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| **UČNI NAČRT PREDMETA / COURSE SYLLABUS** |
| **Predmet:** | **VIRTUALNI PROTOTIPI** |
| **Course title:** | **VIRTUAL PROTOTYPES** |
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| **Študijski program in stopnja****Study programme and level** | **Študijska smer****Study field** | **Letnik****Academic year** | **Semester****Semester** |
| ENERGETIKA, 2. STOPNJA |  | **2** | **1** |
| ENERGY TECHNOLOGY,2.degree |  | **2** | **1** |
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| **Vrsta predmeta / Course type** | Izbirni/Elective |
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| **Univerzitetna koda predmeta / University course code:** | M |
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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:** | **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:** |
| Poznavanje osnov CAD modeliranja  |  | Basic CAD sysems modeling. |
| **Vsebina:**  |  | **Content (Syllabus outline):** |
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| Virtualni prototipi (definicije, značilnosti).Virtualno okolje (VRML in X3D).Kreiranje virtualnih modelov in okolja.Prenos modelov iz CAD z grafičnimi standardi z uporabo računalniških grafičnih standardov. Simulacije v navideznem okolju.Integriran razvoj virtualnega izdelka. |  | Virtual prototypes (definitions, properties).Virtual environment (VRML and X3D).Creation of models and environment.Transfer of CAD models into virtual environment with computer graphics standards.Simulations in virtual environment.Integrated development of virtual product. |
| **Temeljni literatura in viri / Readings:** |
| D.BrutzmanL. Daly, X3D extensible 3D graphics for Web authors, Morgan Kaufman Series in comouter graphics, 2010S. Diehl: Distribuited virtual worlds, Springer, 2001M. Bordegoni, M. Rizzi; Inovation in Product Design,From CAD to virtual prototyping, Springer 2011X3D, Web3DConsortium, open standards for real-time 3D comunication, [www.web3d.org](http://www.web3d.org) |
| **Cilji in kompetence:** |  | **Objectives and competences:** |
| podati poglobljeno znanje s področja postopkov, funkcionalne uporabe in modeliranja virtualnih prototipov izdelkov,spoznavanje možnosti in namena virtualnih prototipov v procesu razvoja izdelka,sposobnost izvedbe virtualnih prototipov lokalno ali preko spleta s pomočjo standardnih orodij ali namenskega HW in SW,sposobnost obvladovanja standardnih razvojnih metod, postopkov in procesov, sposobnost uporabe pridobljenega teoretičnega znanja v praksi. |  | provide detailed knowledge of procedures , functional use and modeling of virtual prototypes of productslearn about opportunities and purpose of virtual prototyping in the product development process,implementing virtual prototypes on PC or using Web using standard tools or a dedicated HW and SW ,ability to handle standard development methods , procedures and processes ,ability to use theoretical knowledge in practice . |
| **Predvideni študijski rezultati:** |  | **Intended learning outcomes:** |
| Znanje in razumevanje:* utrdi predhodno pridobljena znanja in jih aplicira na realnih problemih,
* pozna in razume aktivnosti in orodja razvojnega inženirja,
* razume vlogo, možnosti in zanesljivost virtualnega,
* izdela primer virtualnega prototipa v enostavnem okolju.
 |  | Knowledge and Understanding:* consolidate previous knowledge , and applied to real problems
* recognise and understands the activities and tools of development engineering
* understands the role, potential and reliability of virtual engineering,
* elaborate example of a virtual prototype in a simple environment.
 |
| 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:** |
| Frontalna predavanja.Računalniške vaje.Laboratorijske vaje. |  | Frontal lectures.Tutorials.Laboratory work |
| **Načini ocenjevanja:** | Delež (v %) /Weight (in %) | **Assessment:** |
| Način (pisni izpit, ustno izpraševanje, naloge, projekt)* projekt,
* poročilo z vaj
* teoretični del izpita pisni/ustni/kviz
 | **45****20****35** | Type (examination, oral, coursework, project):* coursework,
* tutorials report
* theoretical examination writen/oral/quiz
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| **Reference nosilca / Lecturer's references:**  |
| HREN, Gorazd, JEZERNIK, Anton. Računalniške tehnologije za podporo konstruiranju : CAx in PxM : zbrano gradivo. Maribor: Fakulteta za strojništvo, 2005. 120 str., ilustr. ISBN 86-435-0704-0. <http://lates.fs.uni-mb.si/gradivo>. [COBISS.SI-ID [54832385](http://cobiss.izum.si/scripts/cobiss?command=DISPLAY&base=COBIB&RID=54832385)] JEZERNIK, Anton, GOLOB, Borut, HREN, Gorazd. Conventional CAD/CAM and virtual engineering for design and manufacturing. V: MARJANOVIĆ, Dorian (ur.). Proceedings of the 6th International Design Conference DESIGN 2000, Cavtat, Dubrovnik, Croatia, May 23-26, 2000. Zagreb: Centre of Technology Transfer: Faculty of Mechanical Engineering and Naval Architecture; Zürich: Workshop Design-Konstruktion, 2000, str. 797-804. [COBISS.SI-ID[5371670](http://cobiss.izum.si/scripts/cobiss?command=DISPLAY&base=COBIB&RID=5371670)] HREN, Gorazd, GOLOB, Borut, JEZERNIK, Anton. Visualisation and optimisation of motorhome prototypes using virtual environment techniques. V: MASTORAKIS, Nikos (ur.). Proceedings of the 5th WSES International Conference on Circuits, Systems, Communications and Computers (CSCC 2001) [and]Proceedings of the 3rd WSES International Conference on Mathematics and Computers in Physics (MCP 2001) [and] Proceedings of the 3rd WSES International Conference on Mathematics and Computers in Mechanical Engineering (MCME 2001) : Rethymno, Greece, July 8-15, 2001. [S.l.]: WSES: IEEE, 2001, [5] str. [COBISS.SI-ID [6430230](http://cobiss.izum.si/scripts/cobiss?command=DISPLAY&base=COBIB&RID=6430230)] JEZERNIK, Anton, HREN, Gorazd, GOLOB, Borut. Assembly configuration and appearance changes in VRLM environment. V: MARJANOVIĆ, Dorian (ur.). Proceedings of the 7th International Design Conference DESIGN 2002, Cavtat, Dubrovnik, Croatia, May 14-17, 2002. Zagreb: Faculty of Mechanical Engineering and Naval Architecture; Glasgow: The Design Society, cop. 2002, str. 503-508. [COBISS.SI-ID [7112982](http://cobiss.izum.si/scripts/cobiss?command=DISPLAY&base=COBIB&RID=7112982)] HREN, Gorazd, JEZERNIK, Anton, LUKŠIČ, Stanislav, PREDIN, Andrej. Integration framework to support cooperation in product development process. Strojniški vestnik, ISSN 0039-2480, 2009, vol. 55, no. 4, str. 254-261, ilustr.<http://www.sv-jme.eu/scripts/download.php?file=/data/upload/2009/SV-4-09/6_hren_zl_p254_261.pdf>. [COBISS.SI-ID [1024004700](http://cobiss.izum.si/scripts/cobiss?command=DISPLAY&base=COBIB&RID=1024004700)] |

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| **UČNI NAČRT PREDMETA / COURSE SYLLABUS** |
| **Predmet:** | **VZVRATNO INŽENIRSTVO** |
| **Course title:** | **REVERSE ENGINEERING**  |
|  |  |  |  |
| **Študijski program in stopnja****Study programme and level** | **Študijska smer****Study field** | **Letnik****Academic year** | **Semester****Semester** |
| ENERGETIKA, 2. STOPNJA |  | **2** | **1** |
| ENERGY TECHNOLOGY,2.degree |  | **2** | **1** |
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| **Vrsta predmeta / Course type** | Izbirni/Elective |
|  |  |
| **Univerzitetna koda predmeta / University course code:** | M |
|  |
| **Predavanja****Lectures** | **Seminar****Seminar** | **Vaje****Tutorial** | **Klinične vaje****work** | **Druge oblike študija** | **Samost. delo****Individ. work** |  | **ECTS** |
| **30** |  | **30** |  |  | **90** |  | **5** |
| **AV** | **LV** | **RV** |  |
|  | **15** | **15** |  |
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| **Nosilec predmeta / Lecturer:** | **GORAZD HREN** |
|  |
| **Jeziki /Languages:** | **Predavanja / Lectures:** | slovenski / Slovene |
| **Vaje / Tutorial:** | slovenski / Slovene |
| **Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:** |  | **Prerequisits:** |
| Poznavanje osnov CAD modeliranja  |  | Basic CAD sysems modeling. |
| **Vsebina:**  |  | **Content (Syllabus outline):** |
| Uvod. Digitalizacija in vzvratni inženiring.Metode in tehnike digitalizacije – naprave za skeniranje.Metode in tehnike vzvratnega inženiringa - strojna in programska oprema, osnovne operacije vzvratnega inženiringa. Metode in tehnike hitre izdelave prototipov –materiali in uporaba Integriran razvoj izdelka. |  | Introduction. Digitalisation and reverse engeneering.Methods and techniques of digitalisation process – scanners.Methods and techniques of reverse engineering – HW and SW, fundamental engineering operations.Methods and techniques of rapid prototyping – materials and usage.Integrated development of product.  |
| **Temeljni literatura in viri / Readings:** |
| * Chua, Leong, Lim: Rapid Prototyping, Principles and applications, 3rd ed., Worl Scientific, 2010
* Messler: Reverse engineering; mechanisms, structures, systems & materials, McGraw-Hill, 2014
* Hopkinson R., Rapid Manufacturing-An industrial revolution for the digital age. Hoboken: John Wiley & Sons, 2005
* Wego W., Reverseengineering: technology of reinvention, Boca Raton: CRC Press, 2011
* Muck T., Križanovski I., 3D-Tisk. Ljubljana: Pasadena. 2015.
 |
| **Cilji in kompetence:** |  | **Objectives and competences:** |
| Podati poglobljeno znanje s področja postopkov, funkcionalne uporabe postopkov digitalizacije.Tehnike vzvratnega inženirstva.Hitra izdelava prototipov. |  | Provide detailed knowledge of procedures , functional use of digitalisation process.Techniques of reverse engineering.Rapid prototyping. |
| **Predvideni študijski rezultati:** |  | **Intended learning outcomes:** |
| Znanje in razumevanje:* utrdi predhodno pridobljena znanja in jih aplicira na realnih problemih,
* pozna in razume aktivnosti in orodja razvojnega inženirja,
* razume vlogo in možnosti vzvratnega inžineringa.
 |  | Knowledge and Understanding:* consolidate previous knowledge , and applied to real problems
* recognise and understands the activities and tools of development engineering
* understands the role and potential of reverse engineering.
 |
| 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:** |
| Frontalna predavanja.Računalniške vaje.Laboratorijsle vaje. |  | Frontal lectures.Tutorials.Laboratory work. |
| **Načini ocenjevanja:** | Delež (v %) /Weight (in %) | **Assessment:** |
| Način (pisni izpit, ustno izpraševanje, naloge, projekt)* projekt,
* poročilo z vaj,
* teoretični del izpita pisni/ustni/kviz
 | **45****20****35** | Type (examination, oral, coursework, project):* coursework,
* tutorial report,
* theoretical examination writen/oral/quiz
 |
| **Reference nosilca / Lecturer's references:**  |
| HREN, Gorazd, JEZERNIK, Anton. Računalniške tehnologije za podporo konstruiranju : CAx in PxM : zbrano gradivo. Maribor: Fakulteta za strojništvo, 2005. 120 str., ilustr. ISBN 86-435-0704-0. <http://lates.fs.uni-mb.si/gradivo>. [COBISS.SI-ID [54832385](http://cobiss.izum.si/scripts/cobiss?command=DISPLAY&base=COBIB&RID=54832385)]HREN, Gorazd, JEZERNIK, Anton, LUKŠIČ, Stanislav, PREDIN, Andrej. Integration framework to support cooperation in product development process. Strojniški vestnik, ISSN 0039-2480, 2009, vol. 55, no. 4, str. 254-261, ilustr.<http://www.sv-jme.eu/scripts/download.php?file=/data/upload/2009/SV-4-09/6_hren_zl_p254_261.pdf>. [COBISS.SI-ID [1024004700](http://cobiss.izum.si/scripts/cobiss?command=DISPLAY&base=COBIB&RID=1024004700)]HREN, Gorazd, GOLOB, Borut, JEZERNIK, Anton. Visualisation and optimisation of motorhome prototypes using virtual environment techniques. V: MASTORAKIS, Nikos (ur.). Proceedings of the 5th WSES International Conference on Circuits, Systems, Communications and Computers (CSCC 2001) [and]Proceedings of the 3rd WSES International Conference on Mathematics and Computers in Physics (MCP 2001) [and] Proceedings of the 3rd WSES International Conference on Mathematics and Computers in Mechanical Engineering (MCME 2001) : Rethymno, Greece, July 8-15, 2001. [S.l.]: WSES: IEEE, 2001, [5] str. [COBISS.SI-ID [6430230](http://cobiss.izum.si/scripts/cobiss?command=DISPLAY&base=COBIB&RID=6430230)]  |

