodynamics and heat and mass transfer
* ability of designing of heat and mass exchangers
 |
| Prenesljive/ključne spretnosti in drugi atributi:* kombinirana uporaba različnih osnovnih znanj za reševanje inženirskih problemov
* projektiranje termodinamičnih sistemov
 |  | Transferable/Key Skills and other attributes:* combined use of different fundamental skills for solution of engineering problems
* designing of thermodynamic systems
 |
| **Metode poučevanja in učenja:** |  | **Learning and teaching methods:** |
| predavanja.Reševanje domačih nalog.Praktično delo pri seminarskih in računalniških vajah.Izdelava seminarske naloge. |  | Lectures.Coursework.Practical work at tutorials and computer work. Seminar (project) work. |
| **Načini ocenjevanja:** | Delež (v %) /Weight (in %) | **Assessment:** |
| Način (pisni izpit, ustno izpraševanje, naloge, projekt)* praktični del izpita v obliki pisnega reševanja nalog
* seminarska naloga
* teoretični del izpita
 | **40****10****50** | Type (examination, oral, coursework, project):* written examination in the form of practical application of calculation methods for machine elements
* seminar work
* theoretical examination
 |
| **Reference nosilca / Lecturer's references:**  |
| 1.AVSEC, Jurij, WANG, Zhaolin, NATERER, Greg F. Thermodynamic and transport properties of fluids and solids in a Cu-Cl solar hydrogen cycle. Journal of thermal analysis and calorimetry, ISSN 1388-6150. [Print ed.], jan. 2017, vol. 127, issue 1, str. 961-967, doi: 10.1007/s10973-016-5875-y. [COBISS.SI-ID 1024244316] 2.STRUŠNIK, Dušan, MARČIČ, Milan, GOLOB, Marjan, HRIBERNIK, Aleš, ŽIVIĆ, Marija, AVSEC, Jurij. Energy efficiency analysis of steam ejector and electric vacuum pump for a turbine condenser air extraction system based on supervised machine learning modelling. Applied energy, ISSN 0306-2619, jul. 2016, vol. 173, str. 386-405, graf. prikazi, doi: 10.1016/j.apenergy.2016.04.047. [COBISS.SI-ID 1024226652] 3.STRUŠNIK, Dušan, GOLOB, Marjan, AVSEC, Jurij. Effect of non-condensable gas on heat transfer in steam turbine condenser and modelling of ejector pump system by controlling the gas extraction rate through extraction tubes. Energy conversion and management, ISSN 0196-8904. [Print ed.], oct. 2016, vol. 126, str. 228-246, doi: 10.1016/j.enconman.2016.07.082. [COBISS.SI-ID 19707158] 4.ŽIVIĆ, Marija, GALOVIĆ, Antun, AVSEC, Jurij, HOLIK, Mario. Exergy analysis of a Brayton cycle with variable physical properties and variable composition of working substance. Tehnički vjesnik : znanstveno-stručni časopis tehničkih fakulteta Sveučilišta u Osijeku, ISSN 1330-3651, 2016, vol. 23, no. 3, str. 801-808. 5. STRUŠNIK, Dušan, AVSEC, Jurij. Exergoeconomic analysis of the potential exploitation of condensation water vapor waste heat in a thermal power plant using heat pumps. Transactions of FAMENA, ISSN 1333-1124, 2016, vol. 40, spec. issue 1, str. 11-22. 6. AVSEC, Jurij, NOVOSEL, Urška. Application of alternative technologies in combination with nuclear energy. Transactions of FAMENA, ISSN 1333-1124, 2016, vol. 40, spec. issue 1, str. 23-32. 7. STRUŠNIK, Dušan, AVSEC, Jurij. Artificial neural networking model of district heating energy and exergy mony flows. Energy and buildings, ISSN 0378-7788. [Print ed.], Jan. 2015, vol. 86, pp. 366-375, graf. prikazi, doi: doi:10.1016/j.enbuild.2014.09.075. [COBISS.SI-ID 1024193116] AVSEC, Jurij, MARČIČ, Milan. Termotehnika. Krško: Fakulteta za energetiko, 2009. XIII, 272 str., ilustr. ISBN 978-961-6800-00-6. |

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| **UČNI NAČRT PREDMETA / COURSE SYLLABUS** |
| **Predmet:** | **HIDRAVLIČNI ENERGETSKI SISTEMI I** |
| **Course title:** | **HYDRAULIC ENERGETIC SYSTEMS I** |
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| **Študijski program in stopnja****Study programme and level** | **Študijska smer****Study field** | **Letnik****Academic year** | **Semester****Semester** |
| ENERGETIKA, 1. stopnja  |  | 2 | 1 |
| ENERGY TECHNOLOGY, 1.degree |  | 2 | 1 |
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| **Vrsta predmeta / Course type** | Obvezni/Obligatory |
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| **Univerzitetna koda predmeta / University course code:** | V |
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| **Predavanja****Lectures** | **Seminar****Seminar** | **Vaje****Tutorial** | **Klinične vaje****work** | **Druge oblike študija** | **Samost. delo****Individ. work** |  | **ECTS** |
| **45** |  | **30** |  |  | **105** |  | **6** |
| **AV** | **LV** | **RV** |  |
| **20** | **10** |  |  |
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| **Nosilec predmeta / Lecturer:** | **ANDREJ PREDIN** |
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| **Jeziki /** **Languages:** | **Predavanja / Lectures:** | slovenski / Slovene |
| **Vaje / Tutorial:** | slovenski / Slovene |
| **Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:** |  | **Prerequisits:** |
| Osnovna znanja fizike, mehanike, termodinamike |  | Basic knowledge of physics, mechanics, thermodynamics |
| **Vsebina:**  |  | **Content (Syllabus outline):** |
| Osnovne vodilne enačbe in zakoni, enačbe stanja, plošna plinska enačba, energijske enačbe, glavni zakoni termodinamike;Osnovni ohranitveni koncepti (ohranitev mase, tokovne enačbe, ohranitev momenta)Gospodarnost hidroenergetskega sistemaRazdelitev HES glede na različne vidikePregled po svetu izvedenih HES sistemovSestav hidroenergetskega postrojaOsnove hidroenergije, oblike, načini izrabe, akumulacija, cikli obratovanja, …Tipi tokov, tokovnica, tokovna cev, diskretizacija tokovnega prostoraOhranitveni zakoni (sistemi enačb)Energijska enačba turbinskega strojaProblematika kinematike tekočin Problematika dinamike tekočin Dimenzijska analiza in hidravlična podobnost Osnovne lastnosti in vrste fluidnih tokov Tok v zaprtih cevovodih, hidravlični udar izgube, … Kompleksni cevni sistemi, pretoki, nivoji, izgube, … Tok v odprtih kanalih, hidravlični skok, izgube, … Stisljiv in nestisljiv tok Hidro-energetski sistemi, tipi in opremaTekočinski stroji in napraveVodne turbineVelikost in narava gonilnih sil in momentovLastnosti in razmerja pri nadtlačnih turbinskih sistemihVloga glavnih dimenzij turbinePogoji podobnega obratovanja turbinDovodni turbinski sistemiTurbinski sistemiOdvodni turbinski sistemiObratovanje in regulacija turbinskega sistemaTranzientni problemi;Razdelitev: stroji vs. napraveRazdelitev: Tokovni in Impulzni stroji,Načini obratovanja tokovnih strojevTehniški in ekonomski kazalci obratovanja tokovnih strojev |  | Basic / governement equations and laws, equations of state, gas equation, energy equations, principal laws of thermodynamics;Basic conservation concepts (conservation of mass, current equation, preservation of momentum)Economy of the hydropower systemHES division according to different aspectsWorldwide overview of HES systemsHydroelectric plant assemblyFundamentals of hydropower, forms, methods of utilization, accumulations, operating cycles, ...Flow currents, circuits, current hose, diskretisation of the current spaceConservation laws (systems of equations)The energy equation of the turbine machineProblems of the kinematics of liquidsProblems of fluid dynamicsDimensional analysis and hydraulic similarityBasic properties and types of fluid flowsFlow in closed pipelines, hydraulic shock loss, ...Complex pipe systems, flows, levels, losses, ...Flow in open channels, hydraulic jump, losses, ...A squeezable and incurable streamHydro-energy systems, types and equipmentLiquids and appliancesWater turbinesThe size and nature of the driving forces and momentsProperties and relationships in overpressure turbine systemsThe role of the main dimensions of the turbineConditions for similar operation of turbinesInlet turbine systemsTurbine systemsDrainage turbine systemsOperation and regulation of the turbine systemTransient problems;Distribution: machinery vs. devicesDistribution: Current and Impulse Machines,Operating modes of current machineryTechnical and economic indicators for the operation of current machinery |
| **Temeljni literatura in viri / Readings:** |
| [1] **H. Požar:** *Osnove energetike 1*, Školska knjiga Zagreb, Sveučilište u Zagrebu, 1992.[2] **W. C. Turner, S. Doty:** *Energy Management Handbook*, Sixth Edition, CRC Press, 2006[3] ] **M. Tuma, M. Sekavčnik:** *Energetski sistemi, Preskrba z električno energijo in toploto*, Univerza v Ljubljani, FS, 2004.[4] **I. H. Shames:** *Mechanics of Fluids*, McGraw-Hill, International Editions, 1992 [5] **H. Sigloch:** *Strömungsmaschinen, Grundlagen und Anwendungen,* 4. aktualisierte Auflage, Hanser Verlag, 2009[6] **J. Giesecke, E. Mosonyi:** *Wasserkraftanlagen, Planung, Bau und Betrieb,* 4. aktualisierte und erweiterte Auflage, Springer Verlag, 2005[7] **D. Horvat:** *Vodene turbine,* Sveučilište u Zagrebu, Zagreb 1965 |
| **Cilji in kompetence:** |  | **Objectives and competences:** |
| Osvojitev osnovnih znanj na področju hidravličnih strojev, sistemov in naprav v energetiki; |  | Basic knowledge in the field of hydraulic machines, systems and devices in the field of energy technology; |
| **Predvideni študijski rezultati:** |  | **Intended learning outcomes:** |
| * Poznavanje osnov hidroenergetskih sistemov
* Celote in delov HES
* Vodenje, upravljanje HES
* Ekonomsko vrednotenje HES;
 |  | - Knowledge of the basics of hydropower systems- Whole and parts of HES- Keeping, managing HES- Economic evaluation of HES; |
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| **Metode poučevanja in učenja:** |  | **Learning and teaching methods:** |
| * Predavanja,
* Avditorne in laboratorijske vaje,
* Izvajanje Računskih primerov;
 |  | - Lectures,- Audit and laboratory exercises,- Worked examples; |
| **Načini ocenjevanja:** | Delež (v %) /Weight (in %) | **Assessment:** |
| * pisni izpit,
* pisna teorija
* kratek ustni zagovor;
 | **40** **50** **10**  | - written examination,- written theory- a brief oral defense; |
| **Reference nosilca / Lecturer's references:**  |
| PREDIN, Andrej, GREGORC, Boštjan, BILUŠ, Ignacijo. Cavitation swirl at the entrance of centrifugal pump. *Journal of energy technology*, ISSN 1855-5748. [Tiskana izd.], Aug. 2009, vol. 2, iss. 3, str. 85-97. [COBISS.SI-ID [1024008284](https://plus.si.cobiss.net/opac7/bib/1024008284?lang=sl)]MIHALIĆ, Tihomir, GUZOVIĆ, Zvonimir, PREDIN, Andrej. CFD flow analysis in the centrifugal vortex pump. *International journal of numerical methods for heat & fluid flow*, ISSN 0961-5539, 2014, vol. 24, no. 3, str. 545-562. <http://www.emeraldinsight.com/journals.htm?issn=0961-5539&volume=24&issue=3&articleid=17109922&show=abstract>, doi: [10.1108/HFF-05-2012-0124](https://doi.org/10.1108/HFF-05-2012-0124). [COBISS.SI-ID [1024162140](https://plus.si.cobiss.net/opac7/bib/1024162140?lang=sl)]BILUŠ, Ignacijo, ŠKERGET, Leopold, PREDIN, Andrej, HRIBERŠEK, Matjaž. Eksperimentalno numerična analiza kavitacijskega toka okoli lopatičnega profila = Experimental and numerical analysis of the cavitational flows around a hydrofoil. *Strojniški vestnik*, ISSN 0039-2480, 2005, letn. 51, št. 2, str. 103-118. [COBISS.SI-ID [8153627](https://plus.si.cobiss.net/opac7/bib/8153627?lang=sl)]PREDIN, Andrej, KLASINC, Roman. Emergency gate vibration of the pipe-turbine model. *Shock and vibration*, ISSN 1070-9622, 2000, vol. 7, no. 1, str. 3-13. <https://dk.um.si/IzpisGradiva.php?id=66228>. [COBISS.SI-ID [5422358](https://plus.si.cobiss.net/opac7/bib/5422358?lang=sl)]GREGORC, Boštjan, PREDIN, Andrej, FABIJAN, Drago, KLASINC, Roman. Experimental analysis of the impact of particles on the cavitating flow. *Strojniški vestnik*, ISSN 0039-2480, apr. 2012, vol. 58, no. 4, str. 238-244, SI 50, ilustr., doi: [10.5545/sv-jme.2011.062](https://doi.org/10.5545/sv-jme.2011.062). [COBISS.SI-ID [1024067932](https://plus.si.cobiss.net/opac7/bib/1024067932?lang=sl)] |

