|  |
| --- |
| **UČNI NAČRT PREDMETA / COURSE SYLLABUS** |
| **Predmet:** | **NAVIDEZNA OKOLJA** |
| **Course title:** | **VIRTUAL ENVIRONMENTS** |
|  |  |  |  |
| **Študijski program in stopnja****Study programme and level** | **Študijska smer****Study field** | **Letnik****Academic year** | **Semester****Semester** |
| ENERGETIKA, 1. stopnja |  | 3 | 1 |
| ENERGY TECHNOLOGY, 1.degree |  | 3 | 1 |
|  |
| **Vrsta predmeta / Course type** | Izbirni/Elective |
|  |  |
| **Univerzitetna koda predmeta / University course code:** | V |
|  |
| **Predavanja****Lectures** | **Seminar****Seminar** | **Vaje****Tutorial** | **Klinične vaje****work** | **Druge oblike študija** | **Samost. delo****Individ. work** |  | **ECTS** |
| **25** |  | **30** |  |  | **65** |  | **4** |
| **AV** | **LV** | **RV** |  |
|  | **10** | **20** |  |
|  |
| **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:** |
| Ni pogojev. |  | None. |
| **Vsebina:**  |  | **Content (Syllabus outline):** |
| Osnove, namen in možnosti navideznih okolij na področju inženiringa, navidezna resničnost, virtualni prototipi.Kreiranje objektov v navideznem okolju: VRML, X3DPrenos CAD objektov v navidezno okolje. Vzvratni inženiring.Metode in tehnike hitre izdelave prototipov (z dodajanjem materiala, z odvzemanjem materiala, litje, …) in njihove značilnosti. |  | Introduction, purpose and possibilities of virtual environments in engineering, virtual reality, virtual prototyping.Creation of objects in virtual environment: VRML, X3DTransfering of CAD objects into virtual environment.Reverse engineering.Methods and techniques for rapid prototyping (adding material, cutting, casting …) and their characteristics. |
| **Temeljni literatura in viri / Readings:** |
| * [M. Mihelj](http://link.springer.com/search?facet-creator=%22Matja%C5%BE+Mihelj%22), [D.Novak](http://link.springer.com/search?facet-creator=%22Domen+Novak%22), [S. Beguš](http://link.springer.com/search?facet-creator=%22Samo+Begu%C5%A1%22): Virtual Reality Technology and Applications, Springer, 2014
* [Klajnšek, G.](http://cobiss4.izum.si/scripts/cobiss?ukaz=SEAL&mode=5&id=1413537621549116&PF=AU&term=%22Klajn%C5%A1ek,%20Gregor%22), [Žalik, B.:](http://cobiss4.izum.si/scripts/cobiss?ukaz=SEAL&mode=5&id=1413537621549116&PF=AU&term=%22%C5%BDalik,%20Borut%22)  Standard VRML : skripta, FERI, 2002
* C. K. Chua, K. F. Leong, C. S. Lim: Rapid Prototyping: Principles and Applications, World Scientific Publishing, 2010.
* R.W.Messler: Reverse engineering : mechanisms, structures, systems, and materials, McGraw-Hill Education, 2014
* Spletni viri/Web sources
 |
| **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:** |
| Znanje in razumevanje:Koncept zaščite in hierahičnega vodenja, Razumevanje in uporaba strojne in programske opreme. |  | Knowledge and understanding:Concept 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:** |
| frontalna predavanja, vaje-praktično delo na računalniških in laboratorijskih vajah. |  | frontal lectures, tutorials-practical work in computer room and laboratory. |
| **Načini ocenjevanja:** | Delež (v %) /Weight (in %) | **Assessment:** |
| Način (pisni izpit, ustno izpraševanje, naloge, projekt)* domače naloge,
* projekt,
* teoretični del izpita (e-vprašalnik)
 | **20****40****40** | Type (examination, oral, coursework, project):* homework,
* course work report,
* theoretical examination (e-kviz).
 |
| **Reference nosilca / Lecturer's references:**  |
| 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, N. (ur.). *Communications World*, (Electrical and computer engineering series). [S.l.]: WSES Press, cop. 2001, str. 341-345. [COBISS.SI-ID [6384406](http://cobiss.izum.si/scripts/cobiss?command=DISPLAY&base=COBIB&RID=6384406)] JEZERNIK, Anton, HREN, Gorazd. A solution to integrate computer-aided design (CAD) and virtual reality (VR) databases in design and manufacturing processes. *The international journal of advanced manufacturing technology*, ISSN 0268-3768, Dec. 2003, vol. 22, no 11/12, str. 768-774. [COBISS.SI-ID [8517398](http://cobiss.izum.si/scripts/cobiss?command=DISPLAY&base=COBIB&RID=8517398)], [[JCR](http://www.cobiss.si/scripts/cobiss?command=SEARCH&base=jcr&select=(sc=0268-3768+and+PY=2003)), [SNIP](http://www.cobiss.si/scripts/cobiss?command=SEARCH&base=snip&select=(sc=0268-3768+and+PY=2003)), [WoS](http://gateway.isiknowledge.com/gateway/Gateway.cgi?GWVersion=2&SrcAuth=Alerting&SrcApp=Alerting&DestApp=WOS&DestLinkType=FullRecord&UT=000187129000002) do 13. 6. 2015: št. citatov (TC): 14, čistih citatov (CI): 13, normirano št. čistih citatov (NC): 25, [Scopus](http://www.scopus.com/inward/record.url?partnerID=2dRBettD&eid=2-s2.0-0348167559) do 13. 5. 2015: št. citatov (TC): 37, čistih citatov (CI): 36, normirano št. čistih citatov (NC): 71] HREN, Gorazd. Web-based environment for mechanism simulation integrated with CAD system. *Engineering with computers*, ISSN 0177-0667, 2010, vol. 26, no. 2, str. 137-148, doi: [10.1007/s00366-009-0146-1](http://dx.doi.org/10.1007/s00366-009-0146-1). [COBISS.SI-ID[1024017244](http://cobiss.izum.si/scripts/cobiss?command=DISPLAY&base=COBIB&RID=1024017244)], [[JCR](http://www.cobiss.si/scripts/cobiss?command=SEARCH&base=jcr&select=(sc=0177-0667+and+PY=2010)), [SNIP](http://www.cobiss.si/scripts/cobiss?command=SEARCH&base=snip&select=(sc=0177-0667+and+PY=2010)), [WoS](http://gateway.isiknowledge.com/gateway/Gateway.cgi?GWVersion=2&SrcAuth=Alerting&SrcApp=Alerting&DestApp=WOS&DestLinkType=FullRecord&UT=000275953000005) do 26. 4. 2010: št. citatov (TC): 0, čistih citatov (CI): 0, normirano št. čistih citatov (NC): 0, [Scopus](http://www.scopus.com/inward/record.url?partnerID=2dRBettD&eid=2-s2.0-77954818899) do 17. 4. 2013: št. citatov (TC): 1, čistih citatov (CI): 1, normirano št. čistih citatov (NC): 1] 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)]  |

|  |
| --- |
| **UČNI NAČRT PREDMETA / COURSE SYLLABUS** |
| **Predmet:** | **LOGISTIKA**  |
| **Course title:** | **LOGISTICS**  |
|  |  |  |  |
| **Študijski program in stopnja****Study programme and level** | **Študijska smer****Study field** | **Letnik****Academic year** | **Semester****Semester** |
| ENERGETIKA, 1. stopnja |  | 3 | 1 |
| ENERGY TECHNOLOGY, 1.degree |  | 3 | 1 |
|  |
| **Vrsta predmeta / Course type** | Izbirni/Elective |
|  |  |
| **Univerzitetna koda predmeta / University course code:** | V |
|  |
| **Predavanja****Lectures** | **Seminar****Seminar** | **Vaje****Tutorial** | **Klinične vaje****work** | **Druge oblike študija** | **Samost. delo****Individ. work** |  | **ECTS** |
| **25** |  | **30** |  |  | **65** |  | **4** |
| **AV** | **LV** | **RV** |  |
|  | **15** | **15** |  |
|  |
|  |
| **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:** |
| Ni pogojev. |  | None. |
| **Vsebina:**  |  | **Content (Syllabus outline):** |
| * pregled oskrbnih sistemov
* oskrbne verige in globalizacija
* logistika in elementi logističnih sistemov
* transportni sistemi zunanje in notranje logistike
* skladiščenje (metode in strategije)
* komisioniranje (metode in strategije)
* embalaža in povratna logistika
* informacijska podpora logistiki
 |  | * introduction to supply systems
* supply chains overview and globalization
* logistics and elements of logistics systems
* transport systems of internal and external logistics
* warehousing (methods and strategies)
* order-picking (methods and strategies)
* packaging and reverse logistics
* information systems in logistics
 |

|  |
| --- |
| **Temeljni literatura in viri / Readings:** |
| * + - * Potrč, T.Lerher: Skladiščno poslovanje, Fakulteta za logistiko, Univerza v Mariboru, 2007
* G.Rak: Logistika notranjega transporta in skladiščenja, Zavod IRC, Ljubljana, 2011
* G.Ghiani, G.Laorte,R.Musmanno: Introduction to logistics systems planning and control, 2nd edition, John Wiley & Sons, 2003
* GS1 standards, www.gs1.org/standards
* E.Vatovec Krmac: Informacijska podpora logističnih procesov, Fakulteta za pomorstvo in promet, Univerza v Ljubljani, 2010
* K. Kavčič; Oskrbne verige, logistika in nabava. ZVS: Univerza v Mariboru, 2011.