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| **UČNI NAČRT PREDMETA / COURSE SYLLABUS** |
| **Predmet:** | **RAVNANJE S TERMOENERGETSKIMI ODPADKI** |
| **Course title:** | **HANDLING WITH THERMOENERGETIC WASTE** |
|  |  |  |  |
| **Študijski program in stopnja****Study programme and level** | **Študijska smer****Study field** | **Letnik****Academic year** | **Semester****Semester** |
| ENERGETIKA, 2. STOPNJA |  | **2** | **1** |
| ENERGY TECHNOLOGY,2.degree |  | **2** | **1** |
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| **Vrsta predmeta / Course type** | Izbirni/Elective |
|  |  |
| **Univerzitetna koda predmeta / University course code:** | M |
|  |
| **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:** | **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):** |
| * Energetskih potencial in klasifikacija termoenergetskih odpadkov.
* Zakonodajni okvir izrabe odpadkov za energetske namene.
* Obdelava muljev pri čiščenju odpadnih vod. Energetska izraba muljev.
* Trdni odpadki: energetska izraba mehansko- biološke obdelave odpadkov, lahka frakcija.
* Krožno gospodarstvo in energetska izraba.
* Energetska izraba in vrste goriv kot produkt varovanja okolja.
* Postopki termične obdelave: sežig na rešetki, sežig v lebdečem sloju, plazemska obdelava.
* Postopki čiščenja dimnih plinov: odstranjevanje trdnih delcev, postopki katalitičnega, kemijskega in absorbijskega čiščenja dimnih plinov.
* Odžvepljevanje dimnih plinov in izločanje dušikovih oksidov.
* Ravnanje z ostanki termične obdelave odpadkov
* Ekonomsko vrednotenje termične obdelave odpadkov.
 |  | * Energy potential and classification of thermo-energy waste.
* The legislative framework for the recovery of waste for energy purposes.
* Sludge treatment in wastewater treatment. Energy utilization of sludges.
* Solid waste: energy use of mechanical and biological treatment of waste, light fraction
* Circular economy and energy use.
* Energy use and types of fuels as a product of environmental protection.
* Thermal treatment processes: incineration of the grill, incineration in the floating layer, plasma treatment.
* Flue gas cleaning procedures: the removal of particulate matter, the processes of catalytic, chemical and absorbent flue gas cleaning.
* Flue gas desulfurization and nitrogen oxide excretion.
* Handling of residues of thermal treatment of waste
* Economic evaluation of thermal treatment of waste.
 |
| **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, 2002, ISBN: 0070418780.Richard O. Gilbert: Statistical Methods for Environmental Pollution Monitoring, Wiley, 1987, ISBN: 0471288780.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 ter ekonomskim preračunom stroškov ravnanja in odstranjevanja energetskimi odpadki. |  | Students get acquainted with the legislation, standards and normatives from the field of environment 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:• 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:• 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.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):• written 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, et al. Challenges of energy data collection in setting up sustainable energy action plans. V: Open days 2013 : proceedings. Brussels: European Union Committee of the Regions. 2013, str. 74. <http://ec.europa.eu/regional_policy/conferences/od2013/doc/OD13_proceedings.pdf>. [COBISS.SI-ID [1024185436](https://plus.si.cobiss.net/opac7/bib/1024185436?lang=sl)]. |

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| **UČNI NAČRT PREDMETA / COURSE SYLLABUS** |
| **Predmet:** | **KROŽNO GOSPODARSTVO IN ENERGETIKA** |
| **Course title:** | **CIRCULAR ECONOMY AND ENERGY TECHNOLOGY** |
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| **Študijski program in stopnja****Study programme and level** | **Študijska smer****Study field** | **Letnik****Academic year** | **Semester****Semester** |
| ENERGETIKA, 2. STOPNJA |  | **2** | **1** |
| ENERGY TECHNOLOGY,2.degree |  | **2** | **1** |
|  |
| **Vrsta predmeta / Course type** |  Izbirni/Elective |
|  |  |
| **Univerzitetna koda predmeta / University course code:** | M |
|  |
| **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** |  |  |
|  |
| **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 s področja linearnega in krožnega gospodarstva.
* Normativni okvir krožnega gospodarstva
* Trajnostno upravljanje z energetskimi viri in transformacija odpadkov v vire
* Trajnostni urbani razvoj, gradnja stavb in mobilnost.
* Energetska učinkovitost v gospodarstvu in javnem sektorju.
* Stroški učinkovitosti tehnoloških rešitev krožnega gospodarstva.
 |  | * General concepts in the field of linear and circular economy.
* The normative framework of the circular economy.
* Sustainable management of energy resources and waste transformation into resources.
* Sustainable urban development, building construction and mobility.
* Energy and energy efficiency in the economy and the public sector.
* Costs for the efficiency of the technological solutions of the circular economy.
 |
| **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 osnovami prehoda v krožno gospodarstvo in trajnostno upravljanje tehnoloških rešitev ter stroškovne učinkovitosti izvedbe. |  | Students get to know the basics of transition to the circular economy and the sustainable management of technological solutions and the cost-effectiveness of the implementation. |
| **Predvideni študijski rezultati:** |  | **Intended learning outcomes:** |
| Znanje in razumevanje:• normativnega okvira krožnega gospodarstva• izbira ustreznih trajnostnih in tehnoloških  rešitev prehoda v krožno gospodarstvo• stroškovna analiza izbranih rešitevPrenesljive/ključne spretnosti in drugi atributi: • uspešno delo na okoljevarstvenih razvojno  raziskovalnih projektih |  | Knowledge and understanding:• the normative framework of the circular  economy• choosing appropriate sustainable and  technological ones solution to the transition  to a circular economy• cost analysis of selected solutionsTransferable/Key Skills and other attributes:• 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.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):• 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: [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]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: [M. Pavlovčič], 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: [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)] . |

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| **UČNI NAČRT PREDMETA / COURSE SYLLABUS** |
| **Predmet:** | **MIKRO IN NANO ENERGETIKA** |
| **Course title:** | **MICRO AND NANO ENERGY TECHNOLOGY** |
|  |  |  |  |
| **Študijski program in stopnja****Study programme and level** | **Študijska smer****Study field** | **Letnik****Academic year** | **Semester****Semester** |
| ENERGETIKA, 2. STOPNJA |  | **2** | **1** |
| ENERGY TECHNOLOGY,2.degree |  | **2** | **1** |
|  |
| **Vrsta predmeta / Course type** | Izbirni/Elective |
|  |  |
| **Univerzitetna koda predmeta / University course code:** | M |
|  |
| **Predavanja****Lectures** | **Seminar****Seminar** | **Vaje****Tutorial** | **Klinične vaje****work** | **Druge oblike študija** | **Samost. delo****Individ. work** |  | **ECTS** |
| **30** |  | **30** |  |  | **90** |  | **5** |
| **AV** | **LV** | **RV** |  |
| **15** | **15** |  |  |
|  |
| **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. Kalorimetrija v energetiki-teoretične osnove
2. Kalorimetrija v energetiki-aplikacija
3. Mikroenergetika v 21. stoletju. Osnovne definicije in pojmi s področja mesomehanike in mikromehanike, uporaba nanomehanike in mikromehanike v tehniki. Meje veljavnosti zakonov klasične termomehanike v mikromehaniki. Uporaba mikrotehnologij v energetiki.
4. Uvod v teorijo MEMS-ov.
5. Tokovi v mikrokanalih in nanokanalih. Magnetohidrodinamika, ferohidrodinamika in elektrohidrodinamika v mikrofluidni tehniki.
6. Teorija vibracij mikronosilcev.
7. Materiali in mikromehanika.
8. Uporaba II. Glavnega zakona termodinamike pri simulaciji tokov v mikrokanalih. Lastnosti NEMS. Fizika zelo tankih plasti. Nanomateriali in njihove lastnosti. Nanotekočine in njihove lastnosti. Sodobne eksperimentalne metode v moderni mikromehaniki.
9. Uporaba vakuumskih tehnologij v energetiki.
10. Osnove statistične termomehanike in kinetične theorije.
11. Vzdrževanje mikroenergetskih naprav.
 |  | 1. Calorimetry in energy engineering-theoretical fundamentals
2. Calorimetry in energy engineering-application
3. Microenergetics in 21st century. Basic definitions and concepts related to mesomechanics and micromechanics, the application of micromechanics in technology. The limits of classical thermomechanics in the micromechanics. The application of microtechnology in energetics.
4. Introduction to MEMS.
5. Liquid flows in microchannels and nanochanels. Magnetohydrodynamics, ferrohydrodynamics and electrohydrodynamics in in microfluid technologies.
6. Theory of micro beams vibrations.
7. Materials and micromechanics.
8. The application of II. Law of thermodynamics for the simulation of flow in microchannels. Mechanical properties of NEMS. Nanomaterials and their properties. Nanofluids and their properties. Modern experimental techniques in the field micromechanics.
9. The use of vacuum technologies in energy engineering.
10. Fundamentals of statistical thermomechanics and kinetic theory.
11. Maintenance of micro systems.
 |
| **Temeljni literatura in viri / Readings:** |
| 1. Adrian Bejan, Thermodynamics, Wiley, 2006
2. Adrian Bejan, Design with constructal theory
3. A. Pippard, Classical thermodynamics, 1966, cambridge University Press
4. Adrian Bejan, Entropy generation minimization, 1995, CRC Press
5. L.E. Reichl,. A modern course with statistical physics, 2009, Wiley
6. B.J. McClelland, Statistical thermodynamics, 1973, Chapman and Hall
7. T. Engel, P. Reid, Thermodynamics, statistical thermodynamics and kinetics, 2013
8. H.B. Calllen, Thermodynamics, 1960
9. M.E. Brown, Introduction to thermal analysis and calorimetry, 2001, Kluwer Academic Publishers
10. K.D. Satler, Handbook of nanophysics, 2009, CRC Press.
11. B. Rogers, J. Adams, S. Pennathur, Nanotechnology, CRC, 2015.
12. G. Hak, Mems, CRC, 2005.
13. R.F. Speyer, Thermal analysis of materials, 1994, Mercel Decker
14. M. E. Brown, Handbook of thermal analysis and calorimetry, Elsevier, 1998.
 |
| **Cilji in kompetence:** |  | **Objectives and competences:** |
| * Prikazati najsodobnejše trende v energetiki
* podati poglobljeno znanje s področja mikrotehnologij in nanotehnologij in kalorimetrije v energetiki;
* prikazati mejno uporabo predhodno pridobljenih osnovnih znanj iz mehanike, matematike, fizike, gradiv, trdnosti;

 razviti sposobnosti študentov za samostojno in kreativno reševanje inženirskih problemov |  | * To show the trends in modern energetics
* to provide detailed knowledge of basic theory, functional use, design and calculation methods of micro- and nanotechnologies and calorimetry in energy technology;
* to demonstrate limit use of previously accumulated knowledge of mechanics, mathematics, physics, materials etc.;

 to further develop student's capabilities of independent thinking and creative solutions of engineering problems. |
| **Predvideni študijski rezultati:** |  | **Intended learning outcomes:** |
| Znanje in razumevanje:Študenti:* poznavanje osnovnih metod in fizikalnih principov v moderni mehaniki, termodinamiki in kalorimetriji
 |  | Knowledge and understanding:Students:* knowledge of basic methods and physical principles in modern mechanics; thermodynamics and calorimetry
 |
| 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:** |
| * predavanja
* dialog
* samostojno reševanje nalog
* mentorsko delo pri izdelavi seminarskega dela
 |  | * lectures
* dialogue
* individual solving of problems
* mentor supervision in preparing of seminar work
 |
| **Načini ocenjevanja:** | Delež (v %) /Weight (in %) | **Assessment:** |
| Način (pisni izpit, ustno izpraševanje, naloge, projekt)* pisni izpit
* ustni izpit
* seminarska naloga
 | **30****50****20** | Type (examination, oral, coursework, project):* written examination
* oral examination
* seminar work
 |
| **Reference nosilca / Lecturer's references:**  |
| 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,AVSEC, Jurij. The calculation of specific heats for some important solid components in hydrogen production process based on CuCl cycle. Thermal science, ISSN 0354-9836, 2014, vol. 18, no. 3, str. 823-831.] AVSEC, Jurij. The vibrations of microbeams and nanotubes. Journal of vibroengineering, ISSN 1392-8716, Dec. 2011, vol. 13, iss. 4, str. 638-645.AVSEC, Jurij, VIRTIČ, Peter, NATERER, Greg F. Nanofluid and ferrofluid slip flow in rectangular and circular microchannels and minichannels. *Przeglęad Elektrotechniczny*, ISSN 0033-2097, 2011, r. 87, nr. 3, str. 5-8. AVSEC, Jurij, NOVOSEL, Urška. The application of nanomechanics in energy technologies = Uporaba nanomehanike v energeskih tehnologijah. Journal of energy technology, ISSN 1855-5748. [Tiskana izd.], dec. 2015, vol. 8, iss. 4, str. 23-41, ilustr. [COBISS.SI-ID 1024224604]. STRUŠNIK, Dušan, GOLOB, Marjan, AVSEC, Jurij. Artificial neural networking model for the prediction of high efficiency boiler steam generation and distribution. Simulation modelling practice and theory, ISSN 1569-190X, 2015, vol. 57, str. 58-70, graf. prikazi, doi: 10.1016/j.simpat.2015.06.003. [COBISS.SI-ID 82929921], [JCR, SNIP, WoS do 31. 8. 2015: št. citatov (TC): 0, čistih citatov (CI): 0, normirano št. čistih citatov (NC): 0, Scopus do 24. 8. 2015: št. citatov (TC): 0, čistih citatov (CI): 0, normirano št. čistih citatov (NC): 0]. |

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| **UČNI NAČRT PREDMETA / COURSE SYLLABUS** |
| **Predmet:** | **TERMOMEHANSKE ANALIZE TOPLOTNIH IN SNOVNIH PRENOSNIKOV** |
| **Course title:** | **THERMOMECHANIC ANALYSIS OF HEAT AND MASS EXCHANGERS** |
|  |  |  |  |
| **Študijski program in stopnja****Study programme and level** | **Študijska smer****Study field** | **Letnik****Academic year** | **Semester****Semester** |
| ENERGETIKA, 2. STOPNJA |  | **2** | **1** |
| ENERGY TECHNOLOGY,2.degree |  | **2** | **1** |
|  |
| **Vrsta predmeta / Course type** | Izbirni/Elective |
|  |  |
| **Univerzitetna koda predmeta / University course code:** | M |
|  |
| **Predavanja****Lectures** | **Seminar****Seminar** | **Vaje****Tutorial** | **Klinične vaje****work** | **Druge oblike študija** | **Samost. delo****Individ. work** |  | **ECTS** |
| **30** |  | **30** |  |  | **90** |  | **5** |
| **AV** | **LV** | **RV** |  |
| **15** | **15** |  |  |
|  |
| **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. Napredna termodinamika, prenos toplote in prenos snovi v povezavi s prenosniki toplote in prenosniki snovi.
2. Napredna mehanika tekočin in trdnost v povezavi s prenosniki toplote in prenosniki snovi.
3. Napredna mehanika in teorija mehanskih nihanj v povezavi s prenosniki toplote in prenosniki snovi.
4. Vibracije v toplotnih prenosnikih.
5. Nihanja tekočin v prenosnikih.
6. Zamašitve toplotnih prenosnikov.
7. Termomehanske analize za kondenzatorje in uparjalnike.
8. Termomehanske analize za cevne prenosnike.
9. Termomehanske analize za ploščne prenosnike.
10. Termomehanske analize za regeneratorje.
11. Termomehanske analize za snovne prenosnike.
12. Mikro prenosniki toplote in snovi.
13. Vzdrževanje toplotnih in snovnih prenosnikov.
14. Uporaba toplotnih in snovnih prenosnikov v termodinamičnih procesih.
15. Modeliranje kombiniranih termodinamičnih procesov.
 |  | 1. Advanced thermodynamics, heat and mass transfer for heat and mass exchangers.
2. Advanced fluid mechanics and mechanics of materials for heat and mass exchangers.
3. Advanced mechanics and mechanical vibrations for heat and mass exchangers.
4. Vibrations of heat exchangers.
5. Flow-induced vibrations.
6. Fouling of heat exchangers.
7. Thermomechanical design analysis for condensers and evaporators.
8. Thermomechanical design methods for shell-and-tube heat exchangers.
9. Thermomechanical design methods for compact heat exchangers.
10. Thermomechanical design methods for regenerators.
11. Micro heat and mass exchangers.
12. Thermomechanical design methods for mass exchangers.
13. Maintenance of heat and mass exchangers.
14. Use of heat and mass exchangers in thermodynamics processes.
15. Modelling of combined thermodynamic processes.
 |
|  |
| 1. Adrian Bejan, Thermodynamics, Wiley, 2006
2. Adrian Bejan, Design with constructal theory
3. Adriam Bejan, Convection heat transfer, 2013 Wiley.
4. R.D. Blevins, Flow-induced vibrations, 1990, VNR.
5. S. Kakac, Heat exchangers, 2012, CRC.
6. F.M. White, Fluid mechanics, 2008, McGraw Hill.
7. S.S. ao, Vibration of continous systems, 2007, Wiley.M.P. paidoussis, S.J. price, E. de langre, Fluid Structure interactions, 2011, Cambridge.
8. S.S. Rao, Mechanical vibrations, 2014, Pearson.
9. F.P. Incropera, D.P. Dewitt, T.L. Bergman, A.S. Lavine, Heat and mass transfer, 2006, Wiley.
10. M.H. Sadd, Elasticity, 2005, elsevier.
 |
| **Cilji in kompetence:** |  | **Objectives and competences:** |
| * Prikazati najsodobnejše trende v energetiki
* podati poglobljeno znanje s področja termomehanike, eksergijskih analiz in toplotnih ter snovnih prenosnikov v energetiki;
* prikazati mejno uporabo predhodno pridobljenih osnovnih znanj iz mehanike, matematike, fizike, gradiv, trdnosti;