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| **UČNI NAČRT PREDMETA / COURSE SYLLABUS** |
| **Predmet:** | **ELEKTRIČNI STROJI** |
| **Course title:** | **ELECTRICAL MACHINES** |
|  |  |  |  |
| **Študijski program in stopnja****Study programme and level** | **Študijska smer****Study field** | **Letnik****Academic year** | **Semester****Semester** |
| ENERGETIKA, 1. stopnja  |  | 2 | 1 |
| ENERGY TECHNOLOGY, 1.degree |  | 2 | 1 |
|  |
| **Vrsta predmeta / Course type** | Obvezni/Obligatory |
|  |  |
| **Univerzitetna koda predmeta / University course code:** | V |
|  |
| **Predavanja****Lectures** | **Seminar****Seminar** | **Vaje****Tutorial** | **Klinične vaje****work** | **Druge oblike študija** | **Samost. delo****Individ. work** |  | **ECTS** |
| **45** |  | **30** |  |  | **105** |  | **6** |
| **AV** | **LV** | **RV** |  |
|  | **30** |  |  |
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| **Nosilec predmeta / Lecturer:** | **BOJAN ŠTUMBERGER** |
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| **Jeziki /** **Languages:** | **Predavanja / Lectures:** | slovenski / Slovene |
| **Vaje / Tutorial:** | slovenski / Slovene |
| **Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:** |  | **Prerequisits:** |
| Ni pogojev. |  | None. |
| **Vsebina:**  |  | **Content (Syllabus outline):** |
| * Uvod: osnovni tipi transformatorjev in rotirajočih električnih strojev, lastnosti mehkomagnetnih materialov, neorientirana in orientirana pločevina, vpliv vrtinčnih tokov v električni pločevini; materiali za prevodnike in kožni pojav, izgube in izkoristek, segrevanje in hlajenje, izolacijski razredi izolacije.
* Električni transformatorji: komponente enofaznih in trifaznih transformatorjev, princip delovanja enofaznega transformatorja v praznem teku in pri obremenitvi, ravnotežne enačbe in nadomestno vezje, kazalčni diagram; vezalne skupine trifaznih transformatorjev, asimetrija tokov neobremenjenega trifaznega transformatorja, nesimetrična obremenitev v ustaljenem stanju; prehodni pojavi; napetostni in tokovni merilni transformatorji; avtotransformatorji.
* Sinhronski stroji: področje uporabe in topologije sinhronskih strojev; porazdeljeno trifazno statorsko navitje; rotorsko vzbujalno navitje; princip delovanja; reakcija armature; sinhronske reaktance; ravnotežne enačbe v ustaljenem stanju in kazalčni diagram; sinhronski generator na lastni mreži, karakteristika prostega teka, kratkega stika in obremenilna karakteristika; sinhronski generator na togi mreži, krivulja delovne moči, krivulja jalove moči; statična stabilnost; sinhronski stroji s trajnimi magneti; sinhronski reluktančni motorji.
* Asinhronski stroji: področje uporabe in konstrukcijski elementi, kratkostična rotorska kletka, princip delovanja, induktivnosti, delovanje trifaznega motorja pri obremenitvi; ravnotežne napetostne enačbe, nadomestno vezje, kazalčni diagram; asinhronski stroj kot generator; asinhronski generator na lastni mreži; asinhronski generator na togi mreži; karakteristike moči v motorskem, generatorskem in zavornem režimu delovanja; različne metode zagona motorja; spreminjanje hitrosti vrtenja; enofazni asinhronski motorji s pomožnim kondenzatorjem.
* Komutatorski stroji: konstrukcijski elementi statorja in rotorja; izvedba vzbujalnega navitja in navitja armature; inducirana napetost; proces komutacije; enosmerni motor/generator s ščetkami s tujim vzbujanjem; enosmerni motor s ščetkami in paralelnim vzbujanjem; enosmerni motor s ščetkami in serijskim vzbujanjem; izmenični motor s ščetkami in serijskim vzbujanjem; spreminjanje hitrosti vrtenja.
 |  | * Introduction: basic types of transformers and rotating electric machines, properties of soft magnetic materials, non-oriented and grain-oriented electrical steel, eddy currents effect in electrical steel, materials for electric conductors and skin effect, losses and efficiency, heating and cooling, insulation classes.
* Electric transformers: components of single and three-phase transformers, operation principle of single phase transformer at no-load and full load, circuit equations and equivalent circuit; phasor diagram; phase connections of three-phase transformers, no-load current asymmetry, unbalanced load in steady state; transients in transformers; instrument voltage and current transformers; autotransformers.
* Synchronous machines: applications and topologies; distributed three-phase stator windings; rotor excitation windings; principle of operation; armature reaction; synchronous reactances; steady-state equations and phasor diagram; synchronous generator at autonomous grid, no-load curve, short-circuit curve and load curve; synchronous generator at power grid, active power capability curve, reactive power capability curve; static stability; topologies of permanent magnet synchronous machines; synchronous reluctance motors.
* Induction machines: applications and construction elements; cage rotor windings; principle of operation, induction machine inductances; motor operation at load; three-phase induction machine circuit equations; equivalent circuit, phasor diagram; power generation at power grid; autonomous generator mode; power capability curves in motor, generator and electric brake operation mode; different starting methods; speed control methods; capacitor split single phase induction motors.
* Brush-commutator machines: stator and rotor construction elements; excitation and armature windings design; electromotive force; commutation process; DC brush motor/generator with separate excitation; DC brush motor with parallel excitation; DC brush series motor; AC brush series motor; speed control methods.
 |
| **Temeljni literatura in viri / Readings:** |
| I. Zagradišnik, B. Slemnik: Električni rotacijski stroji, FERI Maribor, 2009D. Miljavec, P. Jereb: Električni stroji, Ljubljana, 2005D. Dolinar, G. Štumberger: Modeliranje in vodenje elektromehanskih sistemov, FERI Maribor, 2004.H. A. Toliyat, G. B. Kliman: Handbook of Electric Motors, CRC Press, 2004.I. Boldea: The Electric Generators Handbook, Synchronous Generators, CRC Press, 2005.I. Boldea: Variable Speed Generators, CRC Press, 2005.P.C. Krause, O. Wasynczuk, S. D.Sudhoff: Analysis of Electric Machinery and Drive Systems: IEEE Press, 2002.N. Tleis: Power System Modeling and Fault Analysis, Elsevier, 2008.R. D. Doncker, D.W.J. Pulle, A.Veltman: Advanced Electrical Drives, Analysis, Modeling, Control, Springer, 2011.Chee-Mun Ong: Dynamics Simulation of Electric Machinery Using Matlab/Simulink, Prentice Hall, 1998.A.E. Fitzgerald, C. Kingsley, S.D. Umans: Electric Machinery, Mc Grow Hill, 2003.A. Veltman, D. W. Pulle, R. W. De-Doncker: Fundamentals of Electric Drives; Springer,2007 |
| **Cilji in kompetence:** |  | **Objectives and competences:** |
| Dobro poznavanje osnovnih obratovalnih lastnosti in načina delovanja posameznih vrst rotacijskih električnih strojev in transformatorjev, poznavanje področja uporabe posameznega električnega stroja. |  | The main objective is to acquire apropriate skills about basic operating properties and priciple of operation for different types of rotating electrical machines and transformers, knowledge about possible application of a particular type of electric machine. |
| **Predvideni študijski rezultati:** |  | **Intended learning outcomes:** |
| Znanje in razumevanje:Poznavanje in razumevanje teoretičnih osnov pretvarjanja električne energije v električno, pretvarjanja mehanske energije v električno, pretvarjanja električne energije v mehansko, vloga magnetnega polja pri pretvarjanju energije in poznavanje obratovalnih lastnosti posameznih električnih strojev |  | Knowledge and understanding:Obtaining theoretical knowledge connected with: conversion of electrical energy to electrical energy; conversion of mechanical energy to electric energy; conversion of electric energy to mechanical energy; role of magnetic field in the energy conversion; knowledge about operation properties of different electrical machines. |
| Prenesljive/ključne spretnosti in drugi atributi:Znanje o delovanju posameznih električnih strojev, predvsem transformatorjev, sinhronskih, asinhronskih in enosmernih strojev . |  | Transferable/Key Skills and other attributes:Knowledge about operation properties of different electrical machines, i.e. transformers, synchronous, induction and DC machines.  |
| **Metode poučevanja in učenja:** |  | **Learning and teaching methods:** |
| Predavanja z uporabo računalniške projekcije in tableLaboratorijske vaje. |  | Lectures by using powerpoint slides and whiteboard.Laboratory exercises. |
| **Načini ocenjevanja:** | Delež (v %) /Weight (in %) | **Assessment:** |
| Način (pisni izpit, ustno izpraševanje, laboratorijske vaje):* pisni izpit
* ustni izpit
* laboratorijske vaje
 | **40****50****10** | Type ( written and oral examination, laboratory exercises):* written exam
* oral exam
* laboratory exercises
 |
| **Reference nosilca / Lecturer's references:**  |
| ŠTUMBERGER, Bojan, HADŽISELIMOVIĆ, Miralem, HREN, Gorazd. Design of fractional-slot permanent magnet synchronous motor with concentrated windings and interior permanent magnets. *Prz. Elektrotech.*, 2013, r. 89, nr. 2b, str. 5-8. <http://pe.org.pl/articles/2013/2b/2.pdf>. [COBISS.SI-ID[1024124764](http://cobiss.izum.si/scripts/cobiss?command=DISPLAY&base=COBIB&RID=1024124764)]ŠTUMBERGER, Bojan, MARČIČ, Tine, HADŽISELIMOVIĆ, Miralem. Direct comparison of induction motor and line-start IPM synchronous motor characteristics for semi-hermetic compressor drives. *IEEE transactions on industry applications*, 2012, vol. 48, no 6, str. 2310-2321.<http://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=6352909>, doi: [10.1109/TIA.2012.2227094](http://dx.doi.org/10.1109/TIA.2012.2227094). [COBISS.SI-ID [72594433](http://cobiss.izum.si/scripts/cobiss?command=DISPLAY&base=COBIB&RID=72594433)]MARČIČ, Tine, ŠTUMBERGER, Gorazd, ŠTUMBERGER, Bojan. Analyzing the magnetic flux linkage characteristics of alternating current rotating machines by experimental method. *IEEE trans. magn.*, Sep. 2011, vol. 47, iss. 9, str. 2283-2291, graf. prikazi, doi: [10.1109/TMAG.2011.2146266](http://dx.doi.org/10.1109/TMAG.2011.2146266). [COBISS.SI-ID [67349761](http://cobiss.izum.si/scripts/cobiss?command=DISPLAY&base=COBIB&RID=67349761)]ŠTUMBERGER, Bojan, ŠTUMBERGER, Gorazd, HADŽISELIMOVIĆ, Miralem, MARČIČ, Tine, VIRTIČ, Peter, TRLEP, Mladen, GORIČAN, Viktor. Design and finite-element analysis of interior permanent magnet synchronous motor with flux barriers. *IEEE trans. magn.*, Nov. 2008, vol. 44, no. 11, str. 4389-4392, doi: [10.1109/TMAG.2008.2002587](http://dx.doi.org/10.1109/TMAG.2008.2002587). [COBISS.SI-ID [12610582](http://cobiss.izum.si/scripts/cobiss?command=DISPLAY&base=COBIB&RID=12610582)]ŠTUMBERGER, Bojan, ŠTUMBERGER, Gorazd, HADŽISELIMOVIĆ, Miralem, HAMLER, Anton, GORIČAN, Viktor, JESENIK, Marko, TRLEP, Mladen. Performance comparison of three-phase flux reversal permanent magnet motors in BLDC in BLAC operation mode. *J. magn. magn. mater.*. [Print ed.], Oct. 2008, vol. 320, iss. 20, str. e896-e900. [http://dx.doi.org/doi:10.1016/j.jmmm.2008.04.069](http://dx.doi.org/doi%3A10.1016/j.jmmm.2008.04.069), doi: [doi:10.1016/j.jmmm.2008.04.069](http://dx.doi.org/doi%3A10.1016/j.jmmm.2008.04.069). [COBISS.SI-ID [12352278](http://cobiss.izum.si/scripts/cobiss?command=DISPLAY&base=COBIB&RID=12352278)]MARČIČ, Tine, ŠTUMBERGER, Bojan, ŠTUMBERGER, Gorazd. Differential-evolution-based parameter Identification of a line-start IPM synchronous motor. *IEEE transactions on industrial electronics*, ISSN 0278-0046. [Print ed.], Nov. 2014, vol. 61, iss. 11, str. 5921-5929, doi: [10.1109/TIE.2014.2308160](https://doi.org/10.1109/TIE.2014.2308160). [COBISS.SI-ID [17638166](https://plus.si.cobiss.net/opac7/bib/17638166?lang=sl)]PIŠEK, Peter, ŠTUMBERGER, Bojan, MARČIČ, Tine, VIRTIČ, Peter. Design analysis and experimental validation of a double rotor synchronous PM machine used for HEV. *IEEE transactions on magnetics*, ISSN 0018-9464, Jan. 2013, vol. 49, no. 1, str. 152-155, doi: [10.1109/TMAG.2012.2220338](https://doi.org/10.1109/TMAG.2012.2220338). [COBISS.SI-ID [1024117084](https://plus.si.cobiss.net/opac7/bib/1024117084?lang=sl)] |