 |
| **Cilji in kompetence:** |  | **Objectives and competences:** |
| Osnovni namen predmeta je seznaniti študente s pomenom logistike v industrijskem, družbenem in gospodarskem sistemu, še posebej pa v oskrbi energetskih procesov.  |  | The basic purpose of the course is to acquaint the students with the meaning of logistics in industrial, social and economic system, especially in the energetics processes.  |
| **Predvideni študijski rezultati:** |  | **Intended learning outcomes:** |
| Znanje in razumevanje:* osnovnih oskrbovalnih sistemov,
* logističnih in transportnih sistemov,
* razumevanje obratovalnih zahtev in posebnosti,
* podpora informacijskih sistemov;
 |  | Knowledge and understanding:* basic supply systems process
* logistic and transport systems,
* understanding basic demands and specialties
* IT systems support;
 |
|  |  |  |
| **Metode poučevanja in učenja:** |  | **Learning and teaching methods:** |
| * frontalno učenje
* e-učenje
* delo v laboratoriju
 |  | * frontal learning
* e-learning
* lab work
 |
| **Načini ocenjevanja:** | Delež (v %) /Weight (in %) | **Assessment:** |
| Način (pisni izpit, ustno izpraševanje, naloge, projekt)* domača naloga
* pisni izpit
* ustni izpit ali e-kviz
 | **10****45****45** | Type (examination, oral, coursework, project):* homework work
* written examination
* oral examination or e-quiz
 |
| **Reference nosilca / Lecturer's references:**  |
| HREN, Gorazd, *Oskrbni sistemi*, zapiski predavanj, Fakulteta za energetiko, 2014 (https://estudij.um.si/course/view.php)HREN, Gorazd, PREDIN, Andrej. Visualisation of processes in warehouse on website with X3D. V: AYDIN, Ulviyye (ur.). *Maritime logistics : the new port projects of Turkey : proceedings*. Izmir: University: Logistics Association. 2015, str. 215-222. [COBISS.SI-ID [86071553](https://plus.si.cobiss.net/opac7/bib/86071553?lang=sl)] JESIH, Jaka, DROBNE, Matej, LERHER, Tone, POTRČ, Iztok, HREN, Gorazd. Logistics analysis of container housing units assembly. V: 7th International Conference on Computer Aided Design and Manufacturing, September 22nd-26th 2009, Hvar, Croatia. OBSIEGER, Boris (ur.). *CADAM 2009 : proceedings*. Rijeka: Zigo, 2009, str. 25-26, ilustr. [COBISS.SI-ID [13572374](http://cobiss.izum.si/scripts/cobiss?command=DISPLAY&base=COBIB&RID=13572374)] HREN, Gorazd, DROBNE, Matej, JESIH, Jaka, POTRČ, Iztok. Web-framework for cooperation in product evaluation. V: 7th International Conference on Computer Aided Design and Manufacturing, September 22nd-26th 2009, Hvar, Croatia. OBSIEGER, Boris (ur.). *CADAM 2009 : proceedings*. Rijeka: Zigo, 2009, str. 19-20, ilustr. [COBISS.SI-ID [13572118](http://cobiss.izum.si/scripts/cobiss?command=DISPLAY&base=COBIB&RID=13572118)]  |

|  |
| --- |
| **UČNI NAČRT PREDMETA / COURSE SYLLABUS** |
| **Predmet:** | **MODELIRANJE ENERGETSKIH STROJEV IN NAPRAV** |
| **Course title:** | **MODELING OF POWER MACHINES AND DEVICES** |
|  |  |  |  |
| **Študijski program in stopnja****Study programme and level** | **Študijska smer****Study field** | **Letnik****Academic year** | **Semester****Semester** |
| ENERGETIKA, 1. stopnja |  | 3 | 1 |
| ENERGY TECHNOLOGY, 1.degree |  | 3 | 1 |
|  |
| **Vrsta predmeta / Course type** | Izbirni/Elective |
|  |  |
| **Univerzitetna koda predmeta / University course code:** | V |
|  |
| **Predavanja****Lectures** | **Seminar****Seminar** | **Vaje****Tutorial** | **Klinične vaje****work** | **Druge oblike študija** | **Samost. delo****Individ. work** |  | **ECTS** |
| **25** |  | **30** |  |  | **65** |  | **4** |
| **AV** | **LV** | **RV** |  |
|  | **15** | **15** |  |
|  |
| **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:** |
| Ni pogojev. |  | None. |
| **Vsebina:**  |  | **Content (Syllabus outline):** |
| Predavanja:Podpora in vloga CAx tehnologij v življenjskem ciklu izdelka s poudarkom na procesu modeliranja.Metode geometrijskega modeliranja teles in predstavitve modelov s teoretskimi osnovami iz računalniške grafike. Standardi za prenos podatkov med CAx sistemi (virtualna okolja, hitra izdelava prototipov).Računalniške vajeZahtevnejše računalniško geometrijsko modeliranje volumskih teles in ploskev.Sestavljanje sklopov z relacijami in povezovanje parametrov komponent.Upodabljanje in fizikalne lastnosti modelov.Kinematične analize mehanizmov. |  | Lectures:The role and support of the CAx technologies in product life-cycle focused on modeling process.Geometrical modeling and model representation with theoretical background of computer graphics.Standard data transfer between CAx applications (virtual environment, rapid prototyping).TutorialsAdvanced computer geometrical modeling of solids and surfaces.Creation of assemblies with relations and parts parameters coupling.Rendering and Physical characteristic of models.Kinematics analyses of mechanisms. |
| **Temeljni literatura in viri / Readings:** |
| J. Duhovnik, I. Demšar, P. Drešar: Modeliranje z značilkami na osnovi SolidWorks, Univerza v Ljubljani, Fakulteta za strojništvo, 2014Chang, Kuang-Hua: Product design modeling using CAD/CAE, Elsevier Academic Press, 2014Michael E. Mortemson, Geometric Modeling, Third Edition, Industrial Press, New York 2006Spletni viri/Web sources |
| **Cilji in kompetence:** |  | **Objectives and competences:** |
| Študent pridobi znanja s področja modeliranja z uporabo CAx sistemov; modeliranje kompleksnih elementov, sestavljanja v sklope, kinematične analize mehanizmov in standarde za prenos podatkov. |  | Student will be able to model with CAx systems: advanced modelling, assembly, kinematical analyses of mechanisms and standard data transfer. |
| **Predvideni študijski rezultati:** |  | **Intended learning outcomes:** |
| Znanje in razumevanje:Študent bo sposoben načrtovati in izdelati geometrijo zahtevnih elementov in izvesti osnovne analize. |  | Knowledge and understanding:Student will be able to design advanced geometrical elements and basic analyses. |
| Prenesljive/ključne spretnosti in drugi atributi:Prenos teorije na reševanje praktičnih primerov. |  | Transferable/Key Skills and other attributes:The ability to apply theory and solving practical examples. |
| **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 prakseProjekt: 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.Coursework: 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)* domače naloge,
* projekt,
* teoretični del izpita (e-vprašalnik)
 | **20****40****40** | Type (examination, oral, coursework, project):* homework,
* course work report,
* theoretical examination (e-kviz).