 razviti sposobnosti študentov za samostojno in kreativno reševanje inženirskih problemov |  | * To show the trends in modern energetics
* to provide detailed knowledge of basic theory, functional use, design and calculation methods of thermomechanics, exergy analysis and heat and mass exchangers in energy technology;
* to demonstrate limit use of previously accumulated knowledge of mechanics, mathematics, physics, materials etc.;

 to further develop student's capabilities of independent thinking and creative solutions of engineering problems. |
| **Predvideni študijski rezultati:** |  | **Intended learning outcomes:** |
| Znanje in razumevanje:Študenti:* poznavanje osnovnih metod in fizikalnih principov v moderni mehaniki, termodinamiki in kalorimetriji
 |  | Knowledge and understanding:Students:* knowledge of basic methods and physical principles in modern mechanics; thermodynamics and calorimetry
 |
| 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:** |
| * predavanja
* dialog
* samostojno reševanje nalog
* mentorsko delo pri izdelavi seminarskega dela
 |  | * lectures
* dialogue
* individual solving of problems
* mentor supervision in preparing of seminar work
 |
| **Načini ocenjevanja:** | Delež (v %) /Weight (in %) | **Assessment:** |
| Način (pisni izpit, ustno izpraševanje, naloge, projekt)* pisni izpit
* ustni izpit
* seminarska naloga
 | **30****50****20** | Type (examination, oral, coursework, project):* written examination
* oral examination
* seminar work
 |
| **Reference nosilca / Lecturer's references:**  |
| AVSEC, Jurij, AVSEC, Urban. Analysis of pipeline vibration for pressure driven, electromagnetic and combined fluid flow in macro, mini and micro regime. V: GOMES, J. F. Silva (ur.), MEGUID, S. A. (ur.). Recent advances in mechanics and materials in design : proceedings of the 6th International Conference on Mechanics and Materials in Design, P. Delgada, Portugal, 26-30 July 2015. [Porto Delgada]: Abreu PCO. 2015, str. 39-40, graf. prikazi.STRUŠNIK, Dušan, AVSEC, Jurij. Artificial neural networking and fuzzy logic exergy controlling model of combined heat and power system in thermal power plant. Energy, ISSN 0360-5442. [Print ed.], feb. 2015, vol. 80, str. 318-330, graf. prikazi. http://www.sciencedirect.com/science/article/pii/S0360544214013449, doi: 10.1016/j.energy.2014.11.074. [COBISS.SI-ID 1024198748], [JCR, SNIP, WoS do 2. 2. 2016: št. citatov (TC): 3, čistih citatov (CI): 2, normirano št. čistih citatov (NC): 1, Scopus do 2. 2. 2016: št. citatov (TC): 3, čistih citatov (CI): 2, normirano št. čistih citatov (NC): 1] AVSEC, Jurij, PRAUNSEIS, Zdravko, MARČIČ, Milan. Nonlinear vibrational analysis of diesel valve gear. Journal of vibroengineering, ISSN 1392-8716, Dec. 2011, vol. 13, iss. 4, str. 646-653. http://www.jve.lt/Vibro/JVE-2011-13-4/JVE-2011-13-4-676-Avsec2.pdf.pdf. [COBISS.SI-ID 1024082780]NOVOSEL, Urška, AVSEC, Jurij, TRŠELIČ, Ivana, NOVAK, Sonja. The exploitation of ultra-low-enthalpy geothermal energy in an ORC process in combination with RES and a heat pump = Izkoriščanje zelo nizkoentalpijske geotermalne energije v ORC procesu v kombinaciji z OVE in s toplotno črpalko. Journal of energy technology, ISSN 1855-5748. [Tiskana izd.], nov. 2015, vol. 8, iss. 3, str. 11-24, ilustr. [COBISS.SI-ID 1024221532] 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 OsijekuSTRUŠNIK, Dušan, GOLOB, Marjan, AVSEC, Jurij. Artificial neural networking model for the prediction of high efficiency boiler steam generation and distribution. Simulation modelling practice and theory, ISSN 1569-190X, 2015, vol. 57, str. 58-70, graf. prikazi, doi: 10.1016/j.simpat.2015.06.003. [COBISS.SI-ID 82929921], [JCR, SNIP, WoS do 31. 8. 2015: št. citatov (TC): 0, čistih citatov (CI): 0, normirano št. čistih citatov (NC): 0, Scopus do 24. 8. 2015: št. citatov (TC): 0, čistih citatov (CI): 0, normirano št. čistih citatov (NC): 0].TRŠELIČ, Ivana, AVSEC, Jurij. A case study of exergy analysis of waste heat recovery in refrigeration system = Analiza eksergijskih tokov v hladilnem sistemu z izkoriščanjem odpadne toplote. *Journal of energy technology*, ISSN 1855-5748. [Tiskana izd.], May 2014, vol. 7, iss. 2, str. 53-65, graf. prikazi, tabele. |

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| **UČNI NAČRT PREDMETA / COURSE SYLLABUS** |
| **Predmet:** | **PARNI KOTLI IN TURBINE** |
| **Course title:** | **STEAM BOILERS AND TURBINES** |
|  |  |  |  |
| **Študijski program in stopnja****Study programme and level** | **Študijska smer****Study field** | **Letnik****Academic year** | **Semester****Semester** |
| ENERGETIKA, 2. STOPNJA |  | **2** | **1** |
| ENERGY TECHNOLOGY,2.degree |  | **2** | **1** |
|  |
| **Vrsta predmeta / Course type** | Izbirni/Elective |
|  |  |
| **Univerzitetna koda predmeta / University course code:** | M |
|  |
| **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:** | **MILAN MARČIČ** |
|  |
| **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, termodinamike in toplotnih strojev in motorjev z notranjim zgorevanjem v energetiki |  | Completed courses in the following subjects: Mathematics, Mechanics, Thermodynamics and heat engines and internal combustion engine at energy plant |
| **Vsebina:**  |  | **Content (Syllabus outline):** |
| Vsebina predmeta obsega sledeča poglavja:1. Izvedbe parnih kotlov.
2. Zgorevanje v parnih kotlih.
3. Prenos toplote v parnih kotlih.
4. Cirkulacija vode v parnih kotlih.
5. Konstrukcije parnih kotlov.
6. Stirling, Garbe-Sulzer, Schmidt-Hartman, La Mot, Benzon in Sulcer kotli.
7. Onesnaženje parnih kotlov.
8. Oprema parnih kotlov.
9. Razžveplevanje dimnih plinov.
10. Termodinamični procesi parnih turbin.
11. Tokovna mehanika parnih turbin.
12. Curtisova in De Lavalova turbina.
13. Enakotlačna, nadtlačna in kombinirana turbina.
 |  | Content of the Subject:1. Steam boilers types and classification.
2. Combustion process of steam boilers.
3. Heat transfer in the steam boilers.
4. Water circulation in the steam boilers.
5. Design of Steam Boilers.
6. Stirling, Garbe-Sulzer, Schmidt-Hartman, La Mot, Benzon and Sulzer steam boilers.
7. Steam boilers impact on environment.
8. Equipment of steam boilers.
9. Filtration of exhaust gases.
10. Thermodynamic process of steam turbines
11. Flow dynamics of steam turbines.
12. Curtis and De Laval turbine.
13. Action, impulse, combined and condensation turbine.
 |
| **Temeljni literatura in viri / Readings:** |
| Leopold Andree, Parni kotli, Fakulteta za strojništvo, Univerza v LjubljaniBoris Černe, Parne turbine, Tehnička knjiga, ZagrebRolf Kehlhofer, ‎Frank Hannemann, ‎Bert Rukes, Combined-Cycle Gas&Steam Turbine Power Plants, 2009, ISBN 978-1-59370-168-0 |
| **Cilji in kompetence:** |  | **Objectives and competences:** |
| Podat osnovno znanje o parnih turbinah in parnih kotlih |  | Basic knowledge of steam boilers and turbines |
| **Predvideni študijski rezultati:** |  | **Intended learning outcomes:** |
| Znanje in razumevanje:Študent si pridobi osnovna znanja o parnih kotlih in turbinah.Prenesljive/ključne spretnosti in drugi atributi:kombinirana uporaba različnih toplotnih strojev v energetiki |  | Knowledge and Understanding:Student acquires the fundamentals of steam boilers and turbinesTransferable/Key Skills and other attributes:combined use of different heat engines at energy plant |
|  |  |  |
| **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)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:**  |
| GERŠAK, Jelka, MARČIČ, Milan. The effect of clothing on thermoregulatory responses of human body in a hot environment. Journal of fiber bioengineering and informatics, ISSN 1940-8676, March 2017, vol. 10, iss. 1, str. 1-12. 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. 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. http://crescopublications.org/pdf/JMAE/JMAE-1-001.pdf. 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. 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. |

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| **UČNI NAČRT PREDMETA / COURSE SYLLABUS** |
| **Predmet:** | **IZBRANA POGLAVJA IZ INŽENIRINGA V ENERGETIKI** |
| **Course title:** | **SELECTED CHAPTERS FROM ENGINEERING IN ENERGETICS**  |
|  |  |  |  |
| **Študijski program in stopnja****Study programme and level** | **Študijska smer****Study field** | **Letnik****Academic year** | **Semester****Semester** |
| ENERGETIKA, 2. STOPNJA |  | **2** | **1** |
| ENERGY TECHNOLOGY,2.degree |  | **2** | **1** |
|  |
| **Vrsta predmeta / Course type** | Izbirni/Elective |
|  |  |
| **Univerzitetna koda predmeta / University course code:** | M |
|  |
| **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):** |
| * uvodni del iz inženiringa v energetiki
* organizacijske oblike inženiringa glede na vrsto in velikost investicij v energetiki
* vloga in položaj inženiringa v projektnem sistemu
* vsebinska razčlenitev nalog in vloge nosilcev v procesu graditve energetskega objekta
* vrste pogodbenih odnosov med udeleženci s primeri pogodb
* pregled zakonodaje in možnih načinov izbire izvajalcev
* prikaz možnih načinov financiranja graditve energetskih objektov
* določitev, kvantifikacija in obvladovanje rizikov v procesu graditve
* metodologije vrednotenja ponudb
* razvijanje inovacij
* potek izdelave prototipa
* patentna zaščita inovacije
* preizkušanje materialov v inženirstvu
* konstruiranja procesne opreme.
* konstruiranje tlačnih posod
* inženiring spojenih energetskih komponent
* uporaba konceptov mehanike loma v inženirstvu
 |  | * introduction part from energy engineering
* engineering organizational forms due to the type and amount of investments in energetics
* role and position of engineering in project system
* content and task division and carriers roles in construction
* contract relations among the participants and contract examples
* legislation survey and possible ways of performers selection
* survey of possible ways of construction financing
* determination, quantification and risk control in construction process
* offer evaluation methodology
* development of innovation
* course of making prototype
* patent protection of innovation
* testing og engineering materials
* design of process equipment
* design of presure vessels
* engineering of joined energy components
* use of fracture mechanics concepts in engineering
 |
| **Temeljni literatura in viri / Readings:** |
| Ruchard Murch; Project Management; Best Practice for IT Professionals, Printice Hall PTR, Upper Saddle River, New York, U.S. A., 2006.Praunseis, Z. ; Naglič, T.: Elaborat o programu mrežnega podjetniškega inkubatorja Savinjske regije in spin-off inkubatorja Univerze v Maribor. Celje: Mrežni podjetniški inkubator Savinjske regije: Mrežni spin-off inkubator Univerze v Mariboru, 2009.. Mischke, C.: Mechanical Engineering Design, McGraw-hill international edition, 2001Anderson, T.: Fracture Mechanics of Materials, Boston,B&MC,1992Tracey, D.: Joined Engineering Materials, 1985, M.I.T. PressPraunseis, Z.; Naglič T.: Incubators as entities of innovative environment and generation of high-tech enterprises for realisation of these innovative business ideas III međunarodni simpozijum Energetsko rudarstvo 2010, September, 2010, Apatin, Serbia |
| **Cilji in kompetence:** |  | **Objectives and competences:** |
| Seznanitev študentov s pojmi:* s področja energetike
* s področja varstva okolja
* s področja graditve objektov
* s področja organizacije inženiringa
* s področja financiranja graditve objektov
* s področja pogodbenih odnosov med udeleženci pri graditvi
* s področja risk managementa
 |  | Students will be familiar with notions in the field of* energy
* environmental protection
* construction
* engineering organization
* construction financing
* contract relations among the participants
* risk management
 |
| **Predvideni študijski rezultati:** |  | **Intended learning outcomes:** |
| Znanje in razumevanje:* procesa in pojmov pri graditvi objektov
* organiziranja in izvajanja inženiringa
* uporabe relevantne zakonodaje
* načinov financiranja graditve
* projektne organiziranosti
* pogodbenih odnosov med udeleženci v
* procesu graditve
* odnosov z javnostmi v posameznih
* fazah graditve
 |  | Knowledge and Understanding of:* process and notions in construction
* organization and engineering construction
* relevant legislation application
* construction financing manners
* project organization
* contract relations among the participants in construction process
* public relations in individual construction phases
 |
| Prenesljive/ključne spretnosti in drugi atributi:* analiza člankov in primerov s področja graditve objektov
* timsko delo
* pridobitev organizacijskih spretnosti
* razumevanje snovi bo podprto s praktičnimi primeri oblik in načinov graditve objektov
 |  | Transferable/Key Skills and other attributes:* article analysis and examples in construction
* team work
* organization skills
* materials supported by practical examples
 |
| **Metode poučevanja in učenja:** |  | **Learning and teaching methods:** |
| Predavanja s pomočjo uporabe različnih AV sredstev.Uvodno podajanje snovi, nato individualno delo s študenti, študij praktičnih primerov, prebiranje strokovnih člankov s kritično oceno le-teh, predstavitev študentskih mnenj o posameznih problemih iz prakse, organizirane razprave na v naprej določeno temo, predstavitev praktičnih primerov s področja graditve objektov s strani strokovnjakov iz prakse.Izdelava enostavnega investicijskega programa in vodene laboratorijske vaje. |  | Lectures with AV technology.Introductory lecture and individual work with students, study of practical examples, reading professional articles with critical evaluation, presentation of students' opinions on individual problems in real- life, organized discussions on certain topics, expert presentation of practical examples in construction.Preparation of simple investment programme and guided laboratory practice. |
| **Načini ocenjevanja:** | Delež (v %) /Weight (in %) | **Assessment:** |
| Način (pisni izpit, ustno izpraševanje, naloge, projekt)* pisni kolokviji
* ustni izpit
* pisni izpit
 | **30****30****40** | Type (examination, oral, coursework, project):* written test
* oral examination
* written examination
 |
| **Reference nosilca / Lecturer's references:**  |
| PRAUNSEIS, Zdravko. Fracture evaluation of energy components with local brittle zones = Vrednotenje loma v energetskih komponentah z lokalnimi krhkimi področji. *Journal of energy technology*, ISSN 1855-5748. [Tiskana izd.], 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, AVSEC, Jurij, MARČIČ, Simon. Fractografic examination of welds strength mismatching = Fraktografska raziskava trdnostno neenakih zvarov. *Journal of energy technology*, ISSN 1855-5748. [Tiskana izd.], maj 2013, vol. 6, iss. 2, str. 11-16. <http://www.fe.um.si/en/jet.html>. [COBISS.SI-ID [1024142684](http://cobiss.izum.si/scripts/cobiss?command=DISPLAY&base=COBIB&RID=1024142684)] PRAUNSEIS, Zdravko, AVSEC, Jurij, MARČIČ, Simon, STROJKO, Renato. Energy renovation of an older house = Energetska prenova starejše hiše. *Journal of energy technology*, ISSN 1855-5748. [Tiskana izd.], maj 2013, vol. 6, iss. 2, str. 59-69. <http://www.fe.um.si/en/jet.html>. [COBISS.SI-ID [1024143196](http://cobiss.izum.si/scripts/cobiss?command=DISPLAY&base=COBIB&RID=1024143196)] PRAUNSEIS, Zdravko, AVSEC, Jurij, STROJKO, Renato, NOVAK, Sonja. Application and testing of steels for the energy process industry. *Journal of energy technology*, ISSN 1855-5748. [Tiskana izd.], dec. 2013, vol. 6, iss. 3, str. 25-34. <http://www.fe.um.si/en/jet.html>. [COBISS.SI-ID [1024154716](http://cobiss.izum.si/scripts/cobiss?command=DISPLAY&base=COBIB&RID=1024154716)]  |