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| **UČNI NAČRT PREDMETA / COURSE SYLLABUS** |
| **Predmet:** | **ELEKTRIČNE NAPRAVE IN PRENOS ELEKTRIČNE ENERGIJE** |
| **Course title:** | **ELECTRICAL DEVICES AND ELECTRIC POWER TRANSMISSION** |
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| **Študijski program in stopnja****Study programme and level** | **Študijska smer****Study field** | **Letnik****Academic year** | **Semester****Semester** |
| ENERGETIKA, 1. stopnja  |  | 2 | 1 |
| ENERGY TECHNOLOGY, 1.degree |  | 2 | 1 |
|  |
| **Vrsta predmeta / Course type** | Obvezni/Obligatory |
|  |  |
| **Univerzitetna koda predmeta / University course code:** | V |
|  |
| **Predavanja****Lectures** | **Seminar****Seminar** | **Vaje****Tutorial** | **Klinične vaje****work** | **Druge oblike študija** | **Samost. delo****Individ. work** |  | **ECTS** |
| **45** |  | **30** |  |  | **105** |  | **6** |
| **AV** | **LV** | **RV** |  |
|  | **20** | **10** |  |
|  |
| **Nosilec predmeta / Lecturer:** | **SEBASTIJAN SEME** |
|  |
| **Jeziki /** **Languages:** | **Predavanja / Lectures:** | slovenski / Slovene |
| **Vaje / Tutorial:** | slovenski / Slovene |
| **Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:** |  | **Prerequisits:** |
| Ni pogojev. |  | None. |
| **Vsebina:**  |  | **Content (Syllabus outline):** |
| a) Prenos in obratovanje elektroenergetskega sistema. Predstavitev elementov elektroenergetskega sistema, signalov, vezij in transformacij. Prehodni pojavi in okvare v elektroenergetskih sistemih. Simetrične komponente in teorija izračunov simetričnih komponent.b) Elektroenergetski sistem in delitev omrežij po napetosti, funkciji in obliki. Osnove trifaznega prenosa električne energije.c) Teorija električnih stikalnih aparatov in naprav. Osnove delovanja in izbire aparatov in naprav, kot so: kontaktorji, ločilniki, ločilna stikala, odklopniki, transformatorji, stikalne celice in izolacijski materiali.d) Oblikovanje in tehnična izvedba daljnovodov. Izračun povesne verižnice in dopustne natezne napetosti. Upoštevanje varnostne oddaljenosti in višine. Mehanske lastnosti daljnovodnih vrvi.e) Prenos električne energije po daljnovodih.f) Stikališča in transformatorske postaje. |  | a) Transmission and operation of the electric power system. Presentation of elements of the electric power system, signals, circuits and transformations. Transients and failure in power systems. Symmetric components and theory of calculations of symmetric components.b) Electric power system and network sharing by voltage, function and form. Basics of three-phase transmission of electricity.c) Theory of electrical switchgear and appliances. Basics of the operation and selection of apparatus and devices, such as: contactors, disconnectors, switch disconnectors, circuit breakers, transformers, switchgear and insulating materials.d) Design and technical execution of power lines. Calculation of the chain sprocket and the permissible tensile stress. Consideration of safety distance and height. Mechanical properties of power lines.e) Transmission of electricity through power lines.f) Switchgear and transformer stations. |
| **Temeljni literatura in viri / Readings:** |
| J. D. Glover, M. S. Sarma, T. J. Overbye: Power Systems Analysis and Design, Cengage Learning, 2012.N. Tleis: Power System Modeling and Fault Analysis, Elsevier, 2008.V. Mehta, R. Mehta: Priciples of Power Systems, S.Chand&Company Ltd., 2008.M. E. El-Hawary: Introduction to Electrical Power Systems, Wiley, 2008.Xi-Fan. Wang, Y.Song, M. Irving: Modern Power System Analysis, Springer, 2008.I. Kosicki: Analysis and Designof Low-Voltage Power-Systems,Wiley-VCH, 2004.J. Pihler, Stikalne naprave elektroenergetskega sistema, Druga dopolnjena izdaja, Založniška dejavnost FERI Maribor, Maribor, 2003.F. Kiessling, P. Nefzger, J.F. Nolasco, U. Kaintzyk: Overhead Power Lines, Springer 2002.I. Ravnikar, Električne inštalacije, Tretja predelana izdaja, Tehniška založba Slovenije, Ljubljana, 1999.J. Marušič, F. Jakl: Načrtovanje in krajinsko oblikovanje koridorjev daljnovodov in cevnih vodov, 1998.M. Plaper: Elektroenergetska omrežja, deI I, Ljubljana 1974, del II Ljubljana 1975, del III Ljubljana 1977. |
| **Cilji in kompetence:** |  | **Objectives and competences:** |
| Cilj in kompetence predmeta so pridobiti poglobljena teoretična znanja s področja električnih naprav in prenosa električne energije.Spoznati osnovna delovanja elementov elektroenergetskega sistema.Razviti sposobnost samostojnega in kreativnega reševanja inženirskih problemov. |  | The objective and competences of the course are to acquire theoretical knowledge in the field of electrical devices and transmission of electricity.To learn about the basic functioning of the elements of the electric power system.Develop the ability of independent and creative solving of engineering problems. |
| **Predvideni študijski rezultati:** |  | **Intended learning outcomes:** |
| Znanje in razumevanje:Znanje in razumevanje s področja delovanja prenosa električne energije, električnih aparatov in naprav. |  | Knowledge and Understanding:Knowledge and understanding in the Field of Transmission of Eeectricity, electrical apparatus and devices. |
| Prenesljive/ključne spretnosti in drugi atributi:Uporaba teoretičnega znanja v praksi. Izračun električnih in mehanskih karakteristik daljnovodov. |  | Transferable/Key Skills and other attributes:Using theoretical knowledge in practice. Calculation of electrical and mechanical characteristics of power lines. |
| **Metode poučevanja in učenja:** |  | **Learning and teaching methods:** |
| Predavanja.Laboratorijske vaje.Računalniške vaje.Samostojno delo. |  | Lectures.Labor work.Computer work.Individual work. |
| **Načini ocenjevanja:** | Delež (v %) /Weight (in %) | **Assessment:** |
| Opravljene laboratorijske in računalniške vaje.Pisni izpit. | **35****65** | Completed lab and computer work.Written examination. |
| **Reference nosilca / Lecturer's references:**  |
| SEME, Sebastijan, LUKAČ, Niko, ŠTUMBERGER, Bojan, HADŽISELIMOVIĆ, Miralem. Power quality experimental analysis of grid-connected photovoltaic systems in urban distribution networks. Energy, ISSN 0360-5442. [Print ed.], 2017, str. [1-6], graf. prikazi, doi: 10.1016/j.energy.2017.05.088. [COBISS.SI-ID 1024268124], [JCR, SNIP, Scopus do 17. 6. 2017: št. citatov (TC): 0, čistih citatov (CI): 0]POLAJŽER, Boštjan, ŠTUMBERGER, Gorazd, SEME, Sebastijan, DOLINAR, Drago. Detection of voltage sag sources based on instantaneous voltage and current vectors and orthogonal Clarke's transformation. IET generation, transmission & distribution, ISSN 1751-8687. [Print ed.], Mar. 2008, vol. 2, iss. 2, str. 219-226. http://dx.doi.org/10.1049/iet-gtd:20070114. [COBISS.SI-ID 12231702], [JCR, SNIP, WoS do 23. 10. 2017: št. citatov (TC): 14, čistih citatov (CI): 12, Scopus do 23. 10. 2017: št. citatov (TC): 31, čistih citatov (CI): 29]SEME, Sebastijan, HADŽISELIMOVIĆ, Miralem, ŠTUMBERGER, Bojan. Vpliv proizvodnje razpršenih virov na distribucijsko omrežje = The impact of dispersed sources to the distribution network. V: ČOGA, Matej (ur.). Dvanajsta konferenca slovenskih elektroenergetikov, Portorož, 25.-27. maj 2015. [Ljubljana: Slovensko društvo elektroenergetikov CIGRÉ - CIRED. 2015], str. 1-8, ilustr. [COBISS.SI-ID 18747926]PLANTIĆ, Željko, ŠTUMBERGER, Gorazd, SEME, Sebastijan. Vpliv pogonov z asinhronskimi stroji na distribucijsko omrežje. V: VORŠIČ, Jože (ur.). Zbornik = Proceedings, 19. Mednarodno posvetovanje Komunalna energetika, 11. do 13. maj 2010, Maribor, Slovenija. Maribor: Fakulteta za elektrotehniko, računalništvo in informatiko. 2010, str. 1-10. [COBISS.SI-ID 14227990]ŠTUMBERGER, Gorazd, ROŠER, Miran, DEŽELAK, Klemen, SEME, Sebastijan, BERGANT, Peter, VORŠIČ, Jože. Prehajanje motenj čez transformatorje v distribucijskih omrežjih. V: SAJEVIC, Tomaž (ur.). Zbornik CIRED. Zbornik CIGRÉ, Sedma konferenca slovenskih elektroenergetikov, Velenje, 30. maja do 3. junija 2005. Ljubljana: Društvo CIGRE - CIRED. 2005, str. 2-47 - 2-52 (ŠK2-10). [COBISS.SI-ID 9585174]FLUHER, Bogdan, GLOTIĆ, Adnan, KITAK, Peter, PIHLER, Jože, STEGNE, Marjan, TIČAR, Igor, VORŠIČ, Jože, VORŠIČ, Žiga, DEŽELAK, Klemen, RIBIČ, Janez, SEME, Sebastijan, ŠTUMBERGER, Gorazd, VOH, Jurček. Izbira izolacijskih medijev v srednjenapetostnih celicah za distribucijska postrojenja in novih ločilnih stikal : (končno poročilo). Maribor: Fakulteta za elektrotehniko, računalništvo in informatiko, 2009. 159 str., ilustr. [COBISS.SI-ID 13363222]FLUHER, Bogdan, GLOTIĆ, Adnan, KITAK, Peter, PIHLER, Jože, STEGNE, Marjan, TIČAR, Igor, VORŠIČ, Jože, VORŠIČ, Žiga, DEŽELAK, Klemen, RIBIČ, Janez, SEME, Sebastijan, ŠTUMBERGER, Gorazd, VOH, Jurček. Vloga varovalk v srednjenapetostnih distribucijskih postrojenjih : (končno poročilo). Maribor: Fakulteta za elektrotehniko, računalništvo in informatiko, 2010. X, 150 str., graf. prikazi, ilustr. [COBISS.SI-ID 14720278] |

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| **UČNI NAČRT PREDMETA / COURSE SYLLABUS** |
| **Predmet:** | **HIDRAVLIČNI ENERGETSKI SISTEMI II** |
| **Course title:** | **HYDRAULIC ENERGETIC SYSTEMS II** |
|  |  |  |  |
| **Študijski program in stopnja****Study programme and level** | **Študijska smer****Study field** | **Letnik****Academic year** | **Semester****Semester** |
| ENERGETIKA, 1. stopnja  |  | 2 | 2 |
| ENERGY TECHNOLOGY, 1.degree |  | 2 | 2 |
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| **Vrsta predmeta / Course type** | Obvezni/Obligatory |
|  |  |
| **Univerzitetna koda predmeta / University course code:** | V |
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| **Predavanja****Lectures** | **Seminar****Seminar** | **Vaje****Tutorial** | **Klinične vaje****work** | **Druge oblike študija** | **Samost. delo****Individ. work** |  | **ECTS** |
| **30** |  | **30** |  |  | **90** |  | **5** |
| **AV** | **LV** | **RV** |  |
| **20** | **10** |  |  |
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| **Nosilec predmeta / Lecturer:** | **ANDREJ PREDIN** |
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| **Jeziki /** **Languages:** | **Predavanja / Lectures:** | slovenski / Slovene |
| **Vaje / Tutorial:** | slovenski / Slovene |
| **Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:** |  | **Prerequisits:** |
| Osnovna znanja fizike, mehanike, termodinamike |  | Basic knowledge of physics, mechanics, thermodynamics |
| **Vsebina:**  |  | **Content (Syllabus outline):** |
| * Male hidroelektrarne
* Reverzibilne hidroelektrarne
* Vodne in tekočinske črpalke
* Osnovne vrste in njih razdelitev
* Obratovalna problematika
* Kavitacija, kavitacijski parametri, …
* Skupno obratovanje in regulacija
* Načini in vrste regulacij
* Plinske črpalke in kompresorji
* Problematika stisljivosti in zvočne hitrosti toka
* Mejne izvedbe
* Izločanje plinov in tekočin
* Regulacija plinskih črpalk in kompresorjev
* Vetrne turbine
* Osnove vetrov, problemi, …
* Vrste in razdelitev vetrnih turbin
* Izbira lokacije in skupno obratovanje,
* Ekonomika obratovanja vetrnih turbin/polj
* Meritve tokovnih veličin
* Meritve obratovalnih in regulacijskih karakteristik
* Meritve pretokov / obremenitev
* Meritve nivojev
* Vzdrževanje sistemov;
 |  | - Small hydropower plants- Reversible hydroelectric power plants- Water and liquid pumps- Basic species and their distribution- Operational issues- Cavitation, cavitation parameters, ...- Joint operation and regulation- Modes and types of regulations- Gas pumps and compressors- The problem of compressibility and acoustic velocity of the current- Limitations- Exfoliation of gases and liquids- Regulation of gas pumps and compressors- Wind turbines- Basics of winds, problems, ...- Types and distribution of wind turbines- Site selection and joint operation,- Economics of wind turbine / field operation- Measurement of current quantities- Measurements of operating and control characteristics- Measurements of flows / loads- Measurements of levels- Maintenance of systems; |
| **Temeljni literatura in viri / Readings:** |
| **H. Požar:** *Osnove energetike 1*, Školska knjiga Zagreb, Sveučilište u Zagrebu, 1992.**W. C. Turner, S. Doty:** *Energy Management Handbook*, Sixth Edition, CRC Press, 2006**M. Tuma, M. Sekavčnik:** *Energetski sistemi, Preskrba z električno energijo in toploto*, Univerza v Ljubljani, FS, 2004.**I. H. Shames:** *Mechanics of Fluids*, McGraw-Hill, International Editions, 1992 **H. Sigloch:** *Strömungsmaschinen, Grundlagen und Anwendungen,* 4. aktualisierte Auflage, Hanser Verlag, 2009**J. Giesecke, E. Mosonyi:** *Wasserkraftanlagen, Planung, Bau und Betrieb,* 4. aktualisierte und erweiterte Auflage, Springer Verlag, 2005**D. Horvat:** *Vodene turbine,* Sveučilište u Zagrebu, Zagreb 1965 |
| **Cilji in kompetence:** |  | **Objectives and competences:** |
| Osvojitev znanj na področju hidravličnih strojev, sistemov in naprav v energetiki; |  | Futher knowledge in the field of hydraulic machines, systems and devices in the field of energy technology; |
| **Predvideni študijski rezultati:** |  | **Intended learning outcomes:** |
| * Poznavanje hidroenergetskih sistemov
* Celote in delov HES
* Vodenje, upravljanje HES
* Ekonomsko vrednotenje HES;
 |  | - Knowledge of hydropower systems- Whole and parts of HES- Keeping, managing HES- Economic evaluation of HES; |
|  |  |  |
| **Metode poučevanja in učenja:** |  | **Learning and teaching methods:** |
| * Predavanja,
* Avditorne in laboratorijske vaje,
* Izvajanje Računskih primerov;
 |  | - Lectures,- Audit and laboratory exercises, - Worked examples; |
| **Načini ocenjevanja:** | Delež (v %) /Weight (in %) | **Assessment:** |
| * pisni izpit,
* pisna teorija
* kratek ustni zagovor;
 | **40** **50** **10**  | - written examination,- written theory- a brief oral defense; |
| **Reference nosilca / Lecturer's references:**  |
| PREDIN, Andrej, GREGORC, Boštjan, BILUŠ, Ignacijo. Cavitation swirl at the entrance of centrifugal pump. *Journal of energy technology*, ISSN 1855-5748. [Tiskana izd.], Aug. 2009, vol. 2, iss. 3, str. 85-97. [COBISS.SI-ID [1024008284](https://plus.si.cobiss.net/opac7/bib/1024008284?lang=sl)]MIHALIĆ, Tihomir, GUZOVIĆ, Zvonimir, PREDIN, Andrej. CFD flow analysis in the centrifugal vortex pump. *International journal of numerical methods for heat & fluid flow*, ISSN 0961-5539, 2014, vol. 24, no. 3, str. 545-562. <http://www.emeraldinsight.com/journals.htm?issn=0961-5539&volume=24&issue=3&articleid=17109922&show=abstract>, doi: [10.1108/HFF-05-2012-0124](https://doi.org/10.1108/HFF-05-2012-0124). [COBISS.SI-ID [1024162140](https://plus.si.cobiss.net/opac7/bib/1024162140?lang=sl)]BILUŠ, Ignacijo, ŠKERGET, Leopold, PREDIN, Andrej, HRIBERŠEK, Matjaž. Eksperimentalno numerična analiza kavitacijskega toka okoli lopatičnega profila = Experimental and numerical analysis of the cavitational flows around a hydrofoil. *Strojniški vestnik*, ISSN 0039-2480, 2005, letn. 51, št. 2, str. 103-118. [COBISS.SI-ID [8153627](https://plus.si.cobiss.net/opac7/bib/8153627?lang=sl)]PREDIN, Andrej, KLASINC, Roman. Emergency gate vibration of the pipe-turbine model. *Shock and vibration*, ISSN 1070-9622, 2000, vol. 7, no. 1, str. 3-13. <https://dk.um.si/IzpisGradiva.php?id=66228>. [COBISS.SI-ID [5422358](https://plus.si.cobiss.net/opac7/bib/5422358?lang=sl)]GREGORC, Boštjan, PREDIN, Andrej, FABIJAN, Drago, KLASINC, Roman. Experimental analysis of the impact of particles on the cavitating flow. *Strojniški vestnik*, ISSN 0039-2480, apr. 2012, vol. 58, no. 4, str. 238-244, SI 50, ilustr., doi: [10.5545/sv-jme.2011.062](https://doi.org/10.5545/sv-jme.2011.062). [COBISS.SI-ID [1024067932](https://plus.si.cobiss.net/opac7/bib/1024067932?lang=sl)]BILUŠ, Ignacijo, PREDIN, Andrej. Experimental analysis of thermodynamical surge at water pump inlet = Eksperimentalna analiza termodinamičnih fluktuacij toka na vstopu v vodno črpalko. *Journal of energy technology*, ISSN 1855-5748. [Tiskana izd.], Aug. 2010, vol. 3, iss. 3, str. 67-74. <http://www.fe.um.si/index.php/sl/jet-opis/jet-on-line.html>. [COBISS.SI-ID [1024036444](https://plus.si.cobiss.net/opac7/bib/1024036444?lang=sl)]BILUŠ, Ignacijo, PREDIN, Andrej, ŠKERGET, Leopold. The extended homogenous cavitation transport model. *Journal of hydraulic research*, ISSN 0022-1686, 2007, vol. 45, no 1, str. 81-87. [COBISS.SI-ID [11114774](https://plus.si.cobiss.net/opac7/bib/11114774?lang=sl)] |