 |

|  |
| --- |
| **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. Web-based environment for mechanism simulation integrated with CAD system. *Engineering with computers*, ISSN 0177-0667, 2010, vol. 26, no. 2, str. 137-148, doi: [10.1007/s00366-009-0146-1](http://dx.doi.org/10.1007/s00366-009-0146-1). [COBISS.SI-ID[1024017244](http://cobiss.izum.si/scripts/cobiss?command=DISPLAY&base=COBIB&RID=1024017244)], [[JCR](http://www.cobiss.si/scripts/cobiss?command=SEARCH&base=jcr&select=(sc=0177-0667+and+PY=2010)), [SNIP](http://www.cobiss.si/scripts/cobiss?command=SEARCH&base=snip&select=(sc=0177-0667+and+PY=2010)), [WoS](http://gateway.isiknowledge.com/gateway/Gateway.cgi?GWVersion=2&SrcAuth=Alerting&SrcApp=Alerting&DestApp=WOS&DestLinkType=FullRecord&UT=000275953000005) do 26. 4. 2010: št. citatov (TC): 0, čistih citatov (CI): 0, normirano št. čistih citatov (NC): 0, [Scopus](http://www.scopus.com/inward/record.url?partnerID=2dRBettD&eid=2-s2.0-77954818899) do 17. 4. 2013: št. citatov (TC): 1, čistih citatov (CI): 1, normirano št. čistih citatov (NC): 1] JEZERNIK, Anton, HREN, Gorazd. A solution to integrate computer-aided design (CAD) and virtual reality (VR) databases in design and manufacturing processes. *The international journal of advanced manufacturing technology*, ISSN 0268-3768, Dec. 2003, vol. 22, no 11/12, str. 768-774. [COBISS.SI-ID [8517398](http://cobiss.izum.si/scripts/cobiss?command=DISPLAY&base=COBIB&RID=8517398)], [[JCR](http://www.cobiss.si/scripts/cobiss?command=SEARCH&base=jcr&select=(sc=0268-3768+and+PY=2003)), [SNIP](http://www.cobiss.si/scripts/cobiss?command=SEARCH&base=snip&select=(sc=0268-3768+and+PY=2003)), [WoS](http://gateway.isiknowledge.com/gateway/Gateway.cgi?GWVersion=2&SrcAuth=Alerting&SrcApp=Alerting&DestApp=WOS&DestLinkType=FullRecord&UT=000187129000002) do 13. 6. 2015: št. citatov (TC): 14, čistih citatov (CI): 13, normirano št. čistih citatov (NC): 25, [Scopus](http://www.scopus.com/inward/record.url?partnerID=2dRBettD&eid=2-s2.0-0348167559) do 13. 5. 2015: št. citatov (TC): 37, čistih citatov (CI): 36, normirano št. čistih citatov (NC): 71] HREN, Gorazd, PREDIN, Andrej, ŽAGAR, Ivan. Generic model of wind turbine blades = Generični model lopatic vetrne turbine. *Journal of energy technology*, ISSN 1855-5748. [Tiskana izd.], feb. 2013, vol. 6, iss. 1, str. 61-68, ilustr. <http://www.fe.um.si/en/jet.html>. [COBISS.SI-ID [1024133468](http://cobiss.izum.si/scripts/cobiss?command=DISPLAY&base=COBIB&RID=1024133468)] GOLOB, Borut, JEZERNIK, Anton, HREN, Gorazd. A feature based approach for conceptual design. 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. 483-488. [COBISS.SI-ID [7112726](http://cobiss.izum.si/scripts/cobiss?command=DISPLAY&base=COBIB&RID=7112726)]  |

|  |
| --- |
| **UČNI NAČRT PREDMETA / COURSE SYLLABUS** |
| **Predmet:** | **ENERGETIKA IN OKOLJSKO INŽENIRSTVO** |
| **Course title:** | **ENERGY TECHNOLOGY AND ENVIRONMENTAL ENGINEERING** |
|  |  |  |  |
| **Študijski program in stopnja****Study programme and level** | **Študijska smer****Study field** | **Letnik****Academic year** | **Semester****Semester** |
| ENERGETIKA, 1. stopnja |  | 3 | 1 |
| ENERGY TECHNOLOGY, 1.degree |  | 3 | 1 |
|  |
| **Vrsta predmeta / Course type** | Izbirni/Elective |
|  |  |
| **Univerzitetna koda predmeta / University course code:** | V |
|  |
| **Predavanja****Lectures** | **Seminar****Seminar** | **Vaje****Tutorial** | **Klinične vaje****work** | **Druge oblike študija** | **Samost. delo****Individ. work** |  | **ECTS** |
| **25** |  | **30** |  |  | **65** |  | **4** |
| **AV** | **LV** | **RV** |  |
| **20** | **10** |  |  |
|  |
| **Nosilec predmeta / Lecturer:** | **IVAN ŽAGAR** |
|  |
| **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):** |
| * Zakonski predpisi s področja varstva okolja.
* Načrtovanje in prostorsko umeščanje okoljskiih objektov in naprav.
* Emisije-imisije. Nadzor onesnaževanja, monitoring.
* Načrtovanje komunalne infrastrukture za odpadne vode in ravnanje s trdnimi odpadki.
* Obravnava plinskih izpustov, emisije in imisije industrije, prometa,kurišč in drugih virov.
* Obravnava nevarnih odpadkov: radioktivni odpadki, industrijski, javni sektor. Zbiranje,odstranjevanje, skladiščenje
* Toplotno obremenjevanje oklja
* Monitoring in načrtovanje toplotne zaščite objektov in naprav.Standardi in normativi
* Hrup, vpliv na okolico,merjenje in zaščita. Standardi in normativi
* Svetlobno onesnaženje. Sandardi in normativi
* Ekonomsko vrednotenje procesov varovanja oklja, optimizacija stroškov. Primerjava stroškov preventivnih in sanacijskih ukrepov varovanja okolja. Koncesije izrabe naravnih virov.
 |  | * Environment protection legislation.
* Planning and spatial positioning of the surrounding objects and devices.
* Emissions-Imissions. Pollution control, monitoring
* Planning a municipal waste water infrastructure and handling solid waste.
* Discusiscussing gas emissions, emissions and imissions of industry, traffic, fireplaces and other sources.
* Treatment of hazardous waste: radioactive waste, industrial, public sector. Collection, disposal, storage.
* Heat load on the shaft.
* Monitoring and planning of thermal protection of objects and devices. Standards and norms.
* Noise, environmental impact, measurement and protection. Standards and norms.
* Light pollution. Standards and norms.
* Economic valuation of escalation processes, cost optimization. Comparison of costs of preventive and remedial measures of environmental protection. Concessions of the use of natural resources.
 |
| **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, postopki s področja načrtovanja ter ekonomskim preračunom stroškov ravnanja in odstranjevanja energetskimi odpadki. |  | Students get acquainted with the legislation, standards and normatives from the field of environment, planning procedures and economic evaluation of costs treatment and disposal of energy waste. |
| **Predvideni študijski rezultati:** |  | **Intended learning outcomes:** |
| Znanje in razumevanje:• tehnoloških postopkov varovanja tal, voda,  zraka in varstvo pred hrupom• zakonskih predpisov, standardov in  normativov•načrtovanja ustrezne infrastrukture• 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•planning the appropriate infrastructure• 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:**  |
| 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]TKAVC SMOGAVEC, Janja. (mentor: I.Žagar) Prenos pristojnosti izvajanja lokalnih gospodarskih javnih služb s področja energetike na državo : magistrska naloga. Maribor: [J. Tkavc Smogavec], 2016. 115 f. <https://dk.um.si/IzpisGradiva.php?id=61081>. [COBISS.SI-ID [5231147](https://plus.si.cobiss.net/opac7/bib/5231147?lang=sl)]ŽAGAR, Ivan. The optimization options of water supply systems in terms of energy consumption = Možnosti optimizacije vodovodnih sistemov z vidika porabe energije. Journal of energy technology, ISSN 1855-5748. [Tiskana izd.], Nov. 2014, vol. 7, iss. 4, str. 59-76, graf. prikazi, zvd., ilustr. <http://www.fe.um.si/images/jet/JET_november_2014-koncni.pdf>. [COBISS.SI-ID [1024209756](https://plus.si.cobiss.net/opac7/bib/1024209756?lang=sl)] |

|  |
| --- |
| **UČNI NAČRT PREDMETA / COURSE SYLLABUS** |
| **Predmet:** | **TRAJNOSTNO NAČRTOVANJE OBJEKTOV** |
| **Course title:** | **SUSTAINABLE PLANNING OF OBJECTS** |
|  |  |  |  |
| **Študijski program in stopnja****Study programme and level** | **Študijska smer****Study field** | **Letnik****Academic year** | **Semester****Semester** |
| ENERGETIKA, 1. stopnja |  | 3 | 1 |
| ENERGY TECHNOLOGY, 1.degree |  | 3 | 1 |
|  |
| **Vrsta predmeta / Course type** | Izbirni /Elective |
|  |  |
| **Univerzitetna koda predmeta / University course code:** | V |
|  |
| **Predavanja****Lectures** | **Seminar****Seminar** | **Vaje****Tutorial** | **Klinične vaje****Work** | **Druge oblike študija** | **Samost. delo****Individ. work** |  | **ECTS** |
| **25** |  | **30** |  |  | **65** |  | **4** |
| **AV** | **LV** | **RV** |  |
| **20** | **10** |  |  |
|  |
| **Nosilec predmeta / Lecturer:** | **IVAN ŽAGAR** |
|  |
| **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):** |
| * Normativn okvir trajnostnega načrtovanja (PURES)
* Trajnostno urbano načrtovanje energetskih konceptov prostorskih enot
* Analiza toplotnega obremenevanja okolja, objektov in naprav
* Meritve in načrtovanje topolotne zaščite objektov in naprav.