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| **UČNI NAČRT PREDMETA / COURSE SYLLABUS** |
| **Predmet:** | **TEHNOLOGIJA VARJENJA ENERGETSKIH KOMPONENT** |
| **Course title:** | **WELDING TECHNOLOGY OF ENERGY COMPONENTS** |
|  |  |  |  |
| **Študijski program in stopnja****Study programme and level** | **Študijska smer****Study field** | **Letnik****Academic year** | **Semester****Semester** |
| ENERGETIKA MAG, 2. STOPNJA |  | **2** | **1** |
| ENERGY TECHNOLOGY,2. degree |  | **2** | **1** |
|  |
| **Vrsta predmeta / Course type** | Izbirni/Elective |
|  |  |
| **Univerzitetna koda predmeta / University course code:** | M |
|  |
| **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:** | **ZDRAVKO PRAUNSEIS** |
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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. Uvodni del v tehnologijo varjenja materialov.
2. Vrste energetskih materialov in njihove značilnosti.
3. Problematika varjenja energetskih materialov.
4. Pojav hladne in tople razpokljivosti v zvarnih spojih.
5. Trdnostna neenakost zvarnih spojev
6. Varivostni preizkusi
7. Varilna tehnologija visokotrdnostnih mikrolegiranih jekel za obratovanje pri nizkih in visokih temperaturah.
8. Določevanje kakovosti zvarnih spojev
9. Eksperimentalno preizkušanje zvarnih spojev.
 |  | 1. Introduction part of welding technology of materials.
2. Energy materials types and their properties.
3. Welding problems of energy components.
4. Appearance of cold and hot cracking of welded joints.
5. Strenght mis-matching of welded joints.
6. Welding tests.
7. Welding technology of high strenght low alloy steels for operation under low and high temperatures.
8. Determination of quality of welding joints.
9. Experimental testing of welding joints
 |
| **Temeljni literatura in viri / Readings:** |
| Praunseis, Z.: The influence of Strength Under-matched Weld Metal containing Heterogeneous Regions on Fracture Properties of HSLA Steel Weld Joint (Dissertation in English). Faculty of Mechanical Engineering, University of Maribor, Slovenia, 1998BS 5762, Methods for crack opening displacement (COD) testing, The British Standards Institution, London 1979.ASTM E 1152-87, Standard test method for determining J-R curves, Annual Book of ASTM Standards, Vol. 03.01, American Society for Testing and Materials, Philadelphia, 1990.ASTM E 1290-91, Standard test method for crack-tip opening displacement (CTOD) fracture toughness measurement, American Society for Testing and Materials, Philadelphia, 1991.GKSS Forschungszentrum Geesthacht GMBH, GKSS-Displacement Gauge Systems for Applications in Fracture Mechanic.Praunseis, Z., Toyoda, M., Sundararajan, T.: Fracture behaviours of fracture toughness testing specimens with metallurgical heterogeneity along crack front. Steel res., Sep. 2000, 71, no 9,Praunseis, Z., Sundararajan, T., Toyoda, M., Ohata, M.: The influence of soft root on fracture behaviors of high-strength, low-alloyed (HSLA) steel weldments. Mater. manuf. process., 2001, vol. 16, 2Sundararajan, T., Praunseis, Z.: The effect of nitrogen-ion implantation on the corrosion resistance of titanium in comparison with oxygen- and argon-ion implantations. Mater. tehnol., 2004, vol. 38, no. 1/2. |
| **Cilji in kompetence:** |  | **Objectives and competences:** |
| Študenti:- podati osnove o uporabi varjenja v energetiki.- podati osnovno znanje o varilni tehnologiji materialov v energetiki.- pridobiti praktična znanja, ki so potrebna za izdelavo tehnologij varjenja materialov. |  | Students:- to provide the basic knowledge about welding in energetics. - to provide the basic knowledge about welding technology of materials in energetics. - to provide necessary practical application for determination of welding technology of materials.  |
| **Predvideni študijski rezultati:** |  | **Intended learning outcomes:** |
| Znanje in razumevanje:- spoznavanje osnov o namenski uporabi varjenja v energetiki. - spoznavanje modernih postopkov preizkušanja varivosti materialov. - razumevanje osnovnih značilnosti tehnologij varjenja materialov. |  | Knowledge and Understanding:- basic knowledge about purpose usage of welding in energetics. - introduction to basic knowledge of weldability testing of welded joints.- understanding of basic features of welding technologies of materials. |
| **Prenesljive/ključne spretnosti in drugi atributi:**Uporaba standardov in tehniškega znanja za projektiranje varjenih konstrukcij v energetiki. |  | **Transferable/Key Skills and other attributes:**Application of standards and technical knowledge for design of welding constructions in energetics. |
| **Metode poučevanja in učenja:** |  | **Learning and teaching methods:** |
| Predavanja.Reševanje domačih nalog.Laboratorijske vaje. |  | Lectures.Coursework.Laboratory work.  |
| **Načini ocenjevanja:** | Delež (v %) /Weight (in %) | **Assessment:** |
| Način (pisni izpit, ustno izpraševanje, naloge, projekt):* pisni izpit
* ustni izpit
 | **40****60** | Type (examination, oral, coursework, project):* written examination
* oral examination
 |
| **Reference nosilca / Lecturer's references:**  |
| PRAUNSEIS, Zdravko, NOVAK, Sonja, AVSEC, Jurij. The influence of strength mismatching on the fracture properties of heterogeneous joints = Vpliv trdnostne neenakosti na lomne lastnosti heterogenih spojev. Journal of energy technology, ISSN 1855-5748. [Tiskana izd.], Nov. 2012, vol. 5, iss. 4, str. 27-35, ilustr. <http://www.fe.uni-mb.si/images/stories/jet/e-jet/revija_jet_-_volume_5_-_issue_4_-_november_-_za_internet.pdf>. [COBISS.SI-ID [1024118108](https://plus.si.cobiss.net/opac7/bib/1024118108?lang=sl)] PRAUNSEIS, Zdravko. Numerical evaluation of the crack-driving force in heterogeneous regions = Numerična določitev sile razvoja razpoke v heterogenih področjih. Journal of energy technology, ISSN 1855-5748. [Tiskana izd.], Nov. 2012, vol. 5, iss. 4, str. 51-58, ilustr. <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](https://plus.si.cobiss.net/opac7/bib/1024118364?lang=sl)] PRAUNSEIS, Zdravko. Fracture toughness of heterogeneous energy components = Lomna žilavost heterogenih energetskih komponent. Journal of energy technology, ISSN 1855-5748. [Tiskana izd.], aug. 2012, vol. 5, iss. 3, str. 39-45, ilustr. <http://www.fe.uni-mb.si/images/stories/jet/e-jet/revija_jet_-_volume_5_-_issue_3_-_avgust_-_internet.pdf>. [COBISS.SI-ID [1024110684](https://plus.si.cobiss.net/opac7/bib/1024110684?lang=sl)] PRAUNSEIS, Zdravko, MARČIČ, Simon. Global testing of under-matched joints = Globalno preizkušanje nizkotrdnostnih spojev. Journal of energy technology, ISSN 1855-5748. [Tiskana izd.], Nov. 2012, vol. 5, iss. 4, str. 11-18, ilustr. <http://www.fe.uni-mb.si/images/stories/jet/e-jet/revija_jet_-_volume_5_-_issue_4_-_november_-_za_internet.pdf>. [COBISS.SI-ID [1024117852](https://plus.si.cobiss.net/opac7/bib/1024117852?lang=sl)] PRAUNSEIS, Zdravko. Fracture evaluation of energy components with local brittle zones = Vrednotenje loma v energetskih komponentah z lokalnimi krhkimi področji. Journal of energy technology, ISSN 1855-5748. [Tiskana izd.], feb. 2013, vol. 6, iss. 1, str. 51-60, ilustr. <http://www.fe.um.si/en/jet.html>. [COBISS.SI-ID [1024133212](https://plus.si.cobiss.net/opac7/bib/1024133212?lang=sl)] |

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| **UČNI NAČRT PREDMETA / COURSE SYLLABUS** |
| **Predmet:** | **ALTERNATIVNI, AERO- IN HIDRO-ENERGETSKI SISTEMI**  |
| **Course title:** | **ALTERNATIVE, AERO- AND HYDRO-ENERGETIC SYSTEMS**  |
|  |  |  |  |
| **Študijski program in stopnja****Study programme and level** | **Študijska smer****Study field** | **Letnik****Academic year** | **Semester****Semester** |
| ENERGETIKA, 2. stopnja  |  | **2** | **1** |
| ENERGY TECHNOLOGY, 2.degree |  | **2** | **1** |
|  |
| **Vrsta predmeta / Course type** | Izbirni/Elective |
|  |  |
| **Univerzitetna koda predmeta / University course code:** | M |
|  |
| **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** |  |  |
|  |
| **Nosilec predmeta / Lecturer:** | **ANDREJ PREDIN** |
|  |
| **Jeziki /** **Languages:** | **Predavanja / Lectures:** | slovenski / Slovene |
| **Vaje / Tutorial:** | slovenski / Slovene |
| **Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:** |  | **Prerequisits:** |
| Poglobljena znanja fizike, mehanike, termodinamike |  | Advanced knowledge of physics, mechanics, thermodynamics |
| **Vsebina:**  |  | **Content (Syllabus outline):** |
| * Osnovni in napredni pristop - okvir odprte termodinamike
* Mikro / Makro svet v KNA ES
* Pregled smeri razvoja KNA ES
* Tekočinski alternativni KNA ES
* Plinski alternativni energetski sistemi
* Kombinirani konvencionalni, napredni in alternativni energetski sistemi
* Ekonomika in obratovanje KNA ES
* Skupno/mrežno ali sestavljeno oz. kombinirano obratovanje
* Regulacija KNA ES
* Meritve karakteristik KNA ES
* Shranjevalni energetski sistemi in njih kombinacije KNA ES
* Obratovanje in regulacija KNA ES
* Modelske meritve KNA ES
* Eksperimentalne preslikave model VS original
 |  | * A basic and advanced approach - an open thermodynamics framework
* Micro / Macro world at Conventional, advanced and Alterantive energetic systems (CAA ES).
* Review of the development direction of CAA EC
* Liquid Alternative CAA ES
* Gas Alternative Energy Systems
* Combined conventional, advanced and alternative energy systems
* Economics and operation of CAA ES
* Common / network or composite combined operation
* Control of CAA ES
* Measurement of CAA EC characteristics
* Storage energy systems and their combinations of CAA ES
* Operation and control of CAA ES
* Model CAA EC measurements
* Experimental mapping model vs. original system
 |
| **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[8] **A. Predin:** *Črpalke in ventilatorji*, Fakulteta za strojništvo, Univerza v Mariboru, 2000.[9] **C.E. Brennen**: *Hydrodynamics of Pumps*, Concepts ETI, Inc. and Oxford University Press, 1994.[10] **C.E. Brennen:** *Fundamentals of Multiphase flow*, Cambridge University press, 2005.[11] **J.P. Gostelow:** *Cascade Aerodynamics*, Pergaminn press, 1984.[12] **Knapp, Dally, Hammit**: *Cavitation,* McGraw-Hill, 1970.[13] **J.F. Douglas et al.:** *Fluid Mechanics, 3rd edition* LGL press 1995.[14] **Sir Horace Lamb:** *Hydrodynamics*, Cambridge University, 1997. |
| **Cilji in kompetence:** |  | **Objectives and competences:** |
| Osvojitev znanj na področju hidravličnih strojev, sistemov in naprav v energetiki; |  | Advanced 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,
* Implementacija računskih primerov.
 |  | - Lectures,- Classroom and laboratory exercises,- Implementationof calculated examples. |
| **Načini ocenjevanja:** | Delež (v %) /Weight (in %) | **Assessment:** |
| * pisni izpit,
* pisni izpit iz teorije
* kratek ustni zagovor;
 | **40****50****10** | - written examination,- written exam from 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)]PREDIN, Andrej, BILUŠ, Ignacijo. Gonilni mehanizmi kavitacijskega vrtinca v vstopnem vodu radialne črpalke = The driving mechanisms of the cavitation swirl in the entrance pipe of a radial pump. *Strojniški vestnik*, ISSN 0039-2480, 2001, letn. 47, št. 6, str. 234-247. [COBISS.SI-ID [4767003](https://plus.si.cobiss.net/opac7/bib/4767003?lang=sl)] PREDIN, Andrej, BILUŠ, Ignacijo. Influence of additional inlet flow on the prerotation and performance of centrifugal impellers. *Journal of hydraulic research*, ISSN 0022-1686, 2003, vol. 41, 2, str. 207-216. [COBISS.SI-ID [7876630](https://plus.si.cobiss.net/opac7/bib/7876630?lang=sl)]PREDIN, Andrej, HREN, Gorazd. Majhne kinetične vodne turbine, mogoče postavitve in ekonomska učinkovitost. V: VOLFAND, Jože (ur.), CIRMAN, Andreja, ŠIJANEC-ZAVRL, Marjana. *URE, energetika in okolje = Energy efficiency, energy and environment*, (Zbirka Zelena Slovenija). Celje: Fit media. 2013, str. 143-149. [COBISS.SI-ID [76815873](https://plus.si.cobiss.net/opac7/bib/76815873?lang=sl)] |