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| **UČNI NAČRT PREDMETA / COURSE SYLLABUS** |
| **Predmet:** | **ENERGETSKI VIRI** |
| **Course title:** | **ENERGY RESOURCES** |
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| **Študijski program in stopnja****Study programme and level** | **Študijska smer****Study field** | **Letnik****Academic year** | **Semester****Semester** |
| ENERGETIKA, 1. stopnja |  | 2 | 2 |
| ENERGY TECHNOLOGY, 1.degree |  | 2 | 2 |
|  |
| **Vrsta predmeta / Course type** | Obvezni/Obligatory |
|  |  |
| **Univerzitetna koda predmeta / University course code:** | V |
|  |
| **Predavanja****Lectures** | **Seminar****Seminar** | **Vaje****Tutorial** | **Klinične vaje****work** | **Druge oblike študija** | **Samost. delo****Individ. work** |  | **ECTS** |
| **30** |  | **30** |  |  | **90** |  | **5** |
| **AV** | **LV** | **RV** |  |
| **30** |  |  |  |
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| **Nosilec predmeta / Lecturer:** | **MILAN MEDVED** |
|  |
| **Jeziki / Languages:** | **Predavanja / Lectures:** | slovenski / Slovene |
| **Vaje / Tutorial:** | slovenski / Slovene |
| **Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:** |  | **Prerequisits:** |
| Ni pogojev. |  | None. |
| **Vsebina:**  |  | **Content (Syllabus outline):** |
| * človek - energija - okolje
	+ BDP in energetska intenzivnost
	+ rast prebivalstva in poraba energije
* energetika skozi čas
* trajnostni razvoj energetike
* shema energijske pretvorbe
* klasifikacija oblik energije
	+ konvencionalne
	+ nekonvencionalne
* klasifikacija virov energije
	+ neobnovljivi viri
	+ obnovljivi viri
* viri in zaloge energentov,
	+ koeficient R/P
* bilanca energetskih virov v svetu ter v Sloveniji
* električna energija
	+ sklopi elektroenergetskega sistema
	+ proizvajalci in večji porabniki električne energije v Sloveniji
	+ struktura porabnikov električne energije v Sloveniji
	+ struktura cene električne energije
* viri energije ter struktura porabe
	+ nafta
	+ zemeljski plin
	+ premog
	+ uran
	+ obnovljivi viri energije (voda, sonce, biomasa, veter, geotermalna energija, energija oceanov, vodik, itd.)
* energetsko načrtovanje
	+ energetska odvisnost
	+ dolgoročne energetske bilance
	+ strategija oskrbe z energijo
* razmerje preskrba z energijo in potreba po njej
* viri za proizvodnjo električne energije v Sloveniji, EU in v svetu
* primeri tehnoloških postopkov pridobivanja energetskih virov
* vplivi na okolje zaradi pridobivanja,

 transporta ter porabe energije* + plinasta goriva
	+ tekoča goriva
	+ trda goriva
	+ jedrsko gorivo
	+ obnovljivi viri
* novi postopki pridobivanja in transporta energetskih virov
	+ hidravlična frakturizacija
	+ utekočinjeni zemeljski plin
	+ podzemno vplinjevanje premoga
* vloga in učinkovitost CO2 certifikatov
* energetska prihodnost
	+ energetska učinkovitost
	+ varčevanje z energijo
	+ toplogredni plini
	+ energetska samozadostnost
	+ hranilniki energije
	+ tehnološki preskoki, novi patenti
* ekonomski in tržni aspekti energije
* vpliv geopolitičnih razmer na oblikovanje cen energentov
* konkurenčnost obnovljivih virov energije
	+ vrste podpornih shem v EU in Sloveniji
 |  | * man, energy, environment
	+ GDP and energy efficiency
	+ population and energy consumption
* energetics through history
* sustainable development of energetics
* scheme of energy transformation
* classification of energy types
	+ conventional
	+ unconventional
* classification of energy sources
	+ renewable
	+ unrenewable
* resources and reserves of energy sources
	+ R/P ratio
* balance of energy resources in the world and in Slovenia
* electricity transport and distribution systems
	+ power producers and bigger consumers in Slovenia
	+ structure of electricity consumers in Slovenia
	+ electricity price structure
* energy resources and structure of consumption
	+ oil
	+ natural gas
	+ coal
	+ uranium
	+ renewable energy resources (water, sun, biomass, wind, geothermal, ocean’s energy, hydrogen, etc.)
* planning in energetics
	+ energy dependency
	+ long-term energy balances
	+ strategy of energy supply strategy
* relation between energy supply and demand
* energy sources for power production in the world, EU and in Slovenia
* examples of technological procedures for production of energy resources
* environmental impact because of production, transport, and consumption of energy
	+ gas fuel
	+ liquid fuel
	+ solid fuel
	+ nuclear fuel
	+ renewable resources
* new methods of production and transport of energy
	+ hydraulic fracturing
	+ liquified natural gas
	+ underground coal gasification
* role and efficiency of CO2 certificates
* future of energetics
	+ energy efficiency
	+ energy saving
* greenhouse gases
* energy self-efficiency
* electricity storage systems
* technology leap and new patents
* economic and market aspects of energy
* influence of geopolitical conditions on price shaping
* competitiveness of renewable sources
* support schemes types – EU, Slovenia
 |
| **Temeljni literatura in viri / Readings:** |
| 1. BP - Statistical Review of World Energy - all Energy Sources, Yearly Reports 2014 - 2017
2. BP - Energy Outlook 2035
3. World Energy Outlook, International Energy Agency, Yearly Reports 2010 - 2017
4. Key World Energy Statistics, 2014 - 2017
5. World Energy Scenarios: Composing energy futures to 2050, World Energy Council, 2017
6. Letna poročila Javne agencije Republike Slovenije za energijo od 2010 do 2016
7. Dolgoročne energetske bilance Slovenije do leta 2030 in strokovne podlage za določanje nacionalnih energetskih cilje
8. Gradivo za energetski koncept Slovenije, RS Ministrstvo za infrastrukturo
9. Medved, M.: Coal - an important energy source of the 21st century, 3rd Int. Conference Energy Technology and Climate Changes, Slovenia, 2013
10. Medved, M., Konovšek, D.: Energetski viri, Fakulteta za energetiko, gradivo za predavanja 2014 – 2017
11. Publikacije SOPO, SODO in slovenskih proizvajalcev ter dobaviteljev energije
12. Referati in ostala gradiva s svetovnih energetskih portalov
 |
| **Cilji in kompetence:** |  | **Objectives and competences:** |
| * strokovno interdisciplinarno izobraževanje, raziskovanje, izmenjava informacij ter raziskovalnih rezultatov
* spoznavanje trajnostnega razvoja energetike, varovanje omejenih in prostih energetskih virov
* gospodarjenje z okoljem v povezavi s pridobivanjem, transportom ter pretvorbo energetskih virov
* ekonomika gospodarjenja z energetskimi viri
 |  | * professional interdisciplinary education, research, exchange of information and of research results
* being familiar with sustainable development of energetics, protection of limited and free energy resources
* environmental management related to generating, transport and transformation of energy resources
* economy of energy resources management
 |
| **Predvideni študijski rezultati:** |  | **Intended learning outcomes:** |
| Znanje in razumevanje:* kompleksnih problemov gospodarjenja z energetskimi viri
* posledic pomembnih odločitev managerja, planerja, projektanta v gospodarskih družbah na področju gospodarjenja z energetskimi viri
* dogajanj na področju energetskih ter ekoloških trendov, v povezavi z energetskimi viri
* pomena ravnanja z energetskimi viri za prihodnost človeštva
 |  | Knowledge and understanding:* complex problems of energy resources management
* consequences of important decisions of the manager, planner, designer in trade companies related to the energy resources management
* activities in the field of energy and ecological trends related to energy resources
* importance of energy resources application for the future of mankind
 |
| Prenosljive/ključne spretnosti in drugi atributi:* analiza člankov s področja gospodarjenja z energetskimi viri
* teamsko delo
* prebiranje podatkov na svetovnih energetskih portalih
* prebiranje energetskih bilanc ter drugih energetskih strateških dokumentov
* analiziranje odločitev vladnih ter drugih organov v zvezi z gospodarjenjem z energetskimi viri
* razumevanje snovi bo podprto s praktičnimi primeri
* podatki bodo letno posodobljeni
 |  | Transferable/Key Skills and other attributes:* analysis of the articles related to the energy resources management
* team work
* examining data from different world energetics portals
* examining the energy balances and other energy strategic documents
* analysing the decisions of governmental and other institutions related to the energy resources management
* understanding the subject matter will be supported by practical examples
* data will be yearly updated
 |
| **Metode poučevanja in učenja:** |  | **Learning and teaching methods:** |
| * predavanja s pomočjo uporabe različnih AV sredstev,
* uvodno podajanje snovi, razprava o dojemanju vsebine, predstavitev študentskih pogledov na izpostavljene probleme ali značilnosti; predstavitev praktičnih primerov s področja energetskih surovin, samostojno delo študentov pri izdelavi seminarske naloge
* avditorne vaje so namenjene pripravam na pisni izpit; asistent uvodoma povzame bistvo snovi, nato vaje potekajo v obliki reševanja primerov izpitnih nalog, ki jih študenti ob pomoči asistenta rešujejo v zapiske ali na šolsko tablo.
* strokovne ekskurzije
 |  | * lectures supported by different AV equipment
* introductory lecture, discussion on perception of the issues, presentation of student's opinion on exposed or characteristics, presentation of practical examples related to the energy management, individual work of students on seminar tasks
* tutorials are dedicated to preparation of students for written examination; initially assistant explain substance; by assistant help students together solve examples of examination tasks in notes or on board
* professional excursions
 |
| **Načini ocenjevanja:** | Delež (v %) /Weight (in %) | **Assessment:** |
| Način (pisni izpit, ustno izpraševanje, naloge, projekt)* ustni izpit
* pisni izpit
 | **50****50** | Type (examination, oral, coursework,project):* oral examination
* written examination
 |
| **Reference nosilca / Lecturer's references:**  |
| KONOVŠEK, Damjan, PRAUNSEIS, Zdravko, AVSEC, Jurij, BERČIČ, Gorazd, POHAR, Andrej, ZAVŠEK, Simon, MEDVED, Milan. Underground coal gasification - the Velenje coal mine energy and economic calculations. Chemical industry & chemical engineering quarterly, ISSN 1451-9372, 2017, str. 1-28, [COBISS.SI-ID 5975834], [JCR, SNIP]MEDVED, Milan, KONOVŠEK, Damjan. Underground coal gasification - possibilities in Slovenia. Journal of energy technology, ISSN 1855-5748. [Tiskana izd.], aug. 2016, vol. 9, iss. 2, str. 27-38, ilustr. [COBISS.SI-ID 1024237660]MEDVED, Milan. Coal - an important energy source of the 21st century, 3rd International Conference Energy Technology and Climate Changes, [Slovenija, Velenje, 20.-21. 6. 2013]. str. 47-48. [COBISS.SI-ID 9002663]MEDVED, Milan, RISTOVIĆ, Ivica, ROŠER, Janez, VULIĆ, Milivoj. An overview of two years of continuous energy optimization at the Velenje coal mine. *Energies (Basel)*, 2012, vol. 5, no. 6, str. 2017-2029.[COBISS.SI-ID [1217631](http://cobiss.izum.si/scripts/cobiss?command=DISPLAY&base=COBIB&RID=1217631)] LIKAR, Jakob, MEDVED, Milan, LENART, Marjan, MAYER, Janez, MALENKOVIĆ, Vladimir, JEROMEL, Gregor, DERVARIČ, Evgen. Analysis of geomechanical changes in hanging wall caused by longwall multi top caving in coal mining. *J. min. sci.*, 2012, vol. 48, no. 1, str. 135-145. [COBISS.SI-ID [1215327](http://cobiss.izum.si/scripts/cobiss?command=DISPLAY&base=COBIB&RID=1215327)]  |

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| **UČNI NAČRT PREDMETA / COURSE SYLLABUS** |
| **Predmet:** | **GRAFIČNA KOMUNIKACIJA ZA INŽENIRJE** |
| **Course title:** | **GRAPHICS COMMUNICATIONS FOR ENGINEERS** |
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| **Študijski program in stopnja****Study programme and level** | **Študijska smer****Study field** | **Letnik****Academic year** | **Semester****Semester** |
| ENERGETIKA, 1. stopnja |  | 2 | 2 |
| ENERGY TECHNOLOGY, 1.degree |  | 2 | 2 |
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| **Vrsta predmeta / Course type** | Obvezni/Obligatory |
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| **Univerzitetna koda predmeta / University course code:** | V |
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| **Predavanja****Lectures** | **Seminar****Seminar** | **Vaje****Tutorial** | **Klinične vaje****work** | **Druge oblike študija** | **Samost. delo****Individ. work** |  | **ECTS** |
| **30** |  | **30** |  |  | **90** |  | **5** |
| **AV** | **LV** | **RV** |  |
|  | **5** | **25** |  |
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| **Nosilec predmeta / Lecturer:** | **GORAZD HREN** |
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| **Jeziki /** **Languages:** | **Predavanja / Lectures:** | slovenski / Slovene |
| **Vaje / Tutorial:** | slovenski / Slovene |
| **Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:** |  | **Prerequisits:** |
| Ni predpogojev za opravljanje študijskih obveznosti. |  | No especial prerequisites. |
| **Vsebina:**  |  | **Content (Syllabus outline):** |
| Predavanja:* Uvod v grafično komunikacijo in vloga tehniške dokumentacije v procesu inženiringa.
* Računalniška grafika, 3D modeliranje in pomen CAD v procesu kreiranja 3D in 2D dokumentacije.
* Tehnične risbe, pogledi, projekcije, prerezi, kotiranje in tolerance, branje in kreiranje delovnih načrtov z uporabo ISO standardov.
* Osnove numeričnih simulacij.
* Osnove 3D printanja.

Vaje:Kreiranje CAD modelov in 2D tehniške dokumentacije. Enostavne numerične simulacije. |  | Lectures:* Introduction to graphics communications and the role of documentation in engineering process.
* Computer graphics, 3D modelling and impact of CAD systems in 3D and 2D documentation.
* Technical Drawings, views, projections, sections, dimensioning and tolerance, reading and constructing drawings using ISO standards.
* Basic of numerical simulation.
* Basic of 3D printing.