* Trajnostni vidik optimiranja energetske učinkovitosti in drugih parametrov objektov in naprav.
* Ekonomsko vrednotenje in optimizacija stroškov trajnostnih energetskih ukrepov.
 |  | • Normative Framework for sustainable  planning (PURES).• Sustainable urban planning of energy  concepts of spatial units.• Analysis of the heat load of the environment,  facilities and devices.• Measurements and design of topolite  protection of objects and devices.• Sustainable aspect of optimizing energy  efficiency and other parameters of facilities  and devices.• Economic valuation and optimization of the  costs of sustainable energy measures. |
| **Temeljni literatura in viri / Readings:** |
| Richard O. Gilbert: Statistical Methods for Environmental Pollution Monitoring, Wiley, 1987, ISBN: 0471288780.Barney L. Capehart, Wayne C. Turner, William J. Keneddy: Guide to Energy Manegmant, 4th edition, The Fairmont Press, 2003.Turner W.: Energy manegment handbook, Fairmont Press, Lilburn, 2001L.D. Danny Harvey: A handbook on low –energy buildings and district- energy systems Fundamentals, technniques and examples, Earthscan Publications Ltd, 2006 |
| **Cilji in kompetence:** |  | **Objectives and competences:** |
| Študenti se seznanijo z trajnostnim vidikom načrtovanja in optimalne gradnje objektov in naprav. |  | Students get to know the sustainable aspect of planning and optimal construction of facilities and devices. |
| **Predvideni študijski rezultati:** |  | **Intended learning outcomes:** |
| Znanje in razumevanje:• pravilne izbire modelov trajnostnega  načrtovanja objektov in naprav* razumevanje optimizacije stroškov energetskih ukrepov na objektih in napravah iz vidika tajnostnega pristopa

Prenesljive/ključne spretnosti in drugi atributi:• uspešno delo na energetskih razvojno  raziskovalnih projektih |  | Knowledge and understanding:• The correct choice of sustainable models    of planning of facilities and installations• Understanding the optimization of the cost of  energy measures on facilities and devices in  terms of sustainable approachTransferable/Key Skills and other attributes:* successful work on energy development

  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:**  |
| HREN, Gorazd, ŽAGAR, Ivan. CAD mechanism simulations via web environments = Simulacije mehanizmov CAD sistemov na spletu. Journal of energy technology, Nov. 2012, vol. 5, iss. 4, str. 37-49. http://www.fe.uni-mb.si/images/stories/jet/e-jet/revija\_jet\_-\_volume\_5\_-\_issue\_4\_-\_november\_-\_za\_internet.pdf. [COBISS.SI-ID 1024118620] ŽAGAR, Ivan. The optimization options of water supply systems in terms of energy consumption = Možnosti optimizacije vodovodnih sistemov z vidika porabe energije. Journal of energy technology, ISSN 1855-5748. [Tiskana izd.], Nov. 2014, vol. 7, iss. 4, str. 59-76, graf. prikazi, zvd., ilustr. <http://www.fe.um.si/images/jet/JET_november_2014-koncni.pdf>. [COBISS.SI-ID [1024209756](https://plus.si.cobiss.net/opac7/bib/1024209756?lang=sl)]ŽAGAR, Ivan. Robno-območna integralska metoda za dinamiko tekočin laminarnega in turbulentnega toka : doktorska disertacija. Maribor: [I. Žagar], 1992. 133 str., ilustr. [COBISS.SI-ID [13232133](https://plus.si.cobiss.net/opac7/bib/13232133?lang=sl)]  |

|  |
| --- |
| **UČNI NAČRT PREDMETA / COURSE SYLLABUS** |
| **Predmet:** | **OSNOVE VODIKOVIH IN METANOLOVIH TEHNOLOGIJ** |
| **Course title:** | **FUNDAMENTALS OF HYDROGEN AND METHANOL TECHNOLOGIES** |
|  |  |  |  |
| **Študijski program in stopnja****Study programme and level** | **Študijska smer****Study field** | **Letnik****Academic year** | **Semester****Semester** |
| ENERGETIKA, 1. stopnja |  | 3 | 1 |
| ENERGY TECHNOLOGY, 1.degree |  | 3 | 1 |
|  |
| **Vrsta predmeta / Course type** | Izbirni/Elective |
|  |  |
| **Univerzitetna koda predmeta / University course code:** | V |
|  |
| **Predavanja****Lectures** | **Seminar****Seminar** | **Vaje****Tutorial** | **Klinične vaje****work** | **Druge oblike študija** | **Samost. delo****Individ. work** |  | **ECTS** |
| **25** |  | **30** |  |  | **65** |  | **4** |
| **AV** | **LV** | **RV** |  |
| **20** | **10** |  |  |
|  |
| **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. Globalna ekologija in vzroki prihodnje uporabe modernih tehnologij.
2. Uvod in zgodovina nastanka vodikovih in metanolovih tehnologij.
3. Osnovna termodinamika in osnovni principi elektrokemije.
4. Pridobivanje vodika in metanola.
5. Uporaba sončne energije za pridobivanje vodika in metanola.
6. Sistemi za pretvorbo vodika in metanola v toplotno in električno energijo.
7. Tipi gorivnih celic in njihova uporaba.
8. Prednosti in slabosti gorivnih celic.
9. Konstrukcija gorivnih celic.
10. Izraba vodika in metanola v motorjih in turbinah.
11. Shranjevanje in transport vodika in metanola.
12. Alternativni preostali direktni pretvorniki energije.
13. Uporaba gorivnih celic.
14. Ekonomika v vodikovih in metanolovih tehnologijah.
15. Vzdrževanje vodikovih in metanolovih tehnologij.
 |  | 1. Global ecology and reasons of application of modern technologies.
2. Introduction and the history of fuel cells.
3. Basic thermodynamics and basic electrochemistry.
4. Hydrogen and methanol production.
5. The application of solar energy for hydrogen and methanol production.
6. Systems for hydrogen and methanol conversion into heat and electricity.
7. Types of fuel cells and their application.
8. Advantages and weaknesses of fuel cells.
9. Fuel cell system design.
10. The use of hydrogen in engines and turbines.
11. Hydrogen and methanol transport and storage.
12. Alternative other direct energy conversion machines.
13. Application of fuel cells.
14. Economy in hydrogen and methanol technologies.
15. Maintenance of hydrogen and methanol technologirs.
 |
| **Temeljni literatura in viri / Readings:** |
| F. Barbir, PEM Fuel Cells, 2013, Elsevier Academic PressR. [O'Hayre, Ryan P.](http://cobiss4.izum.si/scripts/cobiss?ukaz=FFRM&mode=5&id=1053476975797952&PF1=AU&PF2=TI&PF3=PY&PF4=KW&CS=a&PF5=CB&run=yes&SS1=%22O'Hayre,%20Ryan%20P.%22)Fuel cell fundamentals J. Wiley & Sons, cop. 2006S.I. Sandler, Chemical, Biochemical and Engineering Thermodynamics, Fourth Edition, 2006, Wiley.Handbook of fuel cells, Wiley, 2005.G. Naterer, B. Tokarz, J. Avsec, Fuel cell entropy production with ohmicheating and diffusive polarization, International Journal of Heat and Mass transfer, Vol. 49, No. 15/15, 2006.R.B. Gupta, Hydrogen fuel, CRC, 2009.G. Hoogers, Fuel Cell technology handbook, CRC, 2003.B. Sorensen , Renewable energy, 2011, Academic PressB. Wiswanathan, M. Scibioh, Fuel cells, Academic Press, 2007. |
| **Cilji in kompetence:** |  | **Objectives and competences:** |
| * Prikazati najsodobnejše trende na področju vodikovih in metanolovih tehnologij in prikazati uporabo vodikovih tehnologij v inženirski praksi
* Razviti sposobnosti študentov za samostojno in kreativno reševanje inženirskih problemov.
 |  | * To show the trends in the field of hydrogen and methanol technologies and to show the application of hydrogen technologies in engineering practice
* To further develop student's capabilities of independent thinking and creative solutions of engineering problems.