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| **UČNI NAČRT PREDMETA / COURSE SYLLABUS** |
| **Predmet:** | **ENERGETSKI TRG** |
| **Course title:** | **ENERGY MARKET** |
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| **Študijski program in stopnja****Study programme and level** | **Študijska smer****Study field** | **Letnik****Academic year** | **Semester****Semester** |
| ENERGETIKA, 2. stopnja  |  | **2** | **1** |
| ENERGY TECHNOLOGY, 2.degree |  | **2** | **1** |
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| **Vrsta predmeta / Course type** | Izbirni/Elective |
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| **Univerzitetna koda predmeta / University course code:** | M |
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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** |  |
| **10** |  | **20** |  |
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| **Nosilec predmeta / Lecturer:** | **SEBASTIJAN SEME** |
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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):** |
| a) Osnovne zakonitosti modelov konkurenčnih podjetij.b) Osnovni pojmi iz ekonomije. Osnove trgov – modeliranje potrošnikov in proizvajalcev. Tržno ravnovesje.c) Splošno o vrstah trgov. Trgi z nepopolno konkurenco in trgi z energenti. Vloga države, regulatorjev, direktiv in predpisov na delovanje trgov z energenti.d) Sodelovanje na trgih z energenti z perspektive potrošnika in proizvajalca. Varnostni sistemi in pomožne storitve.e) Prenosna omrežja in investiranje v proizvodne enote. |  | a) The basic principles of the models of competing companies.b) Basic concepts from economics. Basics of markets - modeling of consumers and producers. Market equilibrium.c) General on the types of markets. Markets with incomplete competition and energy markets. The role of the state, regulators, directives and regulations on the functioning of markets for energy products.d) Participation in energy markets from the perspective of the consumer and producer. Security systems and ancillary services.e) Transmission networks and investment in production units. |
| **Temeljni literatura in viri / Readings:** |
| Ivar Wangesteen (2007.), Power System Economics – The Nordic Electricity Market, Tapir Academic Press.Daniel S. Kirschen, Goran Štrbac (2004.), Fundametals of Power System Economics, Wiley.Carol A. Dahl (2004.), International Energy Markets - Understanding Pricing, Policies and Profits, PennWell. |
| **Cilji in kompetence:** |  | **Objectives and competences:** |
| Cilj predmeta so pridobiti razširjeno znanje s področja trgovanja z energenti. Poznavanje liberalizacije energetskega trga in značilnosti energetskih reform vezanih na električno energijo, naravne pline, tekoči derivati in obnovljivi viri.Poznavanje fizičnega in finančnega toka med udeleženci trga (proizvodnja, prenos, distribucija, odjem).Razviti sposobnost samostojnega in kreativnega reševanja inženirskih problemov. |  | The aim of the course is to acquire extensive knowledge in the field of energy trading. Knowledge of the liberalization of the energy market and the characteristics of energy reforms related to electricity, natural gas, liquid derivatives and renewable resources.Knowing the physical and financial flow between market participants (production, transmission, distribution, consumption).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 liberalizacije energetskega trga. Sposobnosti evidentiranja problemov in predvidevanja vezanih na trgovanje z energenti. |  | Knowledge and Understanding:Knowledge and understanding in the field of liberalization of the energy market. Ability to record problems and predictions related to trading in energy products. |
| Prenesljive/ključne spretnosti in drugi atributi:Uporaba teoretičnega znanja v praksi in sposobnost strateškega in operativnega načrtovanja in odločanja. Avtonomnost v strokovnem delu. |  | Transferable/Key Skills and other attributes:Application of theoretical knowledge in practice and the ability of strategic and operational planning and decision making. Autonomy in professional work. |
| **Metode poučevanja in učenja:** |  | **Learning and teaching methods:** |
| Predavanja.Avditorne vaje.Računalniške vaje.Samostojno delo. |  | Lectures.Classroom exercises.Computer exercises.Individual work. |
| **Načini ocenjevanja:** | Delež (v %) /Weight (in %) | **Assessment:** |
| Opravljene računalniške vaje.Pisni izpit. | **35****65** | Completed computer exercises.Written examination. |
| **Reference nosilca / Lecturer's references:**  |
| LUKAČ, Niko, SEME, Sebastijan, DEŽAN, Katarina, ŽALIK, Borut, ŠTUMBERGER, Gorazd. Economic and environmental assessment of rooftops regarding suitability for photovoltaic systems installation based on remote sensing data. Energy, ISSN 0360-5442. [Print ed.], 15 July 2016, vol. 107, str. 854-865, doi: 10.1016/j.energy.2016.04.089. [COBISS.SI-ID 19549718], [JCR, SNIP, WoS do 27. 8. 2017: št. citatov (TC): 3, čistih citatov (CI): 3, Scopus do 8. 9. 2017: št. citatov (TC): 4, čistih citatov (CI): 3]SEME, Sebastijan, SREDENŠEK, Klemen, ŠTUMBERGER, Bojan, HADŽISELIMOVIĆ, Miralem. Technical and economical part of investments in solar power plants and small hydro power plants - comparison between technologies. V: KROPE, Jurij (ur.), et al. Renewable energy sources : (Conference proceedings). Maribor: University of Maribor Press: Faculty of chemistry and chemical engineering. 2017, str. 613-624, doi: 10.18690/978-961-286-061-5.54. [COBISS.SI-ID 1024275292]SEME, Sebastijan, DEŽAN, Katarina, ŠTUMBERGER, Gorazd. Parametri ekonomike fotonapetostnih sistemov. V: VORŠIČ, Jože (ur.). Komunalna energetika : oskrba z energijo. Maribor: Fakulteta za elektrotehniko, računalništvo in informatiko. 2013, str. 1-13, ilustr. http://ke.powerlab.uni-mb.si/arhiv/dokument.aspx?id=81. [COBISS.SI-ID 17092118] |

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| **UČNI NAČRT PREDMETA / COURSE SYLLABUS** |
| **Predmet:** | **ZAŠČITNI IN KRMILNI SISTEMI** |
| **Course title:** | **PROTECTION AND CONTROL SYSTEMS** |
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| **Študijski program in stopnja****Study programme and level** | **Študijska smer****Study field** | **Letnik****Academic year** | **Semester****Semester** |
| ENERGETIKA, 2. stopnja  |  | **2** | **1** |
| ENERGY TECHNOLOGY, 2.degree |  | **2** | **1** |
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| **Vrsta predmeta / Course type** | Izbirni/Elective |
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| **Univerzitetna koda predmeta / University course code:** | M |
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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:** | **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):** |
| Osnovne zahteve za zaščito, kriteriji delovanja, primarna in sekundarna zaščita, sistemi vodenja, hierarhična struktura, sistemska zaščita in vodenje, koordiniran in integriran sekundarni sistem vodenja, statične in numerične zaščite. Primarna in sekundarna zaščita generatorjev in motorjev, energetskih transformatorjev, srednjenapetostnih in visokonapetostnih omrežij in zbiralk, izbira karakteristik, koordinacija in selektivnost. Strojna in programska oprema za vodenje in zaščito; mikroprocesorski releji, zgradba, signalno procesiranje in osnovni algoritmi.Sistemi programabilnih krmilij, strojna in programska oprema, decentralizirane in večnivojske enote, povezljivost, periferne enote, načini programiranja, snovanje krmilnih in regulacijskih funkcij.Integrirani sistemi za zaščito, nadzor in vodenjePraktični zgledi, sekundarno preizkušanje zaščitnih naprav, programiranje industrijskih krmilnikov. |  | Basic requirements for protection, criteria of operation, primary and back-up protection. Hieratical automation structures, system protection and control, coordinated and integrated control system. Unit protection of generators, motors and power transformers, protection in middle voltage and high voltage networks and buses, characteristic selection, coordination, computer based design tools and selectivity testing. Digital control and protection systems, basic software and hardware characteristics, signal processing and basic algorithmsProgrammable logic controllers, hardware and software characteristics, decentralized and multilavel units, peripheral units, programming of protection and control functions. Integrated systems for protection, monitoring and control Problem solving , secondary protection testting, PLC programming. |
| **Temeljni literatura in viri / Readings:** |
| B. Grčar: Uvod v zaščito elementov EES, FERI, 1999.J. L. Blackburn: Protective Relaying, Marcel Dekker, 1998.R.N. Bateson : Control System Technology, Prentice Hall, 1998. |
| **Cilji in kompetence:** |  | **Objectives and competences:** |
| Uporaba sodobnih digialnih naprav za nadzor in vodenje energetskih procesov in zaščito elektroenergetskih sistemov. |  | The implementation of modern digital devices in monitoring and control of energy processes and in power protection. |
| **Predvideni študijski rezultati:** |  | **Intended learning outcomes:** |
| Koncept zaščite in hierahičnega vodenja, razumevanje in uporaba strojne in programske opreme. |  | Koncept of protection and hierarchical control, understanding and use of modern hardware and software. |
| Prenesljive/ključne spretnosti in drugi atributi:Programska orodja za zaščito in vodenje, signalno pogojevanje in pretvorbe . |  | Transferable/Key Skills and other attributes:Programming tools for protection and control, signal conditioning and coversions. |
| **Metode poučevanja in učenja:** |  | **Learning and teaching methods:** |
| Predavanja.Eksperimentalno delo. |  | LecturesExperimental work. |
| **Načini ocenjevanja:** | Delež (v %) /Weight (in %) | **Assessment:** |
| Način (pisni izpit, ustno izpraševanje, naloge, projekt)* pisni izpit
* ustni izpit
* projekt
 | **30****50****20** | Type (examination, oral, coursework, project):* written examination
* oral examination
* 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)]VIRTIČ, Peter. Analysis of rotor disc thickness in coreless stator axial flux permanent magnet synchronous machine. *Prz. Elektrotech.*, 2012, r. 88, nr. 12b, str. 12-15. <http://www.red.pe.org.pl/articles/2012/12b/4.pdf>. [COBISS.SI-ID [1024116572](http://cobiss.izum.si/scripts/cobiss?command=DISPLAY&base=COBIB&RID=1024116572)] AVSEC, Jurij, VIRTIČ, Peter, NATERER, Greg F. Nanofluid and ferrofluid slip flow in rectangular and circular microchannels and minichannels. *Prz. Elektrotech.*, 2011, r. 87, nr. 3, str. 5-8. [COBISS.SI-ID [1024048220](http://cobiss.izum.si/scripts/cobiss?command=DISPLAY&base=COBIB&RID=1024048220)]  |