Tutorials:Constructing CAD models and 2D technical drawing. Basic numerical simulations. |
| **Temeljni literatura in viri / Readings:** |
| Prebil I.: Tehniška dokumentacija, Tehniška založba, Ljubljana 1995Glodež S.: Tehnično risanje, Tehniška založba Slovenije, 2005Bartoline G.R.: Introduction to graphics communications for engineers, 4ed., McGraw-Hill, 2008Giesecke F.E., et.al.: Modern Graphics Communications, 4ed, Prentice Hall, 2009SIST ISO EN Standards.Priročniki za CAD, svetovni splet |
| **Cilji in kompetence:** |  | **Objectives and competences:** |
| * podati osnovno znanje o tehniškem risanju, sestavni in delovni risbi in tehniški dokumentaciji,
* prikazati praktično uporabo pridobljenih znanj na tehničnih elementih,
* pridobiti osnovno tehniko dojemanja prostorske oblike predmeta,
* razviti sposobnost prostorskega modeliranja z računalniškimi programi,
* osnovno poznavanje numeričnih simulacij.
 |  | * to provide the base knowledge about technical drawing, assembly and technical specification,
* practical application of drawing knowledge on technical elements,
* to provide necessary knowledge about 3 dimensional presentations of bodies,
* to develop the knowledge about 3D modelling using comercial software,
* basic knowlwdge of numerical simulations.
 |
| **Predvideni študijski rezultati:** |  | **Intended learning outcomes:** |
| Znanje in razumevanje:* spoznavanje osnov tehniškega izražanja s skico, risbo in računalniškim modelom,
* osnove tehniškega modeliranja in predstavitve predmetov,
* kombinirana uporaba standardov, tehniškega izražanja in računalniških programov za modeliranje in oblikovanje,
* osnovo razumevanje virtualnega inženiringa.
 |  | Knowledge and understanding:* of basic technical expression by using sketch, drawing and computer model,
* the fundaments of technical modelling and visualization of objects,
* combined use of different standards for technical drawing and software for drawing and modelling,
* basic understanding of virtual prototyping.
 |
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| **Metode poučevanja in učenja:** |  | **Learning and teaching methods:** |
| * frontalna predavanja
* projekt,
* praktično delo z CAD sistemom.
 |  | * frontal lectures,
* coursework,
* practical work with CAD system.
 |
| **Načini ocenjevanja:** | Delež (v %) /Weight (in %) | **Assessment:** |
| Način (pisni izpit, ustno izpraševanje, naloge, projekt)* projekt

(pogoj za pristop k izpitu)* praktični del izpita v obliki pisnega reševanja predstavitve predmeta in delavniške risbe
* teoretični del izpita - vprašalnik
 | **30****40****30** | Type (examination, oral, coursework, project):* coursework

(required before examination)* written examination in the form of visualization of objects and technical drawing
* theoretical examination (questionare)
 |
| **Reference nosilca / Lecturer's references:**  |
| HREN, Gorazd, ŽAGAR, Ivan. CAD mechanism simulations via web environments = Simulacije mehanizmov CAD sistemov na spletu. *Journal of energy technology*, Nov. 2012, vol. 5, iss. 4, str. 37-49. HREN, Gorazd. Web-based environment for mechanism simulation integrated with CAD system. Eng. comput., 2010, vol. 26, no. 2, str. 137-148 JCRHREN, Gorazd, PREDIN, Andrej, ŽAGAR, Ivan. Generic model of wind turbine blades = Generični model lopatic vetrne turbine. Journal of energy technology, feb. 2013, vol. 6, iss. 1, str. 61-68HREN, Gorazd, JEZERNIK, Anton. A framework for collaborative product review. Int. j. adv. manuf. technol., June 2009, vol. 42, no 7/8, str. 822-830, [JCR](http://www.cobiss.si/scripts/cobiss?command=SEARCH&base=jcr&select=%28sc=0268-3768+and+PY=2009%29) |

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| **UČNI NAČRT PREDMETA / COURSE SYLLABUS** |
| **Predmet:** | **DVOFAZNI VEČKOMPONENTNI PROCESI V ENERGETSKIH NAPRAVAH** |
| **Course title:** | **TWO-PHASE MULTICOMPONENT PROCESSES IN ENERGETIC EQIPMENTS** |
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| **Študijski program in stopnja****Study programme and level** | **Študijska smer****Study field** | **Letnik****Academic year** | **Semester****Semester** |
| ENERGETIKA, 1. stopnja |  | 2 | 2 |
| ENERGY TECHNOLOGY, 1.degree |  | 2 | 2 |
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| **Vrsta predmeta / Course type** | Obvezni/Obligatory |
|  |  |
| **Univerzitetna koda predmeta / University course code:** | V |
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| **Predavanja****Lectures** | **Seminar****Seminar** | **Vaje****Tutorial** | **Klinične vaje****work** | **Druge oblike študija** | **Samost. delo****Individ. work** |  | **ECTS** |
| **30** |  | **30** |  |  | **90** |  | **5** |
| **AV** | **LV** | **RV** |  |
| **30** |  |  |  |
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| **Nosilec predmeta / Lecturer:** | **IVAN ŽAGAR** |
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| **Jeziki /** **Languages:** | **Predavanja / Lectures:** | slovenski / Slovene |
| **Vaje / Tutorial:** | slovenski / Slovene |
| **Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:** |  | **Prerequisits:** |
| Ni pogojev. |  | None. |
| **Vsebina:**  |  | **Content (Syllabus outline):** |
| * Osnove dvofaznega toka tekočine: pojavne oblike toka,fizikalna formulacije, bazensko vrenje .
* Osnove večkomponentnih, večfaznih sitemov.
* Modeliranje dvofaznih tokov.
* Toplotni menjalniki in energetske naprave večfaznih,večkoponentnih sistemov.
* Določitev toplotnih tokov večfaznih večkomponetnih sitemov.
* Načrtovanje, upravljanje, vzdrževanje večkomponentnih večfaznih sistemov.
* Izločanje plinskih komponent iz plinskih zmesi, Implementacija absorbcije in adsorbcije v energetskih napravah.
* Ekonomska analiza in optimizacija stroškov energetskih naprav.
 |  | * Basics of two-phase fluid flow: phenomena, physical formulations, pool fermentation.
* Basics of multi-component, multi-phase systems
* Modeling of two-phase flows.
* Heat exchangers and energy devices of the multiphase, multiphonent system.
* Determination of the heat flows of multiphase multipoint systems.
* Design, management, maintenance of multicomponent multiphase systems.
* multicomponent multiphase systems.
* Separation of gas components from gas mixtures, Implementation of absorption and adsorption in power plants.
* Economic analysis and cost optimization of energy devices.
 |
| **Temeljni literatura in viri / Readings:** |
| Richard O. Gilbert: Statistical Methods for Environmental Pollution Monitoring, Wiley, 1987, ISBN: 0471288780.G.F.Hewit, G.L. Shires, T.R. Bott: Proces Heat Transfer, CRC Press 1994G. Hetstroni: Two-phase heat transfer, University of California, 1989 |
| **Cilji in kompetence:** |  | **Objectives and competences:** |
| Študenti se seznanijo z osnovami dvofasznih večkomponentnih procesov, toplotnimi izračuni in izibro tehnologij. |  | Students get to know about the basics of two-phase multi-component processes, thermal calculations and vibration technologies. |
| **Predvideni študijski rezultati:** |  | **Intended learning outcomes:** |
| Znanje in razumevanje:• Izvedba analiz, izbra ustrezne opreme- toplotnih menjalnikov• zakonskih predpisov, standardov in  normativov• ekonomike stroškov ravnanja in  odstranjevanja odpadkovPrenesljive/ključne spretnosti in drugi atributi:• uspešno delo na energetskih razvojno  raziskovalnih projektih |  | Knowledge and understanding:• Performing analyzes, choosing suitable equipment - heat exchangers• of legislation, standards and normatives• economics of costs treatment and disposal of wasteTransferable/Key Skills and other attributes:• effectiveness of work on the energy research projects |
|  |  |  |
| **Metode poučevanja in učenja:** |  | **Learning and teaching methods:** |
| Predavanja: študent spozna teoretične vsebine predmeta.Vaje: študent utrdi teoretično znanje in spozna aplikativne možnosti reševanja enostavnih primerov iz prakse.Domača naloga: študent izdela krajšo študijo oziroma projekt, ki se navezuje na tematiko predmeta. |  | Lectures: the student gets acquainted with theoretical content of the subject.Tutorial: the student upgrades the theoretical knowledge with practical experience.Homework: conducting a short study or project regarding the thematic of the subject. |
| **Načini ocenjevanja:** | Delež (v %) /Weight (in %) | **Assessment:** |
| Način (pisni izpit, ustno izpraševanje, naloge, projekt)• pisni izpit• ustni izpit• domača naloga | **40****40****20** | Type (examination, oral, coursework, project):* • writen examination
* • oral examination

•homework |
| **Reference nosilca / Lecturer's references:**  |
| KEKEC, Bojan. (mentor: I.Žagar) Celovito obvladovanje komunalnih odpadkov v Sloveniji s proučitvijo variant energetske izrabe : magistrsko delo 2. stopnje. Krško: [B. Kekec], 2012. IX, 94 str., graf. prikazi. http://dkum.uni-mb.si/IzpisGradiva.php?id=23589. [COBISS.SI-ID 1024089948] OBLAK, Jure. (mentor: I.Žagar) Nadzorno krmilni sistemi Toplarne Celje : magistrsko delo 2. stopnje. Velenje: [J. Oblak], 2012. VIII, 74 f., graf. prikazi. http://dkum.uni-mb.si/IzpisGradiva.php?id=36896. [COBISS.SI-ID 1024093532]KROŠELJ, Alen*.* (mentor: I.Žagar) *Sežigalnice komunalnih odpadkov in termodinamični vidik procesa : magistrsko delo*. Krško: [A. Krošelj], 2017. XIII, 14-113 f., ilustr., tabele. <https://dk.um.si/IzpisGradiva.php?id=61748>. [COBISS.SI-ID [1024267100](https://plus.si.cobiss.net/opac7/bib/1024267100?lang=sl)] ŽAGAR, Ivan, ŠKERGET, Leopold. The numerical simulation of non-linear separation columns by boundary-domain integral method. Computers & chemical engineering, ISSN 0098-1354. [Print ed.], 1995, 19, supplement 2, str. S785-790. [COBISS.SI-ID [7500548](https://plus.si.cobiss.net/opac7/bib/7500548?lang=sl)] |

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| **UČNI NAČRT PREDMETA / COURSE SYLLABUS** |
| **Predmet:** | **VODENJE SISTEMOV** |
| **Course title:** | **SYSTEM CONTROL** |
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| **Študijski program in stopnja****Study programme and level** | **Študijska smer****Study field** | **Letnik****Academic year** | **Semester****Semester** |
| ENERGETIKA, 1. stopnja |  | 2 | 2 |
| ENERGY TECHNOLOGY, 1.degree |  | 2 | 2 |
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| **Vrsta predmeta / Course type** | Obvezni/Obligatory |
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| **Univerzitetna koda predmeta / University course code:** | V |
|  |
| **Predavanja****Lectures** | **Seminar****Seminar** | **Vaje****Tutorial** | **Klinične vaje****work** | **Druge oblike študija** | **Samost. delo****Individ. work** |  | **ECTS** |
| **30** |  | **30** |  |  | **90** |  | **5** |
| **AV** | **LV** | **RV** |  |
|  | **30** |  |  |
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| **Nosilec predmeta / Lecturer:** | **PETER VIRTIČ** |
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| **Jeziki / Languages:** | **Predavanja / Lectures:** | slovenski / Slovene |
| **Vaje / Tutorial:** | slovenski / Slovene |
| **Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:** |  | **Prerequisits:** |
| Ni pogojev. |  | None. |
| **Vsebina:**  |  | **Content (Syllabus outline):** |
| Vrste energetskih procesov, odprtozančni in zaprtozančni sistemi vodenja, cilji in kriterji vodenja sistemov. Binarni procesi; logične funkcije, osnovni aksiomi in teoremi, algebra logičnih funkcij, minimalne realizacije, karakteristične tabele in diagrami stanj. Načrtovanje kombinacijskih, sekvenčnih in koračnih krmilij.Zvezni dinamični procesi; modeliranje na osnovi analogij, NDE, vhodno/izhodni modeli, prostor stanj, modelne pretvorbe; linearni in nelinearni procesi, ravnotežna stanja, linerizacija; analitična rešitev, prehajalna matrika; vodljivost, spoznavnost, stabilnost; kanonske oblike, načrtovanje vodenja, načrtovanje opazovalnikov. Časovno diskretni sistemi, modelne pretvorbe.Praktični zgledi s področja modeliranja in vodenja energetskih procesov in naprav. |  | Types of energy processes, open loop and closed-loop control principles, basic goals and criteria in control.Binary processes, logical functions, fundamental axioms and theorems, algebra of logical functions, minimal realizations, characteristic tables and state diagrams. Design of logical and sequence binary control. Continuous dynamic systems, modeling based on analogy, ODE, input/output modelling, state space, model conversions, linear and non-linear processes, equilibria, linearization; analytical solution, transition matrix; controllability, observability, stability; canonical forms and transformations, control design, observers. Time discrete systems, model conversion. Problem solving; selected examples of modelling and control design for energy processes and devices. |
| **Temeljni literatura in viri / Readings:** |
| G.F. Franklin, J.D. Powell, A. Emami-Naeini: Feedback Control of Dynamic Systems, Pearson, 2010. |
| **Cilji in kompetence:** |  | **Objectives and competences:** |
| Obvladanje sistemskega pristopa pri modeliranju in načrtovanju vodenja energetskih naprav in procesov. |  | The implementation of a system approach in modelling and control design of energy devices and processes. |
| **Predvideni študijski rezultati:** |  | **Intended learning outcomes:** |
| Znanje in razumevanje:Osnov teoretskega modeliranja in metod načrtovanja vodenja energetskih procesov. |  | Knowledge and understanding:Basic of theoretical modelling and control design methods for energy processes. |
| Prenesljive/ključne spretnosti in drugi atributi:Sistemski pristop v reševanju problemov, koncept vhodno/izhodnih relacij, koncept energijskih akumulatorjev. |  | Transferable/Key Skills and other attributes:System approach in problem solving, concept of input/output relations, concept of energy accumulators. |
| **Metode poučevanja in učenja:** |  | **Learning and teaching methods:** |
| * Predavanja, podprta s praktičnimi demonstracijami in eksperimenti.
* Vodene laboratorijske vaje.
* Samostojno praktično delo.
 |  | * Lectures supported with practical demonstrators and experiments.
* Guided laboratory work.
* Independent practical work.
 |
| **Načini ocenjevanja:** | Delež (v %) /Weight (in %) | **Assessment:** |
| Način (pisni izpit, ustno izpraševanje, naloge, projekt)* pisni izpit
* projekt
* ustni izpit
 | **30****20****50** | Type (examination, oral, coursework, project):* written examination
* project
* oral examination
 |
| **Reference nosilca / Lecturer's references:**  |
| PIŠEK, Peter, ŠTUMBERGER, Bojan, MARČIČ, Tine, VIRTIČ, Peter. Design analysis and experimental validation of a double rotor synchronous PM machine used for HEV. *IEEE trans. magn.*, Jan. 2013, vol. 49, no. 1, str. 152-155, doi: [10.1109/TMAG.2012.2220338](http://dx.doi.org/10.1109/TMAG.2012.2220338). [COBISS.SI-ID [1024117084](http://cobiss.izum.si/scripts/cobiss?command=DISPLAY&base=COBIB&RID=1024117084)] ŠLAMBERGER, Jan, VIRTIČ, Peter. Design of electrical machines by using conformal mapping = Konstruiranje električnih strojev z uporabo konformnih preslikav. *Journal of energy technology*, feb. 2013, vol. 6, iss. 1, str. 13-18. <http://www.fe.um.si/en/jet.html>. [COBISS.SI-ID [1024132444](http://cobiss.izum.si/scripts/cobiss?command=DISPLAY&base=COBIB&RID=1024132444)] VIRTIČ, Peter. Determining losses and efficiency of axial flux permanent magnet synchronous motor. *Prz. Elektrotech.*, 2013, r. 89, nr. 2b, str. 13-16. <http://pe.org.pl/articles/2013/2b/4.pdf>. [COBISS.SI-ID [1024123484](http://cobiss.izum.si/scripts/cobiss?command=DISPLAY&base=COBIB&RID=1024123484)] PRAUNSEIS, Zdravko, VIRTIČ, Peter. Evaluation of mechanical properties of soft magnetic materials for axial flux permanent magnet synchronous machines. *Prz. Elektrotech.*, 2013, r. 89, nr. 2b, str. 35-37. <http://www.red.pe.org.pl/articles/2013/2b/10.pdf>. [COBISS.SI-ID [1024122460](http://cobiss.izum.si/scripts/cobiss?command=DISPLAY&base=COBIB&RID=1024122460)] ŠLAMBERGER, Jan, VIRTIČ, Peter. Determining energy production of CdTe photovoltaic system. *Prz. Elektrotech.*, 2013, r. 89, nr. 2b, str. 84-87. <http://pe.org.pl/articles/2013/2b/23.pdf>. [COBISS.SI-ID [1024123740](http://cobiss.izum.si/scripts/cobiss?command=DISPLAY&base=COBIB&RID=1024123740)]  |