 |
| **Predvideni študijski rezultati:** |  | **Intended learning outcomes:** |
| Znanje in razumevanje:poznavanje osnovnih metod in fizikalnih principovPrenesljive/ključne spretnosti in drugi atributi:kombinirana uporaba različnih osnovnih znanj za reševanje inženirskih problemov; |  | Knowledge and understanding:knowledge of basic methods and physical principlesTransferable/Key skills and other attributes:* combined use of different fundamental skills for solution of engineering problems;
 |
| **Metode poučevanja in učenja:** |  | **Learning and teaching methods:** |
| predavanjadialogsamostojno reševanje nalogmentorsko delo pri izdelavi seminarskega dela  |  | lecturesdialogueindividual solving of problemsmentor supervision in preparing of seminar work  |
| **Načini ocenjevanja:** | Delež (v %) /Weight (in %) | **Assessment:** |
| Način (pisni izpit, ustno izpraševanje, naloge, projekt)* pisni izpit
* ustni izpit
* seminarske naloge
 | **30****50****20** | Type (examination, oral, coursework, project):* written examination
* oral examinations
* seminar work
 |
| **Reference nosilca / Lecturer's references:**  |
| NATERER, Greg F., SUPPIAH, S., STOLBERG, L., LEWIS, M., WANG, Z., DINÇER, İbrahim, ROSEN, Marc A., GABRIEL, K., SECNIK, E., EASTON, E. B., PIORO, I., LVOV, S. N., JIANG, J., MOSTAGHIMI, J., IKEDA, B. M., RIZVI, G., LU, L., ODUKOYA, A., SPEKKENS, P., FOWLER, Michael, AVSEC, Jurij. Progress of international hydrogen production network for the thermochemical Cu-Cl cycle. *Int. j. hydrogen energy*. [Print ed.], 24. Jan. 2013, vol. 38, iss. 2, str. 740-759, doi: [10.1016/j.ijhydene.2012.10.023](http://dx.doi.org/10.1016/j.ijhydene.2012.10.023). [COBISS.SI-ID [1024112220](http://cobiss.izum.si/scripts/cobiss?command=DISPLAY&base=COBIB&RID=1024112220)], [[JCR](http://www.cobiss.si/scripts/cobiss?command=SEARCH&base=jcr&select=%28sc=0360-3199+and+PY=2012%29), [WoS](http://gateway.isiknowledge.com/gateway/Gateway.cgi?GWVersion=2&SrcAuth=Alerting&SrcApp=Alerting&DestApp=WOS&DestLinkType=FullRecord&UT=000315001700003) do 15. 4. 2013: št. citatov (TC): 0, čistih citatov (CI): 0, normirano št. čistih citatov (NC): 0, [Scopus](http://www.scopus.com/inward/record.url?partnerID=2dRBettD&eid=2-s2.0-84872020150) do 18. 1. 2013: št. citatov (TC): 0, čistih citatov (CI): 0, normirano št. čistih citatov (NC): 0] NATERER, Greg F., SUPPIAH, S., STOLBERG, L., LEWIS, M., FERRANDON, M., WANG, Z., DINÇER, İbrahim, GABRIEL, K., ROSEN, Marc A., SECNIK, E., EASTON, E. B., TREVANI, L., PIORO, I., TREMAINE, P., LVOV, S. N., JIANG, J., RIZVI, G., IKEDA, B. M., LU, L., KAYE, M. H., SMITH, W. R., MOSTAGHIMI, J., SPEKKENS, P., FOWLER, Michael, AVSEC, Jurij. Clean hydrogen production with the Cu-Cl cycle - Progress of international consortium. Part 1, Experimental unit operations. *Int. j. hydrogen energy*. [Print ed.], Dec. 2011, vol. 36, iss. 24, str. 15472-15485, doi: [10.1016/j.ijhydene.2011.08.012](http://dx.doi.org/10.1016/j.ijhydene.2011.08.012). [COBISS.SI-ID [1024057436](http://cobiss.izum.si/scripts/cobiss?command=DISPLAY&base=COBIB&RID=1024057436)], [[JCR](http://www.cobiss.si/scripts/cobiss?command=SEARCH&base=jcr&select=%28sc=0360-3199+and+PY=2011%29), [WoS](http://gateway.isiknowledge.com/gateway/Gateway.cgi?GWVersion=2&SrcAuth=Alerting&SrcApp=Alerting&DestApp=WOS&DestLinkType=FullRecord&UT=000297089700001) do 21. 8. 2013: št. citatov (TC): 5, čistih citatov (CI): 5, normirano št. čistih citatov (NC): 2, [Scopus](http://www.scopus.com/inward/record.url?partnerID=2dRBettD&eid=2-s2.0-80054842781) do 21. 8. 2013: št. citatov (TC): 10, čistih citatov (CI): 10, normirano št. čistih citatov (NC): 4] NATERER, Greg F., SUPPIAH, S., STOLBERG, L., LEWIS, M., FERRANDON, M., WANG, Z., DINÇER, İbrahim, GABRIEL, K., ROSEN, Marc A., SECNIK, E., EASTON, E. B., TREVANI, L., PIORO, I., TREMAINE, P., LVOV, S. N., JIANG, J., RIZVI, G., IKEDA, B. M., LU, L., KAYE, M. H., SMITH, W. R., MOSTAGHIMI, J., SPEKKENS, P., FOWLER, Michael, AVSEC, Jurij. Clean hydrogen production with the Cu-Cl cycle - Progress of international consortium. Part 2, Simulations, thermochemical data and materials. *Int. j. hydrogen energy*. [Print ed.], Dec. 2011, vol. 36, iss. 24, str. 15486-15501, doi: [10.1016/j.ijhydene.2011.08.013](http://dx.doi.org/10.1016/j.ijhydene.2011.08.013). [COBISS.SI-ID [1024057180](http://cobiss.izum.si/scripts/cobiss?command=DISPLAY&base=COBIB&RID=1024057180)], [[JCR](http://www.cobiss.si/scripts/cobiss?command=SEARCH&base=jcr&select=%28sc=0360-3199+and+PY=2011%29), [WoS](http://gateway.isiknowledge.com/gateway/Gateway.cgi?GWVersion=2&SrcAuth=Alerting&SrcApp=Alerting&DestApp=WOS&DestLinkType=FullRecord&UT=000297089700002) do 21. 8. 2013: št. citatov (TC): 5, čistih citatov (CI): 5, normirano št. čistih citatov (NC): 2, [Scopus](http://www.scopus.com/inward/record.url?partnerID=2dRBettD&eid=2-s2.0-80054838341) do 16. 12. 2011: št. citatov (TC): 0, čistih citatov (CI): 0, normirano št. čistih citatov (NC): 0] NATERER, Greg F., SUPPIAH, S., STOLBERG, L., LEWIS, M., WANG, Z., DAGGUPATI, V., GABRIEL, K., DINÇER, İbrahim, ROSEN, Marc A., SPEKKENS, P., LVOV, S. N., FOWLER, Michael, TREMAINE, P., MOSTAGHIMI, J., EASTON, E. B., TREVANI, L., RIZVI, G., IKEDA, B. M., KAYE, M. H., LU, L., PIORO, I., SMITH, W. R., SECNIK, E., JIANG, J., AVSEC, Jurij. Canada's program on nuclear hydrogen production and the thermochemical Cu-Cl cycle. *Int. j. hydrogen energy*. [Print ed.], Oct. 2010, vol. 35, iss. 20, str. 10905-10926, doi: [10.1016/j.ijhydene.2010.07.087](http://dx.doi.org/10.1016/j.ijhydene.2010.07.087). [COBISS.SI-ID [1024027740](http://cobiss.izum.si/scripts/cobiss?command=DISPLAY&base=COBIB&RID=1024027740)], [[JCR](http://www.cobiss.si/scripts/cobiss?command=SEARCH&base=jcr&select=%28sc=0360-3199+and+PY=2010%29), [WoS](http://gateway.isiknowledge.com/gateway/Gateway.cgi?GWVersion=2&SrcAuth=Alerting&SrcApp=Alerting&DestApp=WOS&DestLinkType=FullRecord&UT=000284443200010) do 27. 8. 2013: št. citatov (TC): 16, čistih citatov (CI): 14, normirano št. čistih citatov (NC): 7, [Scopus](http://www.scopus.com/inward/record.url?partnerID=2dRBettD&eid=2-s2.0-77957348593) do 30. 7. 2013: št. citatov (TC): 21, čistih citatov (CI): 19, normirano št. čistih citatov (NC): 9] AVSEC, Jurij, NOVOSEL, Urška. Application of hydrogen technologies in combination with nuclear energy and renewable sources. V: ŠVAIĆ, Srećko (ur.), BORAS, Ivanka (ur.), DOVIĆ, Damir (ur.). Interklima 2015 : [zbornik radova], (Interklima ... (CD-ROM), ISSN 1848-0527, 2015). Zagreb: Sveučilište u Zagrebu, Fakultet strojarstva i brodogradnje, 2015, 10 str., graf. prikazi. |
| **UČNI NAČRT PREDMETA / COURSE SYLLABUS** |
| **Predmet:** | **OGREVANJE Z OBNOVLJIVIMI VIRI IN INDUSTRIJSKI OGREVALNI PROCESI** |
| **Course title:** | **HEATING WITH RENEWABLE SOURCES AND INDUSTRIAL HEATING PROCESSES** |
|  |  |  |  |
| **Študijski program in stopnja****Study programme and level** | **Študijska smer****Study field** | **Letnik****Academic year** | **Semester****Semester** |
| ENERGETIKA, 1. stopnja |  | 3 | 1 |
| ENERGY TECHNOLOGY, 1.degree |  | 3 | 1 |
|  |
| **Vrsta predmeta / Course type** | Izbirni/Elective |
|  |  |
| **Univerzitetna koda predmeta / University course code:** | V  |
|  |
| **Predavanja****Lectures** | **Seminar****Seminar** | **Vaje****Tutorial** | **Klinične vaje****work** | **Druge oblike študija** | **Samost. delo****Individ. work** |  | **ECTS** |
| **25** |  | **30** |  |  | **65** |  | **4** |
| **AV** | **LV** | **RV** |  |
| **20** | **10** |  |  |
|  |
| **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. Potenciali sončne energije, biomase in geotermalne energije v svetu in v Sloveniji.