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| **UČNI NAČRT PREDMETA / COURSE SYLLABUS** |
| **Predmet:** | **SENZORSKI SISTEMI V ENERGETIKI** |
| **Course title:** | **SENSOR SYSTEMS IN ENERGETICS** |
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| **Študijski program in stopnja****Study programme and level** | **Študijska smer****Study field** | **Letnik****Academic year** | **Semester****Semester** |
| ENERGETIKA, 2. stopnja  |  | **2** | **1** |
| ENERGY TECHNOLOGY, 2.degree |  | **2** | **1** |
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| **Vrsta predmeta / Course type** | Izbirni/Elective |
|  |  |
| **Univerzitetna koda predmeta / University course code:** | M |
|  |
| **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:** | **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.
* Analogni design vhodne stopnje senzorskih sistemov (šumi v merilnih sistemih, poglobljen pregled rabe operacijskih ojačevalnikov v senzoriki).
* Izbrana poglavja iz meritev procesnih veličin (merilniki z dušilnimi elementi, meritve pretokov v odprtih kanalih, merjenja lokalnih hitrosti fluidov, meritve masnega pretoka in gostote, itd.)
* Integrirani polprevodniški senzorji.
* Meritve vibracij in akustične meritve.
* Optični senzorji in uporaba v energetiki.
* Osnove kemijskih senzorjev (uvod v analizno kemične metode, nekateri senzorji plinov in ekoloških parametrov, meritve vlažnosti).
 |  | * Introduction.
* Analog design of the front end circuits in sensor systems (noise in measurement system, optimum application of operational amplifiers, lock in amplifier).
* Selected chapters in measurements of process parameters (flow measurements bases on attenuation devices, measurements of flow in open channels).
* Integrated semiconductor sensors.
* Vibration and acoustical measurements.
* Optical sensors and aplications in the energetics.
* Fundamentals of chemical sensors (introduction in chemical analytical method, gas sensors, environmental parameter sensors, humidity sensors).
 |
| **Temeljni literatura in viri / Readings:** |
| Jacob Fraden, AIP Handbook of Modern Sensors, American Institute of Physics, New York 1993.Đonlagić, Denis, Završnik, Miha, Đonlagić, Dali. Fotonika : uvodna poglavja. Maribor: Fakulteta za elektrotehniko, računalništvo in informatiko, Maribor 1997.John A. Pelesko, David H. Bernstein, Modeling MEMS and NEMS, CRC Press, 2002.Julian W. Gardner, V. K. Varadan, Osama O. Awadelkarim, Microsensors, MEMS and Smart Devices, John Wiley & Sons; 1st edition, 2001. |
| **Cilji in kompetence:** |  | **Objectives and competences:** |
| Pridobitve osnovnih veščin s področja designa senzorski sistemov, pridobitve preglednega znanj s področja naprednih senzorskih sistemov, pridobitve osnovnih zanj iz meritve veličin ki se navezujejo na energetske sisteme. |  | The objective of this course is to obtain knowledge in the design of sensor systems, to get basic knowledge and overview in the field of modern sensors and to get in-depth knowledege of sensors related to energetics systems. |
| **Predvideni študijski rezultati:** |  | **Intended learning outcomes:** |
| Znanje in razumevanje:* razumevanje in poznavanje sodobnih senzorjev,
* pridobitve širšega vpogleda v problematiko meritev ekoloških in drugih za enegetske sisteme relevantnih parametrov,
* pridobitve osnovnih znanj sodobnih senzorskih sistemov,
* uvod v raziskovalno delo na področju senzorskih sistemov.
 |  | Knowledge and understanding:* understanding of modern sensors,
* to get and broader overview of measurements of ecological and other parameters relevant to energy generation,
* obtaining basic knowledge of modern sensor sytems,
* introduction to research work in the field of sensor systems.
 |
| Prenesljive/ključne spretnosti in drugi atributi:* sposobnost samostojnega dela (razvoja) na področju moderne senzorike,
* pridobitev temeljnih in aktualnih znanj na področju naprednih tehnologij potrebnih za opravljanje zahtevnih in aktualni inženirskih nalog ali raziskovalnega dela.
 |  | Transferable/Key Skills and other attributes:* capability to conduct independent development work in the field of modern sensors,
* acquisition of basic and contemporary knowledge in the field of advanced technology needed to conduct demanding engineering tasks or research work.
 |
| **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, 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.IGREC, Dalibor, CHOWDHURY, Amor, HADŽISELIMOVIĆ, Miralem, ŠTUMBERGER, Bojan. Environmental values measuring cell for assessment of wind and solar energy resources. Przeglęad Elektrotechniczny, ISSN 0033-2097, 2011, vol. 87, iss. 12b, str. 65-68.ĆORLUKA, Venco, HEDERIĆ, Željko, HADŽISELIMOVIĆ, Miralem. Moisture measurement in solid samples using Raman spectroscopy. Przeglęad Elektrotechniczny, ISSN 0033-2097, 2011, vol. 87, iss. 12b, str. 25-28.IGREC, Dalibor, CHOWDHURY, Amor, HADŽISELIMOVIĆ, Miralem, ŠTUMBERGER, Bojan. Measuring wind resources = Merjenje vetrne karakteristike. Journal of energy technology, ISSN 1855-5748. [Tiskana izd.], Feb. 2011, vol. 4, iss. 1, str. 49-59.HADŽISELIMOVIĆ, Miralem, GORIČAN, Viktor, MARČIČ, Tine, VIRTIČ, Peter, ŠTUMBERGER, Bojan. Magnetic field analysis in slotless PM linear motor model : comparison of calculated and measured results. Przeglęad Elektrotechniczny, ISSN 0033-2097, 2011, vol. 87, iss. 3, str. 65-69. |

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| **UČNI NAČRT PREDMETA / COURSE SYLLABUS** |
| **Predmet:** | **VODENJE ELEKTRIČNIH POGONOV**  |
| **Course title:** | **ELECTRIC DRIVES CONTROL** |
|  |  |  |  |
| **Študijski program in stopnja****Study programme and level** | **Študijska smer****Study field** | **Letnik****Academic year** | **Semester****Semester** |
| ENERGETIKA, 2. stopnja  |  | **2** | **1** |
| ENERGY TECHNOLOGY, 2.degree |  | **2** | **1** |
|  |
| **Vrsta predmeta / Course type** | Izbirni/Elective |
|  |  |
| **Univerzitetna koda predmeta / University course code:** | M |
|  |
| **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:** | **BOJAN ŠTUMBERGER** |
|  |
| **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: pregled enosmernih motornih pogonov, pregled izmeničnih motornih pogonov, primerjava enosmernih in izmeničnih motornih pogonov, primerjava sinhronskih in asinhronskih motornih pogonov.
* Pretvorniki za motorne pogone z nastavljivo hitrostjo vrtenja: šestkoračni izmenični razsmernik.
* Modulacijske tehnike: blokovne modulacije, pulzno širinski modulacijski algoritmi, vektorski modulacijski algoritmi.
* Modeliranje pretvornikov za motorne pogone: d-q model napetostnega pretvornika, d-q model tokovnega pretvornika, model razsmernika v d-q sinhronem koordinatnem sistemu.
* Dualnosti napetostnega in tokovnega razsmernika.
* Principi vektorskega upravljanja: navorna regulacija enosmernega motorja, vektorsko upravljanje sinhronega motorja, vektorsko upravljanje asinhronskega motorja.
 |  | * Introduction: overview of dc motor drives and induction motor drives, comparison of dc-motors drive and induction motor drives, comparison of synchronous and induction motor drives.
* Inverters for adjustable speed: the six step voltage stiff inverter (VSI).
* Modulation techniques: block modulation, harmonic cancellation methods, sinusoidal three-angle modulation, vector modulation.
* Modeling of solid state power converters: d-q model of voltage source inverters, d-q model of current source inverters, inverter d-q models in synchronous reference frame.
* Duality of voltage and current source inverters.
* The principle of vector control: dc motor drive torque control, vector control of synchronous motor drive, vector control of induction motor drive.
 |
| **Temeljni literatura in viri / Readings:** |
| M. Milanovič: Uvod v močnostno elektroniko, FERI, Maribor, 1997.V. Ambrožič, Sodobne regulacije pogonov z izmeničnimi motorji, FE Ljubljana, 1996D. Dolinar, G. Štumberger: Modeliranje in vodenje elektromehanskih sistemov, FERI Maribor, 2004.J. M. D. Murphy, F. G. Turnbull, Power Electronic:Control of AC Motors, Pergamon press, New York, 1989.B. Bose: Power Electronics and Motor Drives, Advances andTrends, Elsevier, 2006.M. H. Rashid: Power Electronics Handbook, Devices, Circuits and Applications, Elsevier, 2007.R. Krishnan: Electric Motor Drives, Modeling, Analysis and Control, Prentice Hall, 2001.H. A. Toliyat, G. B. Kliman: Handbook of Electric Motors, CRC Press, 2004.B. K. Bose: Modern Power Electronics and AC Drives, Prentice Hall. 2002.N. P. Quang, J.-A. Dittrich,Vector Control of Three-Phase AC Machines,System Development in the Practice, Springer, 2008. |
| **Cilji in kompetence:** |  | **Objectives and competences:** |
| Podati znanje s področja teorije in funkcionalne uporabe elektromotornih pogonov. Praktična uporaba predhodno pridobljenih osnovnih znanj iz električnih strojev, industrijske elektronike in regulacij. |  | The objective of this course is to acquaint students with the theory and functional use of electric drives. Use of practical knowledge of previous classes from the field of electric machines, industrial electronics and control theory. |
| **Predvideni študijski rezultati:** |  | **Intended learning outcomes:** |
| Znanje in razumevanje:Razumevanje principov delovanja električni strojev v vodenih električnih pogonih v povezavi z elementi industrijske elektronike in njihova praktična uporaba. Razumevanje in znanje o načinih vektorskega vodenja v vodenih električnih pogonih z različnimi vrstani električni strojev. |  | Knowledge and Understanding:Understanding of operation principles of electric machines in controlled electric drives in connection with elements of power electronic and their practical use. Knowledge and understanding regarding the priciples of vector control in electric drives with different electrical machines types.  |
| Prenesljive/ključne spretnosti in drugi atributi:Modulacijske tehnike, modeliranje pretvornikov za vodene električne pogone. |  | Transferable/Key Skills and other attributes:Modulation techniques, inverter modeling for electric drives control- |
| **Metode poučevanja in učenja:** |  | **Learning and teaching methods:** |
| Predavanja z uporabo računalniške projekcije in table.Laboratorijske vaje.Računalniške vaje. |  | Lectures by using powerpoint slides and blackboard.Laboratory exercises.Computer exercises. |
| **Načini ocenjevanja:** | Delež (v %) /Weight (in %) | **Assessment:** |
| Način (pisni izpit, ustno izpraševanje, računalniške vaje, laboratorijske vaje):* pisni izpit
* ustni izpit
* računalniške vaje
* laboratorijske vaje
 | **40****40****10****10** | Type ( written and oral examination, computer exercises, laboratory exercises):* written exam
* oral exam
* computer exercises
* laboratory exercises
 |
| **Reference nosilca / Lecturer's references:**  |
| ŠTUMBERGER, Bojan, IGREC, Dalibor, CHOWDHURY, Amor, HADŽISELIMOVIĆ, Miralem. Design of synchronous reluctance generator with dual stator windings and anisotropic rotor with flux barriers. *Prz. Elektrotech.*, 2012, r. 88, nr. 12b, str. 16-19. <http://www.red.pe.org.pl/articles/2012/12b/5.pdf>. [COBISS.SI-ID [1024129372](http://cobiss.izum.si/scripts/cobiss?command=DISPLAY&base=COBIB&RID=1024129372)]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, GORIČAN, Viktor, ŠTUMBERGER, Gorazd, HADŽISELIMOVIĆ, Miralem, MARČIČ, Tine, TRLEP, Mladen. Performance evaluation of synchronous reluctance motor in BLDC drive. *Prz. Elektrotech.*, str. 147-149. [COBISS.SI-ID [13808662](http://cobiss.izum.si/scripts/cobiss?command=DISPLAY&base=COBIB&RID=13808662)]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)]ŠTUMBERGER, Gorazd, ŠTUMBERGER, Bojan, DOLINAR, Drago. Identification of linear synchronous reluctance motor parameters. *IEEE trans. ind. appl.*, Sep./Oct. 2004, vol. 40, no. 5, str. 1317-1324. [COBISS.SI-ID [9043734](http://cobiss.izum.si/scripts/cobiss?command=DISPLAY&base=COBIB&RID=9043734)] |