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| **UČNI NAČRT PREDMETA / COURSE SYLLABUS** |
| **Predmet:** | **JEDRSKA ENERGIJA IN TRAJNOSTNI RAZVOJ**  |
| **Course title:** | **NUCLEAR ENERGY AND SUSTAINABILITY** |
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| **Študijski program in stopnja****Study programme and level** | **Študijska smer****Study field** | **Letnik****Academic year** | **Semester****Semester** |
| ENERGETIKA, 1. stopnja  |  | 2 | 2 |
| ENERGY TECHNOLOGY, 1.degree |  | 2 | 2 |
|  |
| **Vrsta predmeta / Course type** | Obvezni / Obligatory |
|  |  |
| **Univerzitetna koda predmeta / University course code:** | V |
|  |
| **Predavanja****Lectures** | **Seminar****Seminar** | **Vaje****Tutorial** | **Klinične vaje****work** | **Druge oblike študija** | **Samost. delo****Individ. work** |  | **ECTS** |
| **30** |  | **30** |  |  | **90** |  | **5** |
| **AV** | **LV** | **RV** |  |
| **30** |  |  |  |
|  |
| **Nosilec predmeta / Lecturer:** | **TOMAŽ ŽAGAR** |
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| **Jeziki /** **Languages:** | **Predavanja / Lectures:** | slovenski / Slovene |
| **Vaje / Tutorial:** | slovenski / Slovene |
| **Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:** |  | **Prerequisits:** |
| Vpis v letnik.Opravljanje obveznosti po navodilih profesorja in/ali asistenta. Udeležba ogelda na terenu je pogoj za pristop k opravljanju izpita. |  | Enrollment into the program. Fulfillment of obligations under lecturer's and/or assistant's guidance. Participation on field visit is necessary to enter the exam. |
| **Vsebina:**  |  | **Content (Syllabus outline):** |
| Splošno o rabi energije* Trajnostna rabe energije
* Energetska politika
* Podnebne spremembe
* Poraba in proizvodnja elektrike in uravnavanje sistema in trga
* Jedrska proizvodnja elektrike in integracija v energetski sistem ter pomen in vloga JE za energetski sistem

Jedrski reaktorji* Zgodovinski pregled
* Različni tipi v uporabi
* Jedrski sistemi (uvod v osnove)

Jedrski gorivni cikelRadioaktivni odpadki, varstvo pred sevanji* Industrijski odpadki na splošno
* Industirjski odpadki pri proizvodnji jedrske elektrike
* Uvod v ravnanje z RAO

Ekonomski in finančni učinki* Cena proizvodnje električne energije
* Sistemski stroški
* Tržni mehanizmi in regulacija trga (praktični primeri v Sloveniji – AGEN-RS)
* Regulacija jedrske varnosti (praktični primeri v Sloveniji – URSJV)

Ostale aplikacije jedrske energije |  | Energy use in general* Sustainability of energy use
* Energy policy
* Climate change
* Electricity supply and demand, system and market integration
* Nuclear electricity generation and system integration

Nuclear reactors* History
* Different types in use
* Nuclear systems

Nuclear fuel cycleRadwaste, Radiation protection* Industrial waste and institutional waste
* Introduction to radiation protection and RW managment

Economics* Life cycle cost of electricity
* System costs
* Electricity market
* Electricity market regulation
* Nuclear safety regulation

Other nuclear energy applications |
| **Temeljni literatura in viri / Readings:** |
| 1. All about Nuclear Energy, Bertrand Barre, Paris, 2003
2. Nuclear Renaissance, W. J. Nuttall, IoP Institute of Physics Publishing, Bristol, 2005
3. Ian Hore-Lacy ; Nuclear Energy in the 21st Century,World Nuclear University Press, London, 2006
4. Projected Costs of Generating Electricity (2015 Edition), OECD, NEA, Paris, France, 2016
5. Synthesis on the Economics of Nuclear Energy, William D’haeseleer, University of Leuven, EIB, Luxembourg, 2013
6. Poročil o stanju na področju energetike v Sloveniji vletu 2016, Agencija Republike Slovenije za energijo, Maribor, 2017
7. Poročilo o varstvu pred ionizirajočimi sevanji in jedrski varnosti v Republiki Sloveniji leta 2016, Uprava RS za jedrsko varnost, Ljubljana, 2017
 |
| **Cilji in kompetence:** |  | **Objectives and competences:** |
| **Cilji:**Cilj predmeta je študentom podati praktična strokovna znanja o pomenu in vključevanju obratovanja jedrskih objektov v energetski sistem sveta, EU in Slovenije. Predmet poda vidike trajnostnega obratovanja jedrskih energetskih sistemov od nizkoogljičnosti, preko cene do odpadkov in recikliranja goriva. Predmet pokriva različne dimenzije, kako vse jedrska energetika prispeva k trajnostnemu razvoju družbe, energetskih trgov in tehnološkega napredka. |  | **Objectives:**To acquire basic knowledge about the role and integration of nuclear electricity generation in the energy system (world level, EU and Slovenia). The course introduces all aspects of nuclear energy generation: carbon free generation of electricity, price of generataing electricity, waste and fuel supply. The course debates different sustainable power generation options.  |
| **Predvideni študijski rezultati:** |  | **Intended learning outcomes:** |
| **Znanje in razumevanje**Razumevanje osnovnih lastnosti proizvodnje električne energije s pomočjo jedrskih elektrarn. Razumevanje osnovnih lastnosti jedrske energije; brez-ogljična proizvodnja, majhna poraba osnovnih virov (surovin), majhen okoljski odtis jedrske tehnologije, velika kapitalska intenzivnost tehnologije, specifika industerijskih odpadkov jedrske tehnologije (radioaktivni odpadki), specifične varnostne in upravne zahteve. **Uporaba**Pridobljeno znanje je izhodišče in osnova za pravilno razumevanje vloge jedrske energije v trajnostnem sistemu oskrbe človeštva z energijo. |  | **Knowledge and understanding**Understanding of the basic principles of nuclear electricity generation. Understanding of typical and specific attributes of nucelar energy use: low-carbon source of energy, low raw material consumption, capital intensity of this technology, radiaoctive waste and specific of safety requirements and regualtion. **Application**Knowledge is the basis for future understanding of the nuclear energy role in world wide sustainable energy supply. |
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| **Metode poučevanja in učenja:** |  | **Learning and teaching methods:** |
| Predavanja: študent spozna teoretične vsebine predmeta. Vaje: študenti spoznajo praktične aplikacije in izkušnje iz prakse. Vaje vključujejo 10 ur ogleda in dela na terenu, kjer študent med strokovnimi obsiki jedrskih objektov in demonstracijskih naprava spozna praktične vidike in lastnosti trajnostne rabe jedrske energije. |  | Lectures: students learn about the theory. Exercises: avditorial exercises include 10 hours of field visit and work where students meet practical examples of nuclear energy use in real operating conditions. |
| **Načini ocenjevanja:** | Delež (v %) /Weight (in %) | **Assessment:** |
| Način (pisni izpit, ustno izpraševanje, naloge, projekt)Pisni izpit, ustni izpit. | **50****50** | Type (examination, oral, coursework, project):Writen exam, oral exam. |
| **Reference nosilca / Lecturer's references:** |
| 1. Žagar T., Kegel L., Rupret M., “Slovenian Approach to Strategy and Planning for High Level Waste and Spent Fuel Deep Geological Disposal”, Chapter 17, Chapter published in "International Approaches for Nuclear Waste Disposal in Geological Formations: Geological Challenges in Radioactive Waste Isolation—Fifth Worldwide Review”, 2017-04-26, ed:, Faybishenko, Boris; Birkholzer, Jens; Sassani, David; Swift, Peter; DOI: 10.2172/1353043, LBNL-1006984, 2016 / 2017. 2. Žagar T., Kralj M., Učbenik: Ravnanje z odpadki, Zbirka Zelena Slovenija, Učbenik založbe Fit media, 2015, poglavje 3.3.4; Odpadki pri rabi jedrske energije.3. Žagar, T., Buršič, A., Špiler, J., Kim, D., Chiguer, M., David, G., Gillet, P., Recycling as an option of used nuclear fuel management strategy, Nuclear Engineering and Design, 20104. Žagar T., Galy, J., Magill, J., Pulsed Neutron Source with Tabletop Laser – Accelerated Protons, In: H.Schwoerer, et al., Lasers and Nuclei, Lect. Notes Phys. 694, Springer Verlag, Berlin Heidelberg 2006, pp. 109 - 1275. Magill, J., Galy, J., Žagar, T., Laser Transmutation of Nuclear Materials, In: H. Schwoerer, et.sl., Lasers and Nuclei, Lect. Notes Phys. 694, Springer Verlag, Berlin Heidelberg 2006, pp.131 - 1466. Žagar, T., Galy, J., Magill, J., Kellett, M., Laser – generated nanosecond pulsed neutron sources: scaling from VULCAN to table – top. New journal of physics (online ed), 2005, vol. 7, pp. 2537. Žagar, T., Božič, M., Ravnik, M., Long – lived activation products in TRIGA mark II research reactor concrete shield: calculation and experiment. Jour. of Nuc..Mat., 2004, vol. 335/3, pp. 379 - 3868. Žagar, T., Ravnik, M., Determination of long – lived neutron activation products in reactor shielding concrete samples. Nucl. Technol., 2002, vol. 140, pp. 113 - 1269. J. Avsec, P. Virtič, T. Žagar, L. Štrubelj, Economy Analysis of Electricity Production from Hydrogen in Combination with Nuclear Power Plant, Proceedings of the International Conference on Power Engineering POWER 2011, July 12-14, 2011, Denver, Colorado, USA10. T. Žagar, R. Bergant, S.Furst, Nuclear Renaissance as a Viable Solution for Reducing Greenhouse Gases – the Environmental Impact of Different Energy Technologies, Journal of Energy Technology, JET Volume 2 (2009), Issue 3, pp. 11- 28 |

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| **UČNI NAČRT PREDMETA / COURSE SYLLABUS** |
| **Predmet:** | **ENERGETIKA IN VAROVANJE OKOLJA** |
| **Course title:** | **ENERGY TECHNOLOGY AND ENVIRONMENT PROTECTION** |
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| **Študijski program in stopnja****Study programme and level** | **Študijska smer****Study field** | **Letnik****Academic year** | **Semester****Semester** |
| ENERGETIKA, 1. stopnja |  | 3 | 1 |
| ENERGY TECHNOLOGY, 1.degree |  | 3 | 1 |
|  |
| **Vrsta predmeta / Course type** |  Obvezni/Obligatory |
|  |  |
| **Univerzitetna koda predmeta / University course code:** | V |
|  |
| **Predavanja****Lectures** | **Seminar****Seminar** | **Vaje****Tutorial** | **Klinične vaje****Work** | **Druge oblike študija** | **Samost. delo****Individ. work** |  | **ECTS** |
| **45** |  | **30** |  |  | **105** |  | **6** |
| **AV** | **LV** | **RV** |  |
| **20** | **10** |  |  |
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| **Nosilec predmeta / Lecturer:** | **IVAN ŽAGAR** |
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| **Jeziki /** **Languages:** | **Predavanja / Lectures:** | slovenski / Slovene |
| **Vaje / Tutorial:** | slovenski / Slovene |
| **Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:** |  | **Prerequisits:** |
| Ni pogojev. |  | None. |
| **Vsebina:**  |  | **Content (Syllabus outline):** |
| * Splošni pojmi in osnove s področja varstva okolja.
* Odpadne vode: Klasifikacija odpadnih vod iz energetskih procesov. Postopki čiščenja in recikliranja odpadnih vod. Obdelava odpadnega blata. Separacijski procesi čiščenja odpadnih vod.
* Trdni odpadki: Deponija, sežig odpadkov, kompostriranje organskih odpadkov, proizvodnja bioplina in energetsko izkoriščanje organskih odpadkov. Krožno gospodarstvo. Mehansko-biološka obdelava trdnih odpadkov
* Onesnažen zrak: Kemijska sestava plinastih in trdnih škodljivih in strupenih snovi v dimnih plinih. Postopki čiščenja dimnih plinov.
* Ekonomika in ekonomska primerjava.procesov varovanja okolja.
 |  | * General terms and basics from the field of environmental protection.
* Wastewater: Classification of wastewater from energy processes. Processes of purifying and recycling the wastewater.
* Solid waste: Waste disposal site, waste incineration, composting organic waste, generation of biogas and energy production from biomass.
* Poluted air: Chemical composition of harmful and toxic gases and solids in smoke gases. Methods of purification of smoke gases.
* Polluted air: Chemical composition of gaseaus and solid harmful and toxic substances in flue gases. Procedures for cleaning flue gases.
* Economics and economic comparisonprocesses of environmental protection.
 |
| **Temeljni literatura in viri / Readings:** |
| Peter H. Raven, Linda R. Berg: Environment, John Wiley and Sons, 2003, ISBN: 0471451673.George Tchobanoglous, Franklin L. Burton: Wastewater Engineering: Treatment and Reuse, McGraw-Hill, Gerry Best: Environmental Pollution Studies, Liverpool University Press, 1999, ISBN: 0853239231Marquita K. Hill: Understanding Environmental Pollution, Cambridge University Press; 2004, ISBN: 0521527260.Paolo F. Ricci: Environmental and Health Risk Assessment and Management : Principles and Practices, Kluwer Academic Publishers, 2006, ISBN: 1402037759.Peter Morris, Riki Therivel: Methods of Environmental Impact Assessment, Taylor & Francis Books Ltd, 2001, ISBN: 0415239591. |
| **Cilji in kompetence:** |  | **Objectives and competences:** |
| Študenti se seznanijo z zakonskimi predpisi, standardi in normativi s področja okolja, postopki varovanja okolja ter ekonomskim preračunom stroškov ravnanja in odstranjevanja energetskimi odpadki. |  | Students get acquainted with the legislation, standards and normatives from the field of environment, environmental protection procedures and economic evaluation of costs treatment and disposal of energy waste. |
| **Predvideni študijski rezultati:** |  | **Intended learning outcomes:** |
| Znanje in razumevanje:• tehnoloških postopkov varovanja tal, voda,  zraka in varstvo pred hrupom• zakonskih predpisov, standardov in  normativov• ekonomike stroškov ravnanja in  odstranjevanja odpadkovPrenesljive/ključne spretnosti in drugi atributi:• ugotavljanje vpliva emisij in imisij odpadkov  na okolje• uspešno delo na okoljevarstvenih razvojno  raziskovalnih projektih |  | Knowledge and understanding:• of technological processes of protection the  soil, air and protection against the noise• of legislation, standards and normatives• economics of costs treatment and disposal of wasteTransferable/Key Skills and other attributes:• assessment of the effects of emissions and  immissions of waste on the environment• effectiveness of work on the environmental  protection research projects |
|  |  |  |
| **Metode poučevanja in učenja:** |  | **Learning and teaching methods:** |
| Predavanja: študent spozna teoretične vsebine predmeta.Vaje: študent utrdi teoretično znanje in spozna aplikativne možnosti reševanja enostavnih primerov iz prakse.Domača naloga: študent izdela krajšo študijo oziroma projekt, ki se navezuje na tematiko predmeta. |  | Lectures: the student gets acquainted with theoretical content of the subject.Tutorial: the student upgrades the theoretical knowledge with practical experience.Home work: conducting a short study or project regarding the thematic of the subject. |
| **Načini ocenjevanja:** | Delež (v %) /Weight (in %) | **Assessment:** |
| Način (pisni izpit, ustno izpraševanje, naloge, projekt)• pisni izpit• ustni izpit• domača naloga | **40****40****20** | Type (examination, oral, coursework, project):• written examination• oral examination• homework |
| **Reference nosilca / Lecturer's references:**  |
| ŽAGAR, Ivan. Možnosti sofinanciranja ukrepov za doseganje podnebno-energetskih zavez iz sredstev Kohezijskega sklada EU : predavanje na seminarju Vpliv podnebno - energetskih zavez na energetiko v Sloveniji, Krško, 2. december 2009. Krško, 2009. [COBISS.SI-ID 1024009564] KEKEC, Bojan. (mentor: I.Žagar) Celovito obvladovanje komunalnih odpadkov v Sloveniji s proučitvijo variant energetske izrabe : magistrsko delo 2. stopnje. Krško: 2012. IX, 94 str., graf. prikazi. http://dkum.uni-mb.si/IzpisGradiva.php?id=23589. [COBISS.SI-ID 1024089948] OBLAK, Jure. (mentor: I.Žagar) Nadzorno krmilni sistemi Toplarne Celje : magistrsko delo 2. stopnje. Velenje: 2012. VIII, 74 f., graf. prikazi. http://dkum.uni-mb.si/IzpisGradiva.php?id=36896. [COBISS.SI-ID 1024093532]ŽAGAR, Ivan*. Izzivi in rešitve pri izdelavi trajnostnega energetskega akcijskega načrta (SEAP) za Slovensko Bistrico : predavanje na Dnevih Posavske energetike, 12. december 2013, Krško*. Krško, 12. dec. 2013. [http://www.dneviposavskeenergetike.si](http://www.dneviposavskeenergetike.si/). [COBISS.SI-ID [1024171100](https://plus.si.cobiss.net/opac7/bib/1024171100?lang=sl)]PAVLOVČIČ, Martin*.* (mentor: I.Žagar) *Energetski potencial trdnih komunalnih odpadkov na Gorenjskem : magistrsko delo*. Krško: 2014. XII, 60 str., graf. prikazi. <http://dkum.uni-mb.si/IzpisGradiva.php?id=44622>. [COBISS.SI-ID [1024177756](https://plus.si.cobiss.net/opac7/bib/1024177756?lang=sl)]KROŠELJ, Alen*.* (mentor: I.Žagar) *Sežigalnice komunalnih odpadkov in termodinamični vidik procesa : magistrsko delo*. Krško: 2017. XIII, 14-113 f., ilustr., tabele. <https://dk.um.si/IzpisGradiva.php?id=61748>. [COBISS.SI-ID [1024267100](https://plus.si.cobiss.net/opac7/bib/1024267100?lang=sl)]  |