2. Uporaba visokoentalpijske geotermalne energije.
3. Uporaba nizkoentalpijske geotermalne energije.
4. Napredni geotermalni sistemi.
5. Uporaba geotermalne energije v povezavi z nizkotemperaturnimi in industrijskimi toplotnimi črpalkami.
6. Geotermalne elektrarne.
7. Termodinamika sončnega sevanja
8. Solarni vodni ogrevalni sistemi, Naravnao cirkulacijski sistemi, sistemi s prisilno cirkulacijo.
9. Kapljevinski solarni sistemi za ogrevanje.
10. Zračni solarni sistemi za ogrevanje.
11. Solarna kogeneracija.
12. Sistemi s koncentrirano sončno energijo.
13. Uporaba sončne energije za razvlaževanje.
14. Uporaba sončne energije za razsoljevanje morske vode.
15. Proizvodnja vodika s sončno energijo.
16. Uporaba sončne energije v povezavi s klasičnimi elektrarnami.
17. ORC procesi and Kalina s solarno in geotermalno energijo.
18. Električni sistemi ogrevanja: uporovno ogrevanje, indukcijsko segrevanje, dielektrično segrevanje, IR segrevanje.
19. Ogrevanje z biomaso: klasično ogrevanje, piroliza, ogrevanje s sekanci in peleti, soproizvodnja toplote in elektrike.
20. Industrijska uporaba biomase v termoelektrarnah in kogeneracijskih enotah.
 |  | 1. Potentials of geothermal and solar energy.
2. The use of high enthalpy geothermal energy.
3. The use of low enthalpy geothermal energy.
4. Enhanced geothermal systems.
5. Low temperature and industrial heat pumps using geothermal energy.
6. Geothermal power plants.
7. Thermodynamics of solar radiation.
8. Solar water-heating systems, natural circulation systems, forced-circulation systems.
9. Liquid-based solar heating systems for buildings
10. Solar air-heating systems.
11. Solar cogeneration systems.
12. Concentrated solar power technology.
13. Solar cooling and dehumidification.
14. Solar distillation of saline water.
15. Hydrogen production with solar energy.
16. Combination of solar technology with classic power plants.
17. Organic Rankine and Kalina processes with solar and geothermal energy.
18. Electrical heating systems: resistive heating, induction heating, dielectric heating, IR heating.
19. Biomass Heating: Classical heating, pyrolysis, wood chip and pellet heating, combined heat and power.
20. Industrial use of biomass in thermal power plants and cogeneration units.
 |
| **Temeljni literatura in viri / Readings:** |
| R. Di Pippo, geothermal Power Plants, BH, 2012.E. Heugens, Geothermal energy systems J. Wiley & Sons, cop. 2012D.Y. Goswami, Principles of Solar Engineering, CRC Press, 2012.J. Voršič, J. Bratina, Elektrotermija, Univerza v Mariboru, 2000.F. Keith, D.Y. Ghoswami, Handbook of energy efficiency and renewable energy, CRC. 2007J. Avsec, M. Marčič, Termotehnika, Univerza v Mariboru, 2009. |
| **Cilji in kompetence:** |  | **Objectives and competences:** |
| * Prikazati najsodobnejše trende na področju obnovljivih virov za ogrevanje in hlajenje
* Razviti sposobnosti študentov za samostojno in kreativno reševanje inženirskih problemov.
 |  | * To show the trends in the field of renewable sources for heating and cooling…
* To further develop student's capabilities of independent thinking and creative solutions of engineering problems.
 |
| **Predvideni študijski rezultati:** |  | **Intended learning outcomes:** |
| Znanje in razumevanje:poznavanje osnovnih metod in fizikalnih principov Prenesljive/ključne spretnosti in drugi atributi:kombinirana uporaba različnih osnovnih znaza reševanje inženirskih problemov; |  | Knowledge and understanding:knowledge of basic methods and physical principlesTransferable/Key skills and other attributes:* combined use of different fundamental skills for solution of engineering problems;
 |
| **Metode poučevanja in učenja:** |  | **Learning and teaching methods:** |
| predavanjadialogsamostojno reševanje nalogmentorsko delo pri izdelavi seminarskega dela  |  | lecturesdialogueindividual solving of problemsmentor supervision in preparing of seminar work  |
| **Načini ocenjevanja:** | Delež (v %) /Weight (in %) | **Assessment:** |
| Način (pisni izpit, ustno izpraševanje, naloge, projekt)* pisni izpit
* ustni izpit
* seminarske naloge
 | **30****50****20** | Type (examination, oral, coursework, project):* written examination
* oral examinations
* seminar work
 |
| **Reference nosilca / Lecturer's references:**  |
| NATERER, Greg F., SUPPIAH, S., STOLBERG, L., LEWIS, M., WANG, Z., DINÇER, İbrahim, ROSEN, Marc A., GABRIEL, K., SECNIK, E., EASTON, E. B., PIORO, I., LVOV, S. N., JIANG, J., MOSTAGHIMI, J., IKEDA, B. M., RIZVI, G., LU, L., ODUKOYA, A., SPEKKENS, P., FOWLER, Michael, AVSEC, Jurij. Progress of international hydrogen production network for the thermochemical Cu-Cl cycle. *Int. j. hydrogen energy*. [Print ed.], 24. Jan. 2013, vol. 38, iss. 2, str. 740-759, doi: [10.1016/j.ijhydene.2012.10.023](http://dx.doi.org/10.1016/j.ijhydene.2012.10.023). [COBISS.SI-ID [1024112220](http://cobiss.izum.si/scripts/cobiss?command=DISPLAY&base=COBIB&RID=1024112220)], [[JCR](http://www.cobiss.si/scripts/cobiss?command=SEARCH&base=jcr&select=%28sc=0360-3199+and+PY=2012%29), [WoS](http://gateway.isiknowledge.com/gateway/Gateway.cgi?GWVersion=2&SrcAuth=Alerting&SrcApp=Alerting&DestApp=WOS&DestLinkType=FullRecord&UT=000315001700003) do 15. 4. 2013: št. citatov (TC): 0, čistih citatov (CI): 0, normirano št. čistih citatov (NC): 0, [Scopus](http://www.scopus.com/inward/record.url?partnerID=2dRBettD&eid=2-s2.0-84872020150) do 18. 1. 