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| **UČNI NAČRT PREDMETA / COURSE SYLLABUS** |
| **Predmet:** | **NEPORUŠNE JEDRSKE PREISKOVALNE METODE** |
| **Course title:** | **NUCLEAR NONDESTRUCTIVE TESTING METHODS** |
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| **Študijski program in stopnja****Study programme and level** | **Študijska smer****Study field** | **Letnik****Academic year** | **Semester****Semester** |
| ENERGETIKA, 2. STOPNJA |  | **2** | **1** |
| ENERGY TECHNOLOGY, 2.degree |  | **2** | **1** |
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| **Vrsta predmeta / Course type** | Izbirni/Elective |
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| **Univerzitetna koda predmeta / University course code:** | M |
|  |
| **Predavanja****Lectures** | **Seminar****Seminar** | **Vaje****Tutorial** | **Klinične vaje****work** | **Druge oblike študija** | **Samost. delo****Individ. work** |  | **ECTS** |
| **30** |  | **30** |  |  | **90** |  | **5** |
| **AV** | **LV** | **RV** |  |
| **10** | **20** |  |  |
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| **Nosilec predmeta / Lecturer:** | **IGOR LENGAR** |
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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 osnove interakcije jedrskih sevanj s snovjo in pojavi pri prehodu skozi snov (jedrske reakcije, sipanje in povratno sipanje, zaviranje delcev, aktivacija, vzbujanje sekundarnih sevanj).
* Radiometrične metode preiskovanja in uporaba v industriji.
* Autoradiografske metode, (radiografski filmi in nuklearne emuilzije), nevtronsko inducirana autoradiografija, fisionografija in ionska autoradiografija.
* Radiografske, radioskopske in tomografske metode (uporaba težkih nabitih delcev, delcev beta, pozitronskega sevanja, mehkih žarkov X, žarkov gama in nevtronov).
* Sipanje in uklon jedrskih sevanj (žarki X in nevtroni) in njihova uporaba za določanje notranjih struktur in fizikalnih lastnosti materialov.
* Jedrske sonde in mikroanalitične tehnike določanja profilov vsebnosti lahkih elementov v snovi.
* Radioanalitične metode aktivacijske analize z nevtroni, protoni in žarki X in gama. Zakasnele in promptne tehnike instrumentalne aktivacijske analize.
* Pregled preostalih neporušnih metod (ultrazvok)
 |  | * The physical fundamentals of the interactions of nuclear radiation with matter (nuclear reactions, scattering and back-scattering, particle attenuation, activation, induced secondary radiation).
* Radiometrical methods of investigation and application in industry.
* Autoradiographic techniques (radiographic films, nuclear emulsions), neutron induced autoradiography, fissionography and ion autoradiography
* Radiographical, radioscopic and tomography methods (use of heavy charged particles, beta particles, positron emission, soft gamma rays, gamma rays and neutrons).
* Scattering and diffraction of nuclear radiation (x-rays and neutrons) and the use for internal structure characterization and physical properties of materials.
* Nuclear probe and micro-analytical techniques for light element determination in matter.
* Radio-analytical activation analysis techniques with neutrons, protons, gamma and x-rays. Delayed and prompt techniques of instrumental activation analyses.
* A survey of other techniques (ultra sound).
 |
| **Temeljni literatura in viri / Readings:** |
| P. O. Moore, Non-Destructive Testing Handbook – Radiographic Testing, ASNT, 2002.G.Deconnick, Introduction to Radioanalytical Physics, Akademiai Kiado, 1978.G.F.Knoll, Radiation Detection and Measurement, J.Wiley and Sons, 2000. |
| **Cilji in kompetence:** |  | **Objectives and competences:** |
| Podati pregled modernih jedrskih preiskovalnih in analitičnih metod in njihove uporabe pri razvoju modernih materialov, novih tehnologij in za industrijsko kontrolo kvalitete. |  | A survey of modern nuclear testing methods and analytical techniques and their use in the development of new materials and technologies for industrial quality control. |
| **Predvideni študijski rezultati:** |  | **Intended learning outcomes:** |
| Znanje in razumevanje:Študent zna našteti področja uporabe nedestruktivnih jedrskih metod v industriji in njihove prednosti ter slabosti. |  | Knowledge and Understanding:The student can summarize the filed of application of nondestructive nuclear testing methods in industry, their advantages and disadvantages. |
| Prenesljive/ključne spretnosti in drugi atributi:Študent se pri vajah spozna s praktično uporabo nevtronske radiografije in/ali nevtronske aktivacijske analize. |  | Transferable/Key Skills and other attributes:The student learns during practical training the use of radiography and neutron activation analyses. |
| **Metode poučevanja in učenja:** |  | **Learning and teaching methods:** |
| Predavanja, pri katerih študent spozna teoretične vsebine predmeta. Pri vajah študent utrdi teoretično znanje z mentorsko vodenim reševanjem izbranih praktičnih nalog in izvaja vaje v sevalnem laboratoriju, kjer sledi demonstraciji nevtronske aktivacijske analize in nevtronske radiografije. |  | The student learns the theoretical fundamentals of the course during lectures.During the tutorial the student strengthens the acquired knowledge with practical problem solving. The tutorial is guided by the mentor and carried out in a radiation laboratory where the student follows the demonstration of neutron activation analyses and neutron radiography. |
| **Načini ocenjevanja:** | Delež (v %) /Weight (in %) | **Assessment:** |
| Način (pisni izpit, ustno izpraševanje, naloge, projekt)* pisni izpit
* ustni izpit
* poročilo o vajah
 | **40****40****20** | Type (examination, oral, coursework, project):* written examination
* oral examination
* additionally a report about practical exercises has to be delivered by the student.
 |
| **Reference nosilca / Lecturer's references:**  |
| LENGAR, Igor, ČUFAR, Aljaž, CONROY, S., BATISTONI, P., POPOVICHEV, Sergei, SNOJ, Luka, SYME, Brian, VILA, Rafael, STANKUNAS, Gediminas, et al. Radiation damage and nuclear heating studies in selected functional materials during the JET DT campaign. Fusion Engineering and Design, ISSN 0920-3796. 2016, doi: /10.1016/j.fusengdes.2016.01.03. [COBISS.SI-ID 29290279].ČUFAR, Aljaž, LENGAR, Igor, KODELI, Ivan Aleksander, MILOCCO, Alberto, SAUVAN, Patrick, CONROY, S., SNOJ, Luka. Comparison of DT neutron production codes MCUNED, ENEA-JSI source subroutine and DDT. Fusion Engineering and Design, ISSN 0920-3796. 2016, 6 str., doi: 10.1016/j.fusengdes.2016.03.036. [COBISS.SI-ID 29366055].SNOJ, Luka, LENGAR, Igor, ČUFAR, Aljaž, SYME, B., POPOVICHEV, Sergei, BATISTONI, P., CONROY, S., et al. Neutronic analysis of JET external neutron monitor response. Fusion Engineering and Design, ISSN 0920-3796. 2016, 6 str., doi: 10.1016/j.fusengdes.2016.03.046. [COBISS.SI-ID 29365799].FILLIATRE, P., JAMMES, C., BARBOT, L., FOURMENTEL, D., GESLOT, B., LENGAR, Igor, JAZBEC, Anže, SNOJ, Luka, ŽEROVNIK, Gašper. Experimental assessment of the kinetic parameters of the JSI TRIGA reactor. Annals of Nuclear Energy, ISSN 0306-4549. 2015, vol. 83, str. 236-245. [COBISS.SI-ID 28565031].SYME, D.B., POPOVICHEV, Sergei, CONROY, S., LENGAR, Igor, SNOJ, Luka, SOWDEN, Benjamin Choyce, et al. Fusion yield measurements on JET and their calibration. Fusion Engineering and Design, ISSN 0920-3796. 2014, iss. 11, vol. 89, str. 2766-2775. [COBISS.SI-ID 28006439].VUOLO, M., BONIFETTO, R., DULLA, S., HEINOLA, K., LENGAR, Igor, RAVETTO, Pierro, VILLARI, R., WIDDOWSON, A., ZANINO, R., et al. Evaluation of the neutron activation of JET in-vessel components following DT irradiation,. Fusion Engineering and Design, ISSN 0920-3796, Vol. 89, Iss. 9-10. Barcelona: Elsevier, 2014, iss. 9-10, vol. 89, str. 2071-2075. [COBISS.SI-ID 28447527].LENGAR, Igor, SNOJ, Luka. Benchmark evaluation of interacting aluminum cylinders containing uranyl fluoride solution, Nuclear engineering and design, ISSN 0029-5493, Vol. 261, 2013. Amsterdam: Elsevier, vol. 261, str. 232-237. [COBISS.SI-ID 26907687].RADULOVIĆ, Vladimir, LENGAR, Igor, TRKOV, Andrej. Effect of systematic error in the fuel mass on ksub[eff] in pebble bed reactors, Nuclear Engineering and Design, ISSN 0029-5493, Vol. 246). Amsterdam: Elevier, 2012, vol. 246, str. 75-81. [COBISS.SI-ID 25788455].LENGAR, Igor. Evaluation of neutron scattering in fusion reactor diagnostics and tile material. Journal of energy technology, ISSN 1855-5748. [Tiskana izd.], Nov. 2008, vol. 1, iss. 1, str. 31-41. [COBISS.SI-ID 12996886].LENGAR, Igor, SNOJ, Luka, ROGAN, Petra, RAVNIK, Matjaž. Re-evaluation of the criticality experiments of the "Otto Hahn Nuclear Ship" reactor. Kerntechnik, ISSN 0932-3902, 2008, vol. 73, str. 242-248, [COBISS.SI-ID 22170919].RANT, Jože, MILIĆ, Zoran, ISTENIČ, Janka, KNIFIC, Timotej, LENGAR, Igor, RANT, Andrej. Neutron radiography examination of objects belonging to the cultural heritage. Applied Radiation and Isotopes, ISSN 0969-8043. 2006, vol. 64, str. 7-12. [COBISS.SI-ID 19648807]. |

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| **UČNI NAČRT PREDMETA / COURSE SYLLABUS** |
| **Predmet:** | **FIZIKA TLAČNOVODNIH REAKTORJEV** |
| **Course title:** | **PWR PHYSICS** |
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| **Študijski program in stopnja****Study programme and level** | **Študijska smer****Study field** | **Letnik****Academic year** | **Semester****Semester** |
| ENERGETIKA, 2. STOPNJA |  | **2** | **1** |
| ENERGY TECHNOLOGY, 2.degree |  | **2** | **1** |
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| **Vrsta predmeta / Course type** | Izbirni/Elective |
|  |  |
| **Univerzitetna koda predmeta / University course code:** | M |
|  |
| **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:** | **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:** |  | **Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:** |
| Ni pogojev. |  | None. |
| **Vsebina:**  |  | **Content (Syllabus outline):** |
| * Cepitev jeder
* Nevtronski cikel
* Nevtronsko ravnovesje in kritičnost v 2-grupnem difuzijskem približku
* Kinetika reaktorja
* Podkritično pomnoževanje
* Odziv reaktorja pri nizkih in visokih močeh
* Kratkoročne spremembe reaktivnosti
* Srednjeročne spremembe reaktivnosti
* Dolgoročne spremembe reaktivnosti
* Gorljivi absorberji
* Upravljanje z gorivom
* Regulacija z regulacijskimi palicami
* Regulacija s kemično kompenzacijo
* Krmiljenje reaktorja
 |  | * Nuclear fission
* Neutron cycle
* Neutron balance and criticality in 2-group diffusion approximation
* Reactor kinetics
* Subcritical multiplication
* Reactor response at low and high power
* Short term reactivity changes
* Intermediate term reactivity changes
* Long term reactivity changes
* Burnable poisons
* Fuel management
* Regulation with control rods
* Regulation with chemical compensation
* Reactor control
 |
| **Temeljni literatura in viri / Readings:** |
| Bruno Cvikl, Jedrski energetski sistemi (z uvodom v fiziko stacionarnih reaktorjev), 119 strani, Univerza v Mariboru in Inštitut “Jožef Stefan” Ljubljana, 2010.E. Srebotnjak, Osnove reaktorske fizike, Izobraževalni center za jedrsko tehnologijo »Milana Čopiča«, 2015.H. Sekimoto, Nuclear Reactor Theory, COE-INES, Tokyo Institute of Technology, 2007. |
| **Cilji in kompetence:** |  | **Objectives and competences:** |
| Študenti:* spoznajo in osvojijo osnovne procese v jedrskem reaktorju,

spoznajo odziv reaktorja na spremembe reaktivnosti, * spoznajo časovno odvisne spremembe v fisijskem reaktorju in način kontrole reaktorja.
 |  | Students:* get acquainted and gain understanding of the basic processes in nuclear reactor,
* get acquainted with reactor response produced by reactivity changes,
* get understanding of time-dependent changes in a reactor and its control.
 |
| **Predvideni študijski rezultati:** |  | **Intended learning outcomes:** |
| Znanje in razumevanje:* poznavanje osnovnih procesov v jedrskem reaktorju,
* sposobnost napovedi obnašanja reaktorja,
* sposobnost uporabe pridobljenega teoretičnega znanja v praksi,
* avtonomnost v svojem strokovnem delu.
 |  | Knowledge and understanding:* knowledge of the basic processes in nuclear reactor,
* ability to predict reactor behaviour,
* ability to use theoretical knowledge in practice,
* independence in professional work and obligation to professional ethics.
 |
| Prenesljive/ključne spretnosti in drugi atributi:* Znanje, ki naj omogoči nadaljni študij sorodnih področij.
* Razvoj veščin in spretnosti v uporabi znanja na svojem konkretnem strokovnem delovnem področju.
 |  | Transferable/Key Skills and other attributes:* Skills enabling in-depth study of connected areas.
* 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
 |  | * Lectures
* Exercises
* Dialogue
* Repetition (revision) and consolidation of acquired knowledge
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| **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:**  |
| 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]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]  |

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|  **UČNI NAČRT PREDMETA / COURSE SYLLABUS** |
| **Predmet:** | **ANALIZA IN PROJEKTIRANJE JEDRSKEGA REAKTORJA** |
| **Course title:** | **NUCLEAR REACTOR ANALYSIS AND DESIGN** |
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| **Študijski program in stopnja****Study programme and level** | **Študijska smer****Study field** | **Letnik****Academic year** | **Semester****Semester** |
| ENERGETIKA, 2. STOPNJA |  | **2** | **1** |
| ENERGY TECHNOLOGY, 2.degree |  | **2** | **1** |
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| **Vrsta predmeta / Course type** | Izbirni/Elective |
|  |  |
| **Univerzitetna koda predmeta / University course code:** | M |
|  |
| **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:** | **MARJAN KROMAR, ANDREJ TRKOV** |
|  |
| **Jeziki /Languages:** | **Predavanja / Lectures:** | slovenski / Slovene |
| **Vaje / Tutorial:** | slovenski / Slovene |
| **Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:** |  | **Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:** |
| Ni pogojev. |  | None. |
| **Vsebina:**  |  | **Content (Syllabus outline):** |
| * Ponovitev definicij (fluks in spekter nevtronov, reakcijska hitrost, jedrske konstante, reaktivnost).
* Uporaba metod reševanja transportne enačbe za projektne izračune sredice reaktorja:
* energijsko večgrupna diskretizacija,
* PN metoda,
* SN metoda,
* metoda karakteristik
* difuzijska aproksimacija.
* Primerjava determinističnih in Monte Carlo metod.
* Reaktivnostni povratni efekti.
* Izračuni reaktorske kinetike in dinamike.
* Pregled primera projektnega izračuna sredice PWR reaktorja.
 |  | * Refreshment of definitions (neutron flux, spectrum, reaction rate, nuclear constants, reactivity).
* Numerical methods for the solution of transport equation for nuclear core design calculations:
* energy multigroup discretization,
* PN method,
* SN method,
* method of characteristics,
* diffusion approximation.
* Comparison of deterministic and Monte Carlo methods.
* Reactivity feedback effects.
* Reactor dynamics and kinetics.
* Overview of pressurised-water reactor core design calculations.
 |
| **Temeljni literatura in viri / Readings:** |
| A. Hébert, Applied Reactor Physics, Presses internationales Polytechnique, ISBN 978-2-553-01436-9, 2009.E. E. Lewis, W. F. Jr. Miller, Computational Methods of Neutron Transport, Wiley-Interscience, 1993.Rudi J. J. Stammler, Maximo J. Abbate, Methods of Steady-state Reactor Physics in Nuclear Design, Academic Press, 1983.M. Kromar, A. Trkov, Nuclear design calculations of the NPP Krško core, Journal of energy technology, ISSN 1855-5748, 2009, vol. 2, iss. 4, pp. 41-50. [COBISS.SI-ID 23313959] |
| **Cilji in kompetence:** |  | **Objectives and competences:** |
| * Seznanitev z lastnostmi reaktorja kot izvora toplotne energije.
* Seznanitev z metodami modeliranja reaktorja.
* Seznanitev z viri jedrskih podatkov in njihovo pripravo za aplikacije.
 |  | Description of:* Poperties of a nuclear reactor as a heat source.
* Mthematical modelling of a reactor.
* Nuclear data and processing for applications.
 |
| **Predvideni študijski rezultati:** |  | **Intended learning outcomes:** |
| Znanje in razumevanje:* spoznavanje metod za projektne izračune sredice reaktorja
* seznanitev z viri jedrskih in drugih podatkov in njihovo pripravo za aplikacije
 |  | Knowledge and Understanding:* methods for nuclear reactor core design calculations
* sources of nuclear data and processing for applications
 |
| Prenesljive/ključne spretnosti in drugi atributi:Spoznavanje osnovnih lastnosti nekaterih programov, ki se uporabljajo za projektne izračune sredice reaktorja. |  | Transferable/Key Skills and other attributes:Basic properties and capabilities of selected codes for reactor core design calculations. |
| **Metode poučevanja in učenja:** |  | **Learning and teaching methods:** |
| * Predavanja
* Vaje
* Dialog
* Ponavljanje in utrjevanje pridobljenega znanja
 |  | * Lectures
* Exercises
* Dialogue
* Repetition (revision) and consolidation of acquired knowledge
 |
| **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:**  |
| 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]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]  |