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| **UČNI NAČRT PREDMETA / COURSE SYLLABUS** |
| **Predmet:** | **MENEDŽMENT IN INŽENIRING V ENERGETIKI** |
| **Course title:** | **MANAGEMENT AND ENGINEERING IN ENERGETICS** |
|  |  |  |  |
| **Študijski program in stopnja****Study programme and level** | **Študijska smer****Study field** | **Letnik****Academic year** | **Semester****Semester** |
| ENERGETIKA, 1. stopnja |  | 3 | 1 |
| ENERGY TECHNOLOGY, 1.degree |  | 3 | 1 |
|  |
| **Vrsta predmeta / Course type** | Obvezni/Obligatory |
|  |  |
| **Univerzitetna koda predmeta / University course code:** | V |
|  |
| **Predavanja****Lectures** | **Seminar****Seminar** | **Vaje****Tutorial** | **Klinične vaje****work** | **Druge oblike študija** | **Samost. delo****Individ. work** |  | **ECTS** |
| **45** |  | **30** |  |  | **105** |  | **6** |
| **AV** | **LV** | **RV** |  |
|  | **30** |  |  |
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| **Nosilec predmeta / Lecturer:** | **ZDRAVKO PRAUNSEIS** |
|  |
| **Jeziki / Languages:** | **Predavanja / Lectures:** | slovenski / Slovene |
| **Vaje / Tutorial:** | slovenski / Slovene |
| **Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:** |  | **Prerequisits:** |
| Ni pogojev. |  | None. |
| **Vsebina:** |  | **Content (Syllabus outline):** |
| Uvodni del z definicijo za menedžment v energetiki in inženiring v energetiki.Menedžment v energetiki:* Osnove energetske izkaznice
* Osnove energetskih pregledov
* Energetske instalacije zgradb (ogrevanje, hlajenje, prezračevanje). Naravno prezračevanje, prezračevanje stanovanjskih objektov. Mešalno in izpodrivno prezračevanje.
* Izračun toplotnih potreb za ogrevanje zgradb.
* Ogrevalni sistemi. Radiatorsko ogrevanje, talno ogrevanje, stensko ogrevanje, daljinsko ogrevanje.
* Osnovni preračun centralne kurjave.
* Kakovost zraka in bivanja.
* Ekonomsko vrednotenje kombiniranih ogrevalno – prezračevalnih sistemov.

Vodenje energetskih projektov, vodilo uspešnega delovnega procesa. Projektni energetski management in njegove posebnosti Inženiring v energetiki:* Osnove snovanja in razvoja izdelka
* Pomen in delitev procesnih naprav v sodobnih visoko zmogljivih energetskih procesih Predstavitev posebnih materialov za procesne stroje in aparate (kovinski in nekovinski materiali, toplotni vplivi, zahteve za kriotehnične aparate)
* Osnovne lastnosti sipkega materiala, Rankinov in Jansenov model in formula
* Transporterji z vlečnim in brez vlečnega organa (konstrukcijske značilnosti, osnovni parametri za izbiro, standardni preračuni in pristopi po sekcijskem izračunu).
 |  | * Introduction part with definition of management and engineering in energetics.

Management in energetics:* Fundamentals of energy performance certificate
* Fundamentals of energy audit
* Engineering networks of buildings (heating, cooling, ventilation). Natural ventilation, ventilation of residential buildings. Mixing and supplanting ventilation.
* Calculating energy needs for heating the buildings.
* Heating systems. Radiator heating, floor heating, wall heating, district heating.
* Basic calculation of central heating.
* Quality of air and living.
* Economic evaluation of combined heat – ventilating systems.

Energy project management, a guide to successful work processs. Energy project management and its specialities. Engineering in energetics: * Basic of planning and development of product
* Presentation and significance of process equipment
* Materials for design of process equipment (metallic and non- metallic materials, thermal influence)
* Structural characteristics of materials in material flow in power production systems (Rank’s and Jansen’s model)
* Construction characteristic of material handling machines with and without traction element. Section method for determination of traction force
 |
| **Temeljni literatura in viri / Readings:** |
| Barney L. Capehart, Wayne C. Turner, William J. Kennedy: Guide to Energy Management, 4th edition, The Fairmont Press, 2003.Prasad, Biren: Concurrent Engineering . Fundamentals: Integrated Product & Process Organisation, Vol 1 & 2, Prentice Hall, USA, 1996. Jawad / Farr: Structural analysis and design of process equipment (John Wiley &Sons, 2009)Young: Roark’s form. for stress and strain (McGraw - Hill , 1999).Turner W.; Energy management handbook, Fairmont Press, Lilburn, 2001.Carrow R.; Energy systems, McGraw-Hill, New York, 1999.Praunseis Z.;Energetska oskrba objektov. Univerzitetni učbenik,[1. izd.]. Krško: Fakulteta za energetiko, 2014. XVII, 286 str., ilustr., tabele. ISBN 978-961-6800-11-2. [COBISS.SI-ID [76157441](https://plus.si.cobiss.net/opac7/bib/76157441?lang=en)]Praunseis, Z.; Inženiring v energetiki : zapiski predavanj. Krško: Fakulteta za energetiko, 2016. 148 str., graf. prikazi. [COBISS.SI-ID [1024222812](https://plus.si.cobiss.net/opac7/bib/1024222812?lang=sl)] Praunseis, Z.; Projektni management : zapiski predavanj. Krško: Fakulteta za energetiko, 2015. 78 str., graf. prikazi. [COBISS.SI-ID [1024222556](https://plus.si.cobiss.net/opac7/bib/1024222556?lang=sl)]L. D. Danny Harvey: A handbook on low – energy buildings and district – energy systems: Fundamentals, techniques and examples, Earthscan Publications Ltd, 2006. |
| **Cilji in kompetence:** |  | **Objectives and competences:** |
| Sposobnost reševanja in načrtovanja učinkovitih sistemov v energetskem menedžmentu in inženiringu.Znanja o ekonomskih metodah, ki omogočajo primerjavo rentabilnosti investicij v različne energetske sisteme. |  | The ability to solve and plan efficient systems in energy management and engineering. To acquire knowledge about economical methods, that allows the comparison of rentability of investments in different energy systems. |
| **Predvideni študijski rezultati:** |  | **Intended learning outcomes:** |
| Znanje in razumevanje:* poznavanje energetskega menedžmenta in inženiringa.
 |  | Knowledge and understanding:* knowledge of energy management and engineering.
 |
| Prenesljive/ključne spretnosti in drugi atributi:* sposobnost reševanja konkretnih praktičnih primerov
* timsko delo
 |  | Transferable/Key Skills and other attributes:* the ability to solve practical examples
* team work
 |
| **Metode poučevanja in učenja:** |  | **Learning and teaching methods:** |
| Predavanja: študent spozna teoretične vsebine predmeta.Vaje: študent utrdi teoretično znanje in spozna aplikativne možnosti reševanja enostavnih primerov iz prakse. |  | Lectures: the student gets acquainted with theoretical content of the subject.Tutorial: the student upgrades the theoretical knowledge with practical experience. |
| **Načini ocenjevanja:** | Delež (v %) /Weight (in %) | **Assessment:** |
| Način (pisni izpit, ustno izpraševanje, naloge, projekt)* domače naloge
* praktični del izpita v obliki pisnega reševanja izvedbe konstrukcijskega elementa v napravah procesne opreme
* teoretični del pisnega izpita v obliki dopolnjevanja dokumentacije in preračunov.
 | **10****45****45** | Type (examination, oral, coursework, project):* completed coursework
* written examination in the form of practical solution for structural parts of process equipment
* theoretical examination in the form of completing technical documentation and calculations.
 |
| **Reference nosilca / Lecturer's references:**  |
|  1**.** PRAUNSEIS, Zdravko*. Inženiring v energetiki : zapiski predavanj*. Krško: Fakulteta za energetiko, 2016. 148 str., graf. prikazi. [COBISS.SI-ID [1024222812](https://plus.si.cobiss.net/opac7/bib/1024222812?lang=en)] **2.** PRAUNSEIS, Zdravko*. Projektni management : zapiski predavanj*. Krško: Fakulteta za energetiko, 2015. 78 str., graf. prikazi. [COBISS.SI-ID [1024222556](https://plus.si.cobiss.net/opac7/bib/1024222556?lang=en)] 3. PRAUNSEIS, Zdravko, STROJKO, Renato*. Energetska oskrba objektov*. [1. izd.]. Krško: Fakulteta za energetiko, 2014. XVII, 286 str., ilustr., tabele. ISBN 978-961-6800-11-2. [COBISS.SI-ID [76157441](https://plus.si.cobiss.net/opac7/bib/76157441?lang=en)]4. PRAUNSEIS, Zdravko*. Snovanje in konstruiranje jeklenega mostu : študijska naloga*. Krško: Fakulteta za energetiko, 2014. 26 str., graf. prikazi. [COBISS.SI-ID [1024223836](https://plus.si.cobiss.net/opac7/bib/1024223836?lang=en)]5. PRAUNSEIS, Zdravko*. Uporaba trigeneracijskih sistemov za energetsko oskrbo zgradb : predštudija projekta*. Krško: Fakulteta za energetiko, 2010. 22 f., graf. prikazi. [COBISS.SI-ID [1024121436](https://plus.si.cobiss.net/opac7/bib/1024121436?lang=sl)] |

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| **UČNI NAČRT PREDMETA / COURSE SYLLABUS** |
| **Predmet:** | **OSNOVE JEDRSKIH ENERGETSKIH SISTEMOV** |
| **Course title:** | **FUNDAMENTALS OF NUCLEAR ENERGY**  |
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| **Študijski program in stopnja****Study programme and level** | **Študijska smer****Study field** | **Letnik****Academic year** | **Semester****Semester** |
| ENERGETIKA, 1. stopnja |  | 3 | 1 |
| ENERGY TECHNOLOGY, 1.degree |  | 3 | 1 |
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| **Vrsta predmeta / Course type** | Obvezni/Obligatory |
|  |  |
| **Univerzitetna koda predmeta / University course code:** | V |
|  |
| **Predavanja****Lectures** | **Seminar****Seminar** | **Vaje****Tutorial** | **Klinične vaje****work** | **Druge oblike študija** | **Samost. delo****Individ. work** |  | **ECTS** |
| **45** |  | **30** |  |  | **105** |  | **6** |
| **AV** | **LV** | **RV** |  |
| **30** |  |  |
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| **Nosilec predmeta / Lecturer:** | **MARJAN KROMAR** |
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| **Jeziki / Languages:** | **Predavanja / Lectures:** | slovenski / Slovene |
| **Vaje / Tutorial:** | slovenski / Slovene |
| **Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:** |  | **Prerequisits:** |
| Ni pogojev. |  | None. |
| **Vsebina:**  |  | **Content (Syllabus outline):** |
| * Osnove atomske in jedrske fizike
* Jedrske reakcije
* Radioaktivnost
* Vezavna energija, razcep in zlivanje
* Verižna reakcija
* Osnove fizike nevtronov
* Jedrski energetski sistemi
* Jedrski reaktor-gorivo in gorivni ciklus
* Časovno odvisno dogajanje v reaktorju in njegovo upravljanje
 |  | * Fundamentals of atomic and nuclear physics
* Nuclear reactions
* Radioactivity
* Binding energy, nuclear fission and fusion
* Chain reaction
* Fundamentals of neutron physics
* Nuclear energy systems
* Nuclear reactor-fuel and fuel cycle
* Time-dependent change of a reactor and its control
 |
| **Temeljni literatura in viri / Readings:** |
| B. Cvikl, Jedrski energetski sistemi (z uvodom v fiziko stacionarnih reaktorjev), zbrano gradivo, Univerza v Mariboru in Inštitut “Jožef Stefan” Ljubljana, 2015.H. Sekimoto, Nuclear Reactor Theory, COE-INES, Tokyo Institute of Technology, 2007.E. Srebotnjak, Osnove reaktorske fizike, Izobraževalni center za jedrsko tehnologijo »Milana Čopiča«, 2015.Raymond L. Murray: Nuclear energy – an introduction to the concepts, systems and application of nuclear processes. Elsevier, 6nd Edition, Amsterdam, 2009.John. R. Lamarsh, Anthony J. Baratta, Introduction to nuclear engineering, Prentice-Hall, New Jersey, 2001. |
| **Cilji in kompetence:** |  | **Objectives and competences:** |
| Študenti:* spoznajo in osvojijo osnove pojme atomske in jedrske fizike,