2013: št. citatov (TC): 0, čistih citatov (CI): 0, normirano št. čistih citatov (NC): 0] NATERER, Greg F., SUPPIAH, S., STOLBERG, L., LEWIS, M., FERRANDON, M., WANG, Z., DINÇER, İbrahim, GABRIEL, K., ROSEN, Marc A., SECNIK, E., EASTON, E. B., TREVANI, L., PIORO, I., TREMAINE, P., LVOV, S. N., JIANG, J., RIZVI, G., IKEDA, B. M., LU, L., KAYE, M. H., SMITH, W. R., MOSTAGHIMI, J., SPEKKENS, P., FOWLER, Michael, AVSEC, Jurij. Clean hydrogen production with the Cu-Cl cycle - Progress of international consortium. Part 1, Experimental unit operations. *Int. j. hydrogen energy*. [Print ed.], Dec. 2011, vol. 36, iss. 24, str. 15472-15485, doi: [10.1016/j.ijhydene.2011.08.012](http://dx.doi.org/10.1016/j.ijhydene.2011.08.012). [COBISS.SI-ID [1024057436](http://cobiss.izum.si/scripts/cobiss?command=DISPLAY&base=COBIB&RID=1024057436)], [[JCR](http://www.cobiss.si/scripts/cobiss?command=SEARCH&base=jcr&select=%28sc=0360-3199+and+PY=2011%29), [WoS](http://gateway.isiknowledge.com/gateway/Gateway.cgi?GWVersion=2&SrcAuth=Alerting&SrcApp=Alerting&DestApp=WOS&DestLinkType=FullRecord&UT=000297089700001) do 21. 8. 2013: št. citatov (TC): 5, čistih citatov (CI): 5, normirano št. čistih citatov (NC): 2, [Scopus](http://www.scopus.com/inward/record.url?partnerID=2dRBettD&eid=2-s2.0-80054842781) do 21. 8. 2013: št. citatov (TC): 10, čistih citatov (CI): 10, normirano št. čistih citatov (NC): 4] NATERER, Greg F., SUPPIAH, S., STOLBERG, L., LEWIS, M., FERRANDON, M., WANG, Z., DINÇER, İbrahim, GABRIEL, K., ROSEN, Marc A., SECNIK, E., EASTON, E. B., TREVANI, L., PIORO, I., TREMAINE, P., LVOV, S. N., JIANG, J., RIZVI, G., IKEDA, B. M., LU, L., KAYE, M. H., SMITH, W. R., MOSTAGHIMI, J., SPEKKENS, P., FOWLER, Michael, AVSEC, Jurij. Clean hydrogen production with the Cu-Cl cycle - Progress of international consortium. Part 2, Simulations, thermochemical data and materials. *Int. j. hydrogen energy*. [Print ed.], Dec. 2011, vol. 36, iss. 24, str. 15486-15501, doi: [10.1016/j.ijhydene.2011.08.013](http://dx.doi.org/10.1016/j.ijhydene.2011.08.013). [COBISS.SI-ID [1024057180](http://cobiss.izum.si/scripts/cobiss?command=DISPLAY&base=COBIB&RID=1024057180)], [[JCR](http://www.cobiss.si/scripts/cobiss?command=SEARCH&base=jcr&select=%28sc=0360-3199+and+PY=2011%29), [WoS](http://gateway.isiknowledge.com/gateway/Gateway.cgi?GWVersion=2&SrcAuth=Alerting&SrcApp=Alerting&DestApp=WOS&DestLinkType=FullRecord&UT=000297089700002) do 21. 8. 2013: št. citatov (TC): 5, čistih citatov (CI): 5, normirano št. čistih citatov (NC): 2, [Scopus](http://www.scopus.com/inward/record.url?partnerID=2dRBettD&eid=2-s2.0-80054838341) do 16. 12. 2011: št. citatov (TC): 0, čistih citatov (CI): 0, normirano št. čistih citatov (NC): 0] NATERER, Greg F., SUPPIAH, S., STOLBERG, L., LEWIS, M., WANG, Z., DAGGUPATI, V., GABRIEL, K., DINÇER, İbrahim, ROSEN, Marc A., SPEKKENS, P., LVOV, S. N., FOWLER, Michael, TREMAINE, P., MOSTAGHIMI, J., EASTON, E. B., TREVANI, L., RIZVI, G., IKEDA, B. M., KAYE, M. H., LU, L., PIORO, I., SMITH, W. R., SECNIK, E., JIANG, J., AVSEC, Jurij. Canada's program on nuclear hydrogen production and the thermochemical Cu-Cl cycle. *Int. j. hydrogen energy*. [Print ed.], Oct. 2010, vol. 35, iss. 20, str. 10905-10926, doi: [10.1016/j.ijhydene.2010.07.087](http://dx.doi.org/10.1016/j.ijhydene.2010.07.087). [COBISS.SI-ID [1024027740](http://cobiss.izum.si/scripts/cobiss?command=DISPLAY&base=COBIB&RID=1024027740)], [[JCR](http://www.cobiss.si/scripts/cobiss?command=SEARCH&base=jcr&select=%28sc=0360-3199+and+PY=2010%29), [WoS](http://gateway.isiknowledge.com/gateway/Gateway.cgi?GWVersion=2&SrcAuth=Alerting&SrcApp=Alerting&DestApp=WOS&DestLinkType=FullRecord&UT=000284443200010) do 27. 8. 2013: št. citatov (TC): 16, čistih citatov (CI): 14, normirano št. čistih citatov (NC): 7, [Scopus](http://www.scopus.com/inward/record.url?partnerID=2dRBettD&eid=2-s2.0-77957348593) do 30. 7. 2013: št. citatov (TC): 21, čistih citatov (CI): 19, normirano št. čistih citatov (NC): 9] AVSEC, Jurij, NOVOSEL, Urška. Application of hydrogen technologies in combination with nuclear energy and renewable sources. V: ŠVAIĆ, Srećko (ur.), BORAS, Ivanka (ur.), DOVIĆ, Damir (ur.). Interklima 2015 : [zbornik radova], (Interklima ... (CD-ROM), ISSN 1848-0527, 2015). Zagreb: Sveučilište u Zagrebu, Fakultet strojarstva i brodogradnje, 2015, 10 str., graf. prikazi. |

|  |
| --- |
| **UČNI NAČRT PREDMETA / COURSE SYLLABUS** |
| **Predmet:** | **OGREVALNI IN HLADILNI SISTEMI** |
| **Course title:** | **HEATING AND COOLING SYSTEMS** |
|  |  |  |  |
| **Študijski program in stopnja****Study programme and level** | **Študijska smer****Study field** | **Letnik****Academic year** | **Semester****Semester** |
| ENERGETIKA, 1. stopnja |  | 3 | 1 |
| ENERGY TECHNOLOGY, 1.degree |  | 3 | 1 |
|  |
| **Vrsta predmeta / Course type** | Izbirni/Elective |
|  |  |
| **Univerzitetna koda predmeta / University course code:** | V |
|  |
| **Predavanja****Lectures** | **Seminar****Seminar** | **Vaje****Tutorial** | **Klinične vaje****work** | **Druge oblike študija** | **Samost. delo****Individ. work** |  | **ECTS** |
| **25** |  | **30** |  |  | **65** |  | **4** |
| **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 in termodinamike |  | Completed courses in the following subjects: Mathematics, Mechanics, Thermodynamics |
| **Vsebina:**  |  | **Content (Syllabus outline):** |
| Vsebina predmeta obsega sledeča poglavja:1. Osnove prenosa in prehoda toplote.2. Procesi ogrevanja in ohlajevanja3. Kotli za ogrevanje4. Sistemi centralnega ogrevanja.5. Dimenzioniranje ogrevalnih in hladilnih sistemov6. Vlažni zrak.7. Udobje in klimatizacijski pogoji za bivanje8. Diagrami vrenja binarnih zmesi9. Proces dušenja binarnih zmesi10. Absorbcija. 11. Absorbcijski hladilni sistemi. |  | Content of the Subject:1. Fundamentals of the heat transfer.