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| **UČNI NAČRT PREDMETA / COURSE SYLLABUS** |
| **Predmet:** | **TEHNOLOGIJA FUZIJSKE ENERGIJE** |
| **Course title:** | **INTRODUCTION TO FUSION ENERGY** |
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| **Študijski program in stopnja****Study programme and level** | **Študijska smer****Study field** | **Letnik****Academic year** | **Semester****Semester** |
| ENERGETIKA, 2. STOPNJA |  | **2** | **1** |
| ENERGY TECHNOLOGY,2.degree |  | **2** | **1** |
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| **Vrsta predmeta / Course type** | Izbirni/Elective |
|  |  |
| **Univerzitetna koda predmeta / University course code:** | M |
|  |
| **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:** | **IGOR LENGAR** |
|  |
| **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 (energijski viri, jedrska energija, zgodovina fuzije)
* Fuzijske reakcije in zaloge goriva, masna enačba
* Sipanje, gibanje nabitih delcev, energijske porazdelitve
* Reakcijske hitrosti, vžig,
* Magnetno omejevanje plazme, vztrajnostno omejevanje
* Osnovni pojmi fizike plazme
* Fizika omejevanja v tokamakih
* Fuzijska tehnologija
* Osnove drugih fuzijskih naprav (stelaratorji, fuzija z inercijskim omejevanjem)
* Lawsonov kriterij
 |  | * Introduction (energy resources, nuclear energy, fusion history)
* Fusion reactions and fuel resources, mass equation
* Scattering, motion of charged particles, energy distributions
* Reaction rates, ignition
* Magnetic confinement of plasma, inertial confinement
* Basic of plasma physics
* Tokamak confinement physics
* Fusion technology
* Other fusion concepts (stellarators, inertial.confinement fusion)
* Lawson criterion
 |
| **Temeljni literatura in viri / Readings:** |
| A. Harms et al., Principles of fusion energy : an introduction to fusion energy for students of science and engineering, Singapore: World Scientific, 2010.J. Reader et al., Controlled Nuclear Fusion, John Wiley & Sons, 1986.R.A. Gross, Fusion Energy, John Wiley & Sons, 1984.J. Wesson, Tokamaks, Clarendon Press – Oxford, 2004.K. Miyamoto, Plasma Physics and Controlled Nuclear Fusion, Springer, 2005.G. McCracken and P. Stott, Fusion : the energy of the universe, Oxford : Elsevier/Academic Press, 2013. |
| **Cilji in kompetence:** |  | **Objectives and competences:** |
| Fuzija bo glavni osnovni vir energije v prihodnosti, komplementarna obnovljivim virom (vodna, sončna, bio-masa, vetrna) ter klasičnim virom (fisija, nafta, premog).Pri študiju je potrebno pridobiti vsaj osnovno vedenje o fuzijski tehnologiji. |  | Fusion will be the main basic source of energy in future, complementary to renewable sources ( hydro, sun, bio-mass, wind) and classical sources (fission, oil, coal)It is inevitable and necessary for students of energy technology to get basic knowledge on fusion technology. |
| **Predvideni študijski rezultati:** |  | **Intended learning outcomes:** |
| Znanje in razumevanje:Študenti pridobijo osnovno znanje o fiziki plazme in fuzijski tehnologiji. Poudarek je na tehnologiji tokamakov. |  | Knowledge and Understanding:Students get basic knowledge on plasma physics and fusion technology. Emphasis is given on tokamak concepts. |
| Prenosljive/ključne spretnosti in drugi atributi:Omogočeno je spremljanje razvoja fuzijske energije in eventualno vključevanje v razvojno delo na bodočih reaktorjih. |  | Transferable/Key Skills and other attributes:Following of the development of fusion energy and involvement in R&D of future reactors is enabled. |
| **Metode poučevanja in učenja:** |  | **Learning and teaching methods:** |
| Predavanja,Vaje (naloge).  |  | Lectures.Problem solving. |
| **Načini ocenjevanja:** | Delež (v %) /Weight (in %) | **Assessment:** |
| Način (pisni izpit, ustno izpraševanje, naloge, projekt)* pisni izpit
* ustni izpit
* projekt
 | **30****50****20** | Type (examination, oral, coursework, project):* written examination
* oral examination
* project
 |
| **Reference nosilca / Lecturer's references:**  |
| LENGAR, Igor, ČUFAR, Aljaž, CONROY, S., BATISTONI, P., POPOVICHEV, Sergei, SNOJ, Luka, SYME, Brian, VILA, Rafael, STANKUNAS, Gediminas, et al. Radiation damage and nuclear heating studies in selected functional materials during the JET DT campaign. Fusion Engineering and Design, ISSN 0920-3796. 2016, doi: /10.1016/j.fusengdes.2016.01.03. [COBISS.SI-ID 29290279].ČUFAR, Aljaž, LENGAR, Igor, KODELI, Ivan Aleksander, MILOCCO, Alberto, SAUVAN, Patrick, CONROY, S., SNOJ, Luka. Comparison of DT neutron production codes MCUNED, ENEA-JSI source subroutine and DDT. Fusion Engineering and Design, ISSN 0920-3796. 2016, 6 str., doi: 10.1016/j.fusengdes.2016.03.036. [COBISS.SI-ID 29366055].SNOJ, Luka, LENGAR, Igor, ČUFAR, Aljaž, SYME, B., POPOVICHEV, Sergei, BATISTONI, P., CONROY, S., et al. Neutronic analysis of JET external neutron monitor response. Fusion Engineering and Design, ISSN 0920-3796. 2016, 6 str., doi: 10.1016/j.fusengdes.2016.03.046. [COBISS.SI-ID 29365799].FILLIATRE, P., JAMMES, C., BARBOT, L., FOURMENTEL, D., GESLOT, B., LENGAR, Igor, JAZBEC, Anže, SNOJ, Luka, ŽEROVNIK, Gašper. Experimental assessment of the kinetic parameters of the JSI TRIGA reactor. Annals of Nuclear Energy, ISSN 0306-4549. 2015, vol. 83, str. 236-245. [COBISS.SI-ID 28565031].SYME, D.B., POPOVICHEV, Sergei, CONROY, S., LENGAR, Igor, SNOJ, Luka, SOWDEN, Benjamin Choyce, et al. Fusion yield measurements on JET and their calibration. Fusion Engineering and Design, ISSN 0920-3796. 2014, iss. 11, vol. 89, str. 2766-2775. [COBISS.SI-ID 28006439].VUOLO, M., BONIFETTO, R., DULLA, S., HEINOLA, K., LENGAR, Igor, RAVETTO, Pierro, VILLARI, R., WIDDOWSON, A., ZANINO, R., et al. Evaluation of the neutron activation of JET in-vessel components following DT irradiation,. Fusion Engineering and Design, ISSN 0920-3796, Vol. 89, Iss. 9-10. Barcelona: Elsevier, 2014, iss. 9-10, vol. 89, str. 2071-2075. [COBISS.SI-ID 28447527].LENGAR, Igor, SNOJ, Luka. Benchmark evaluation of interacting aluminum cylinders containing uranyl fluoride solution, Nuclear engineering and design, ISSN 0029-5493, Vol. 261, 2013. Amsterdam: Elsevier, vol. 261, str. 232-237. [COBISS.SI-ID 26907687].RADULOVIĆ, Vladimir, LENGAR, Igor, TRKOV, Andrej. Effect of systematic error in the fuel mass on ksub[eff] in pebble bed reactors, Nuclear Engineering and Design, ISSN 0029-5493, Vol. 246). Amsterdam: Elevier, 2012, vol. 246, str. 75-81. [COBISS.SI-ID 25788455].LENGAR, Igor. Evaluation of neutron scattering in fusion reactor diagnostics and tile material. Journal of energy technology, ISSN 1855-5748. [Tiskana izd.], Nov. 2008, vol. 1, iss. 1, str. 31-41. [COBISS.SI-ID 12996886].LENGAR, Igor, SNOJ, Luka, ROGAN, Petra, RAVNIK, Matjaž. Re-evaluation of the criticality experiments of the "Otto Hahn Nuclear Ship" reactor. Kerntechnik, ISSN 0932-3902, 2008, vol. 73, str. 242-248, [COBISS.SI-ID 22170919].RANT, Jože, MILIĆ, Zoran, ISTENIČ, Janka, KNIFIC, Timotej, LENGAR, Igor, RANT, Andrej. Neutron radiography examination of objects belonging to the cultural heritage. Applied Radiation and Isotopes, ISSN 0969-8043. 2006, vol. 64, str. 7-12. [COBISS.SI-ID 19648807].  |

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| **UČNI NAČRT PREDMETA / COURSE SYLLABUS** |
| **Predmet:** | **VARNOSTNE ANALIZE** |
| **Course title:** | **SAFETY ASSESSMENT** |
|  |  |  |  |
| **Študijski program in stopnja****Study programme and level** | **Študijska smer****Study field** | **Letnik****Academic year** | **Semester****Semester** |
| ENERGETIKA, 2. STOPNJA |  | **2** | **1** |
| ENERGY TECHNOLOGY,2.degree |  | **2** | **1** |
|  |
| **Vrsta predmeta / Course type** | Izbirni/Elective |
|  |  |
| **Univerzitetna koda predmeta / University course code:** | M |
|  |
| **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:** | **IVAN KODELI** |
|  |
| **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):** |
| Tveganja, povezana z jedrskimi objekti, in obvladovanje tveganj.Osnovna merila za projektiranje varnostnih, varovalnih in pomožnih sistemov. Varnostni razredi in pomembnejša zaporedja nezgodnih dogodkov.Verjetnostne varnostne analize: cilji, metode in rezultati treh nivojev verjetnostnih varnostnih analiz.Deterministične varnostne analize: poenostavljeni modeli značilnih nezgod, s poudarkom na tlačnovodnih reaktorjih, konservativni vs. »best estimate« pristop z upoštevanjem negotovosti.Verifikacija in validacija računskih modelov in programov. |  | Nuclear risks and risk management. Basic design criteria for protection system, engineered safety features and auxiliary systems. Safety classes and critical accident sequences Probabilistic Safety Assessment (PsA): Aims, methods and results of the three levels of PRA. Deterministic safety assessment: Simplified models of typical accidents, main focus on Pressurized Water Reactors, conservative vs. best estimate + uncertainty analysis approach. Verification and validation of computer models and codes. |
| **Temeljni literatura in viri / Readings:** |
| Probabilistic risk assessment and management for engineers and scientists / Hiromitsu Kumamoto, Ernest J. Henley. - 2nd ed. - New York : IEEE Press, cop. 1996.Nuclear engineering : theory and technology of commercial nuclear power / Ronald Allen Knief. - [2nd ed.]. - New York : Taylor & Francis, cop. 1992.Deterministic Safety Analysis for Nuclear Power Plants, IAEA Safety Standards Ssries No. SSG-2, IAEA 2009 |
| **Cilji in kompetence:** |  | **Objectives and competences:** |
| Spoznati tveganja, ki jih prinašajo jedrske naprave, osnovne metode za ocenjevanje tveganj in osnove obvladovanja teh tveganj. |  | Learn about nuclear risks, basic estimation methods and basic risk management strategies. |
| **Predvideni študijski rezultati:** |  | **Intended learning outcomes:** |
| Znanje in razumevanje:Vzroki, ocenjevanje in obvladovanje tveganj v jedrski industriji. |  | Knowledge and Understanding:Causes, estimation and management of risks in nuclear industry. |
| Prenesljive/ključne spretnosti in drugi atributi:Znanje je prenosljivo v druge industrijske panoge. |  | Transferable/Key Skills and other attributes:The knowledge is applicable in other industrial branches. |
| **Metode poučevanja in učenja:** |  | **Learning and teaching methods:** |
| Predavanja.Vaje. |  | Lectures.Tutorial. |
| **Načini ocenjevanja:** | Delež (v %) /Weight (in %) | **Assessment:** |
| Način (pisni izpit, ustno izpraševanje, naloge, projekt)* projekt
* ustni izpit
 | **60****40** | Type (examination, oral, coursework, project):* project
* oral exam
 |
| **Reference nosilca / Lecturer's references:**  |
| I. Kodeli, S. Slavič, SUSD3D Computer Code as Part of the XSUN-2017 Windows Interface Environment for Deterministic Radiation Transport and Cross Section Sensitivity-Uncertainty Analysis, Science and Technology of Nuclear Installations (in press).I. Kodeli, Combined use of k-effective and beta-effective measurements for nuclear data validation and improvement, Proc. ND2016, Int. Conf. On Nuclear Data for Science and Technology, 11-16/09/2016, Bruges, Belgium, EPJ Web of Conferences.I. Kodeli, K. Kondo, R.L. Perel, U. Fischer, Cross-Section Sensitivity and Uncertainty Analysis of the FNG Copper Benchmark Experiment, *Fusion Engineering and Design*, **109-111** (2016) 1222-1226.I. Kodeli, W. Zwermann, Evaluation of Uncertainties in eff by Means of Deterministic and Monte Carlo Methods, *Nuclear Data Sheets* **118** (2014) 370-373.I. Kodeli, A. Milocco, P. Ortego, E. Sartori, 20 Years of SINBAD (Shielding Integral Benchmark Archive and Database), *Progress in Nuclear Science and Technology*, **4** (2014) pp. 308-311.I. Kodeli, Sensitivity and Uncertainty in the Effective Delayed Neutron Fraction (eff), *Nuclear Instruments and Methods in Physics Research A* **715**}(2013)70-78.I. Kodeli, G. Rimpault, P. Dufay, Y. Peneliau, J. Tommasi, E. Fridman, W. Zwermann, A. Aures, E. Ivanov, K. Ivanov, Y. Nakahara, T. Ivanova, J. Gulliford, Uncertainty Analysis of Kinetic Parameters for Design, Operation and Safety Analysis of SFRs, Proc. Int. Conf. on Fast Reactors and Related Fuel Cycles: Next Generation Nuclear Systems for Sustainable Development (FR17), 26-29 June 2017, Yekaterinburg, RF.G. Rimpault, L. Buiron, N. E. Stauff, T. K. Kim, T. A. Taiwo, Y-K Lee, A. Aures, F. Bostelmann, E. Fridman, A. Kereszturi, I.-A. Kodeli, K. Mikityuk, A. Peregudov, Y. Nakahara, J. Dyrda, T. Ivanova, Objectives and Status of the OECD/NEA sub-group on Uncertainty Analysis in Modelling (UAM) for Design, Operation and Safety Analysis of SFRs (SFR-UAM), Proc. Int. Conf. on Fast Reactors and Related Fuel Cycles: Next Generation Nuclear Systems for Sustainable Development (FR17), 26-29 June 2017, Yekaterinburg, RF..I. Kodeli, Experience in Using the S/U Analysis for Basic Data Validation and Other Fission/Fusion Reactor Applications, Int. Expert Conf. on Nuclear Technology, May 16-17, Berlin.I. Kodeli, Nuclear Data and Code Testing Using the Radiation Shielding Experiments in SINBAD, M&C 2017 – Int. Conf. on Math. & Comput. Meth. Applied to Nucl.Sci.& Eng., Jeju, Korea, April 16-20, 2017 (2017).I. Kodeli, G. Žerovnik, A. Milocco, Examples of Recent Use of SINBAD Database for Nuclear Data and Code Validation, Proc. ICRS-13 & RPSD-2016 Conference, Paris, Oct. 3-6, 2016. |