spoznajo jedrske energetske koncepte in njihove principe delovanja, * spoznajo časovno odvisne spremembe v fisijskem reaktorju in način kontrole reaktorja.
 |  | Students:* get acquainted and gain understanding of the basic concepts of atom and nuclear physics,
* get acquainted with nuclear energy systems and principles of their operation,
* get understanding of time-dependent changes in a fission reactor and its control.
 |
| **Predvideni študijski rezultati:** |  | **Intended learning outcomes:** |
| Znanje in razumevanje:* poznavanje jedrskih energetskih konceptov in njihove principe delovnja,
* sposobnost uporabe pridobljenega teoretičnega znanja v praksi,
* avtonomnost v svojem strokovnem delu.
 |  | Knowledge and understanding:* knowledge of nuclear energy systems and principles of their operation,
* ability to use theoretical knowledge in practice,
* independence in professional work and obligation to professional ethics.
 |
| Prenesljive/ključne spretnosti in drugi atributi:* Bazično znanje, ki naj omogoči nadaljni bolj poglobljen študij jedrskih energetskih objektov.
* Razvoj veščin in spretnosti v uporabi znanja na svojem konkretnem strokovnem delovnem področju.
 |  | Transferable/Key Skills and other attributes:* Basic skills enabling in-depth study of nuclear installations.
* Development of skills and expertise in the use of knowledge in a specific technical working area.
 |
| **Metode poučevanja in učenja:** |  | **Learning and teaching methods:** |
| * Predavanja
* Vaje
* Dialog
* Ponavljanje in utrjevanje pridobljenega znanja
* Ogled reaktorja TRIGA in Nuklearne elektrarne Krško.
 |  | * Lectures
* Exercises
* Dialogue
* Repetition (revision) and consolidation of acquired knowledge
* Tour to the TRIGA reactor and NPP Krško.
 |
| **Načini ocenjevanja:** | Delež (v %) /Weight (in %) | **Assessment:** |
| Način (pisni izpit, ustno izpraševanje, naloge, projekt)* pisni izpit
* domače naloge
 | **70****30** | Type (examination, oral, coursework, project):* written examination
* coursework
 |
| **Reference nosilca / Lecturer's references:**  |
| MERLJAK, Vid, KROMAR, Marjan, TRKOV, Andrej. Verification of kinetic capabilities of the GNOMER neutron diffusion code. Annals of Nuclear Energy, ISSN 0306-4549. [Print ed.], 2017, vol. 109, str. 431-439, doi: /10.1016/j.anucene.2017.04.037. [COBISS.SI-ID 30552103] ĆALIĆ, Dušan, TRKOV, Andrej, KROMAR, Marjan, SNOJ, Luka. Use of Effective Diffusion Homogenization method with the Monte Carlo code for light water reactor. Annals of Nuclear Energy, ISSN 0306-4549. [Print ed.], 2016, vol. 94, str. 392-398. [COBISS.SI-ID 29443879] KROMAR, Marjan, ĆALIĆ, Dušan, KURINČIČ, Bojan. Analysis of the Krško NPP spent fuel storage criticality safety under hypothetical degraded conditions = Analiza zagotovitve varnostne meje pred kritičnostjo bazena za iztrošeno gorivo Nuklearne elektrarne Krško pri hipotetičnih degradiranih pogojih. Journal of energy technology, ISSN 1855-5748. [Tiskana izd.], apr. 2016, iss. 1, vol. 9, str. 11-27, graf. prikazi. [COBISS.SI-ID 29519399] LENGAR, Igor, TRKOV, Andrej, KROMAR, Marjan, SNOJ, Luka. Digital meter of reactivity for use during zero-power physics tests at the Krško NPP = Uporaba digitalnega merilnika reaktivnosti pri zagonskih testih na ničelni moči v NE Krško. Journal of energy technology, ISSN 1855-5748. [Tiskana izd.], feb. 2012, vol. 5, iss. 1, str. 13-26, graf. prikazi. http://www.fe.uni-mb.si/images/stories/jet/e-jet/jet\_5-1.pdf. [COBISS.SI-ID 1024080988] KROMAR, Marjan, KURINČIČ, Bojan. DRAGON and CORD-2 nuclear calculations of the NPP Krško fuel assembly. V: TRKOV, Andrej (ur.), LENGAR, Igor (ur.). Selected and expanded papers from International Conference Nuclear Energy for new Europe 2010, Portorož, September 6-9, 2010, (Nuclear Engineering and Design, ISSN 0029-5493, Vol. 246). Amsterdam: Elevier. 2012, 7 str. [COBISS.SI-ID 24963111] KROMAR, Marjan, KURINČIČ, Bojan. Fine geometrical modeling of the neutron transport in the NPP Krško's fuel, using the Serpent Monte Carlo transport code = Nevtronski transportni izračun goriva Nuklearne elektrarne Krško z Monte Carlo programom Serpent na fini geometrijski mreži. Journal of energy technology, ISSN 1855-5748. [Tiskana izd.], Aug. 2011, vol. 4, iss. 3, str. 33-44. [COBISS.SI-ID 25205287] SNOJ, Luka, KROMAR, Marjan, ŽEROVNIK, Gašper, RAVNIK, Matjaž. Advanced methods in teaching reactor physics. V: MAVKO, Borut (ur.), HASSAN, Yassin A. (ur.), CIZELJ, Leon (ur.). Special issue on the International Conference Nuclear Energy for New Europe 2009, September 14 and 17, 2009, Bled, Slovenija, (Nuclear engineering and design, ISSN 0029-5493, vol. 241, no. 4, 2011). Amsterdam: North-Holland. 2011, vol. 241, issue 4, str. 1008-1012, doi: 10.1016/j.nucengdes.2010.02.040. [COBISS.SI-ID 23623975] KROMAR, Marjan, KURINČIČ, Bojan. Impact of thicker cladding on the nuclear parameters of the NPP Krško fuel = M. Kromar, B. Kurinčič. V: MAVKO, Borut (ur.), HASSAN, Yassin A. (ur.), CIZELJ, Leon (ur.). Special issue on the International Conference Nuclear Energy for New Europe 2009, September 14 and 17, 2009, Bled, Slovenija, (Nuclear engineering and design, ISSN 0029-5493, vol. 241, no. 4, 2011). Amsterdam: North-Holland. 2011, vol. 241, issue 4, str. 1087-1089, doi: 10.1016/j.nucengdes.2010.04.009. [COBISS.SI-ID 23664167] KROMAR, Marjan, TRKOV, Andrej. Nuclear design calculations of the NPP Krško core. Journal of energy technology, ISSN 1855-5748. [Tiskana izd.], 2009, vol. 2, iss. 4, str. 41-50. [COBISS.SI-ID 23313959] |

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| **UČNI NAČRT PREDMETA / COURSE SYLLABUS** |
| **Predmet:** | **PRAKTIČNO USPOSABLJANJE**  |
| **Course title:** | **PROFESSIONAL SKILLS** |
|  |  |  |  |
| **Študijski program in stopnja****Study programme and level** | **Študijska smer****Study field** | **Letnik****Academic year** | **Semester****Semester** |
| ENERGETIKA, 1. stopnja |  | 3 | 2 |
| ENERGY TECHNOLOGY, 1.degree |  | 3 | 2 |
|  |
| **Vrsta predmeta / Course type** | Obvezni/Obligatory |
|  |  |
| **Univerzitetna koda predmeta / University course code:** | V |
|  |
| **Predavanja****Lectures** | **Seminar****Seminar** | **Vaje****Tutorial** | **Klinične vaje****work** | **Druge oblike študija** | **Samost. delo****Individ. work** |  | **ECTS** |
|  | **5** |  |  |  | **595** |  | **20** |
| **AV** | **LV** | **RV** |  |
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| **Nosilec predmeta / Lecturer:** | **VSI NOSILCI** |
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| **Jeziki / Languages:** | **Predavanja / Lectures:** | slovenski / Slovene |
| **Vaje / Tutorial:** |  |
| **Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:** |  | **Prerequisits:** |
| Ni pogojev. |  | None. |
| **Vsebina:**  |  | **Content (Syllabus outline):** |
| * spoznavanje organizacije
* seznanitev s problemom, ki ga bo študent reševal v času prakse
* konzultacije z mentorjem v organizaciji
* konzultacije z mentorjem na fakulteti
* delo na strokovnem problemu
* predstavitev rešitve problema v organizaciji in na fakulteti
* možnosti za realizacijo
* priporočila za nadaljnje delo
 |  | * exploring the organization
* define the problem for student to solve in the practice work period
* consultations with mentor in the organization
* consultations with mentor at the faculty
* problem solving
* presentation of the results at organization and faculty
* feasibility study
* recommendations for the future work
 |
| **Temeljni literatura in viri / Readings:** |
| * interni akti organizacij / organisation’s documents
* priročniki / manual
* navodila za delo / work instructions
 |
| **Cilji in kompetence:** |  | **Objectives and competences:** |
| Seznaniti študente s konkretno prakso in konkretnim delovnim okoljem. |  | To acquaint students with practical work and concrete working environment. |
| **Predvideni študijski rezultati:** |  | **Intended learning outcomes:** |
| Znanje in razumevanje:* naučiti študenta obravnavati in reševati probleme v realnem okolju
 |  | Knowledge and understanding:* knowledge about problem solving in real environment
 |
| Prenesljive/ključne spretnosti in drugi atributi:* usposobljenost za konkretno reševanje problemov
 |  | Transferable/Key Skills and other attributes:* ability to solve concrete problems
 |
| **Metode poučevanja in učenja:** |  | **Learning and teaching methods:** |
| * učenje na konkretnem problemu
* uporaba računalniške in ustrezne druge

tehnologije |  | * learning by doing
* use of computer and other suitable technology
 |
| **Načini ocenjevanja:** | Delež (v %) /Weight (in %) | **Assessment:** |
| Način (pisni izpit, ustno izpraševanje, naloge, projekt)* zagovor zaključnega poročila pred komisijo
 | 100 | Type (examination, oral, coursework, project):* presentation of the final report
 |
| **Reference nosilca / Lecturer's references:**  |
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| **UČNI NAČRT PREDMETA / COURSE SYLLABUS** |
| **Predmet:** | **DIPLOMSKO DELO** |
| **Course title:** | **GRADUATE THESIS** |
|  |  |  |  |
| **Študijski program in stopnja****Study programme and level** | **Študijska smer****Study field** | **Letnik****Academic year** | **Semester****Semester** |
| ENERGETIKA, 1. stopnja |  | 3 | 2 |
| ENERGY TECHNOLOGY, 1.degree |  | 3 | 2 |
|  |
| **Vrsta predmeta / Course type** | Obvezni/Obligatory |
|  |  |
| **Univerzitetna koda predmeta / University course code:** | V |
|  |
| **Predavanja****Lectures** | **Seminar****Seminar** | **Vaje****Tutorial** | **Klinične vaje****work** | **Druge oblike študija** | **Samost. delo****Individ. work** |  | **ECTS** |
|  | **10** |  |  |  | **290** |  | **10** |
| **AV** | **LV** | **RV** |  |
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| **Nosilec predmeta / Lecturer:** |  |
|  |
| **Jeziki / Languages:** | **Predavanja / Lectures:** | slovenski / Slovene |
| **Vaje / Tutorial:** |  |
| **Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:** |  | **Prerequisits:** |
| Ni pogojev. |  | None. |
| **Vsebina:**  |  | **Content (Syllabus outline):** |
| 1. Ovitek.
2. Notranja naslovna stran
3. Izjava kandidata o avtorstvu diplomskega dela
4. Zahvala
5. Povzetek diplomskega dela v slovenskem in tujem (angleškem, nemškem) jeziku in ključne besede
6. Pregled vsebine - kazalo
7. Pregled slik - kazalo.
8. Pregled tabel - kazalo.
9. Pregled prilog - kazalo.
10. Uvod.
11. Teoretične osnove.
12. Praktični (problemski) del diplomskega dela.
13. Prispevek diplomskega dela k stroki
14. Zaključek.
15. Literatura in viri.
16. Priloge (po potrebi).
17. Pojmovnik (po potrebi).
18. Kratice in akronimi (po potrebi)
 |  | 1. Cover.2. Inside title page.3. Statement of the candidate about his authorship of the graduate thesis.4. Acknowledgement.5. Summary of the graduate thesis in Slovenian and in a foreign (English or German) language and key words.6. Review of the subject – index.7. Review of the tables – index.9. Review of the supplements – index.10. Introduction.11. Theoretical basis.12. Practical part of the graduate thesis concerning a problem.13. Contribution of the graduate thesis to the professional field.14. Conclusion.15. Literature and sources.16. Supplements (if needed).17. Glossary (if needed).18. Abbreviations and acronymes (if needed). |
| **Temeljni literatura in viri / Readings:** |
| Literatura mora biti navedena po stilu APA.The literature should be quoted according to the APA style. |
| **Cilji in kompetence:** |  | **Objectives and competences:** |
| Diplomsko delo je pisni dokument, s katerim študent dokaže sposobnost uporabe teoretičnih znanj in v praksi pridobljenih izkušenj za rešitev problema, ki si ga je izbral s prijavo teme diplomskega dela. V diplomskem delu študent pokaže sposobnost izbire in uporabe domače ter tuje strokovne literature in dodatnih virov za potrebe rešitve izbranega problema.  |  | The degree’s work is a written document by means of which the student proves his ability to use the theoretical knowledge and in his practical work achieved experiences in resolving a problem chosen by applying for a theme of his graduate thesis. In his graduate thesis the student presents the ability to choose and use his national and foreign professional literature and additional sources in order to solve the chosen problem. |
| **Predvideni študijski rezultati:** |  | **Intended learning outcomes:** |
| Znanje in razumevanje:Znanje širšega strokovnega področja, v katerega sodi diplomska naloga in ožje znanje ter razumevanje pojmovnika, ki ga zajema tema diplomskega dela. Poudarek je na praktičnih znanjih in enostavnejših metodologijah zajemanja, obdelovanja in prikazovanja podatkov. |  | Knowledge and understanding:Knowledge of the broader professional field to which belongs the graduate thesis and special knowledge of the glossary concerned by the graduate thesis. The emphasis is on the practical skills and relatively more simple methodologies of collecting, processing and presenting data. |
| Prenesljive/ključne spretnosti in drugi atributi:Strokovno zapisovanje in izražanje vsebine, obvladanje reševanja strokovnih problemov, suverena predstavitev ključnih spoznanj in spretnost argumentiranja. |  | Transferable/Key Skills and other attributes:Documenting and expressing the subject in a professional way, mastering the solving of the professional problems, independent presentation of the key conclusions and ability in arguing |
| **Metode poučevanja in učenja:** |  | **Learning and teaching methods:** |
| Mentor na konsultacijah preverja vsebinski in strukturni vidik naloge.Mentor pripravi kandidata na elektronsko predstavitev diplomskega dela in na verjetna okvirna vprašanja pri zagovoru. |  | The content and the structural aspect of the thesis is monitored by tutor during his consultations.The candidate is readied by his tutor to present his graduate thesis electronically and to be able to answer hypothetical questions in defending his work. |
| **Načini ocenjevanja:** | Delež (v %) /Weight (in %) | **Assessment:** |
| Način (pisni izpit, ustno izpraševanje, naloge, projekt):* vsebina diplomskega dela
* zagovor
 | **80****20** | Type (examination, oral, coursework, project):* content of the graduate thesis
* defense
 |
| **Reference nosilca / Lecturer's references:**  |
|  |