2. Heating and cooling cycles.3. Furnaces and boilers for heating.4. Central heating systems5. Designing of heating and cooling systems.6. Moist air.7. Comfort and health-indoor environmental quality.8. Binary system evaporation diagrams.9. Damping of binary system.10. Absorbtion.11. Absorbtion cooling systems. |
| **Temeljni literatura in viri / Readings:** |
| Milan Marčič, Jurij Avsec, Hladilna tehnika, Fakulteta za strojništvo, Univerza v Mariboru, 2003Miran Oprešnik, Termodinamika, Fakulteta za strojništvo, Univerza v Ljubljani, 1987Faye McQuiston, Jerald Parker, Jefrey Spitler, Heating, Ventilating and Air-Conditioning, John Wiley&Sons 2000 |
| **Cilji in kompetence:** |  | **Objectives and competences:** |
| Študent se spozna z osnovami termodinamike in prenosa toplote, ter ogrevalnimi in hladilnimi sistemi |  | Student acquires the fundamentals of thermodynamics and heat transfer, which is necessary for understanding and designing of heating and cooling systems. |
| **Predvideni študijski rezultati:** |  | **Intended learning outcomes:** |
| Znanje in razumevanje:1. Razumevanje toka energije pri hladilnih in ogrevalnih sistemih.2. Sposobnost projektiranja grelnih in hladilnih sistemov Prenesljive/ključne spretnosti in drugi atributi:kombinirana uporaba različnih toplotnih strojev v energetiki |  | Knowledge and understanding:1. Knowledge of energy flow at heating and cooling system.2. Ability of designing heating and cooling systems.Diesel Engines and Gas Engines.Transferable/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 vajah |  | 1. Lectures, 2. Practical work at tutorials |
| **Načini ocenjevanja:** | Delež (v %) /Weight (in %) | **Assessment:** |
| Način (pisni izpit, ustno izpraševanje, naloge, projekt)1. Praktični del izpita v obliki pisnega reševanja nalog.2. Teoretični del izpita. | **40****60** | Type (examination, oral, coursework, project):1. Written examination in the form of practical application. 2. Theoretical examination |
| **Reference nosilca / Lecturer's references:**  |
| 1. 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. http://www.jfbi.org/EN/Y2017/V10/I1/1, doi: 10.3993/jfbim00252. [COBISS.SI-ID 20431382], [SNIP] 2. STRUŠNIK, Dušan, MARČIČ, Milan, GOLOB, Marjan, HRIBERNIK, Aleš, ŽIVIĆ, Marija, AVSEC, Jurij. Energy efficiency analysis of steam ejector and electric vacuum pump for a turbine condenser air extraction system based on supervised machine learning modelling. Applied energy, ISSN 0306-2619, jul. 2016, vol. 173, str. 386-405, graf. prikazi, doi: 10.1016/j.apenergy.2016.04.047. [COBISS.SI-ID 1024226652], [JCR, SNIP, WoS do 24. 9. 2017: št. citatov (TC): 4, čistih citatov (CI): 3, Scopus do 31. 8. 2017: št. citatov (TC): 5, čistih citatov (CI): 4] 3. 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.  |

|  |
| --- |
| **UČNI NAČRT PREDMETA / COURSE SYLLABUS** |
| **Predmet:** | **PROCESNA, POŽARNA IN EKSPLOZIJSKA VARNOST** |
| **Course title:** | **PROCESS, FIRE AND EXPLOSIVE SAFETY** |
|  |  |  |  |
| **Študijski program in stopnja****Study programme and level** | **Študijska smer****Study field** | **Letnik****Academic year** | **Semester****Semester** |
| ENERGETIKA, 1. stopnja |  | 3 | 1 |
| ENERGY TECHNOLOGY, 1.degree |  | 3 | 1 |
|  |
| **Vrsta predmeta / Course type** | Izbirni/Elective |
|  |  |
| **Univerzitetna koda predmeta / University course code:** | V |
|  |
| **Predavanja****Lectures** | **Seminar****Seminar** | **Vaje****Tutorial** | **Klinične vaje****work** | **Druge oblike študija** | **Samost. delo****Individ. work** |  | **ECTS** |
| **25** |  | **30** |  |  | **65** |  | **4** |
| **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):** |
| * osnovni pojmi. Pomen varnosti splošno in posebej v energetskih sistemih
* bistvo in pomen varnosti
* ocena ranljivosti in ogroženosti
* zakonska ureditev varnosti
* požarna varnost
* varnost in zdravje pri delu
* varstvo okolja
* varnost v notranjem transportu
* Procesna, požarna in eksplozijska varnost kot sestavni del varnostnega sistema.
* Varnost jedrske elektrarne
* Varnost termoelektrarne
* Varnost hidroelekrarne
* Varnost fotovoltaičnih elektrarn
* načini nadziranja varnostnih mehanizmov.
* konkretni primeri in uporaba
 |  | * Basic concept. Meaning of safety in general and especially in systems in energetics.
* Essence and meaning of safety.
* Assessment of vulnerability and threatening.
* Legal regulation of safety.
* Fire safety.
* Safety and health at work.
* Environment protection.
* Safety  in inner transport.
* Procedural, fire and explosive safety as composed part of safety system.
* Safety of nuclear power station
* Safety of steam power station
* Safety of hydroelectric power station
* Safety of photovoltaic power plant
* Ways of controling safety mechanisms.
* Examples
 |
| **Temeljni literatura in viri / Readings:** |
| Golob, R.: Sistemi zaščite in varovanja oseb in premoženja, Tiskarna Povše, Ljubljana, 1997, COBISS.SI-ID: 65679104.Praunseis, Z.: Osnove procesne, požarne in eksplozijske varnosti, Univerzitetni učbenik, Univerza v Mariboru, 2011Zakon o varstvu pred požarom, Ur. l. RS, št. 71/1993.Zakon o varnosti in zdravju pri delu, Ur. l. RS, št. 56/1999.Zakon o varstvu pred naravnimi in drugimi nesrečami, Ur. l. RS, št. 64/1994.Zakon o varnosti in zdravju pri delu, Ur. l. RS, št. 56/1999.Zakon o tajnih podatkih, Ur. l. RS, št. 87/2001. |
| **Cilji in kompetence:** |  | **Objectives and competences:** |
| Študenti:* spoznajo pojme varnosti, njen pomen in obvezne varnostne mehanizme
* spoznajo in usvojijo varnostne standarde v organizacijah
* se usposobijo za realno ocenjevanje ogroženosti in tveganj
* se usposobijo za načrtovanje varnostnih ukrepov v energetskih procesih
 |  | Students:* learn the concept of safety, its meaning in organization and all manditory safety mechanisms
* know how to use safety standards in organizations
* have ability to evaluate threat and risk and know how to act in exceptional cases
* know how to plan safety measures in systems in energetics
 |
| **Predvideni študijski rezultati:** |  | **Intended learning outcomes:** |
| Znanje in razumevanje:Študenti:* usvojijo pojme varnosti, njen pomen v organizaciji in vse obvezne varnostne mehanizme
* znajo uporabiti varnostne standarde v logističnih organizacijah
* so sposobni oceniti ogroženost in tveganje ter ukrepati v izjemnih primerih
* znajo načrtovati potrebne varnostne ukrepe v energetskih sistemih
 |  | Knowledge and understanding:* Students:
* learn the concept of safety, its meaning in organization and all manditory safety mechanisms
* know how to use safety standards in logistics organizations
* have ability to evaluate threat and risk and know how to act in exceptional cases
* know how to plan safety measures in systems in energetics
 |
| Prenesljive/ključne spretnosti in drugi atributi:* timsko delo
* pridobitev organizacijskih spretnosti
* razumevanje snovi bo podprto s praktičnimi primeri oblik in načinov projektnega vodenja v skupinah
 |  | Transferable/Key Skills and other attributes:* team work
* to gain organization skills
* understanding of the subject will be supported with practical examples project management in teams
 |
| **Metode poučevanja in učenja:** |  | **Learning and teaching methods:** |
| Predavanja: pri predavanjih študent spozna teoretične vsebine predmeta. Vaje: pri vajah študent utrdi teoretično znanje in spozna aplikativne možnosti. |  | Lectures: the student gets acquainted with theoretical content of the subject.Tutorial: the student upgrades the theoretical knowledge with practical experience. |
| **Načini ocenjevanja:** | Delež (v %) /Weight (in %) | **Assessment:** |
| Način (pisni izpit, ustno izpraševanje, naloge, projekt)* pisni kolokviji
* ustni izpit
* pisni izpit
* zagovor laboratorijskih vaj
 | **30****30****30****10** | Type (examination, oral, coursework, project):* written test
* oral examination
* written examination
* laboratory work defense
 |
| **Reference nosilca / Lecturer's references:**  |
| PRAUNSEIS, Zdravko*. Osnove procesne, požarne in eksplozijske varnosti : [univerzitetni učbenik z recenzijo]*. Krško: Fakulteta za energetiko, 2011. IV, 185 str., graf. prikazi. ISBN 978-961-6800-07-5. [COBISS.SI-ID [68223233](http://cobiss.izum.si/scripts/cobiss?command=DISPLAY&base=COBIB&RID=68223233)]PRAUNSEIS, Zdravko*. Načrtovanje postavitve sončne elektrarne : (študija za projekt)*. Krško: Fakulteta za energetiko, 2014. 14 str., ilustr. [COBISS.SI-ID [1024223324](https://plus.si.cobiss.net/opac7/bib/1024223324?lang=en)]CERJAK, Mitja*. (mentor Zdravko Praunseis).Požarna varnost fotovoltaičnih elektrarn : diplomsko delo*. Krško: [M. Cerjak], 2014. XII, 52 f., ilustr. <http://dkum.uni-mb.si/IzpisGradiva.php?id=45301>. [COBISS.SI-ID [1024193372](https://plus.si.cobiss.net/opac7/bib/1024193372?lang=en)]  |

|  |
| --- |
| **UČNI NAČRT PREDMETA / COURSE SYLLABUS** |
| **Predmet:** | **LESENE PASIVNE ZGRADBE** |
| **Course title:** | **TIMBER PASSIVE BUILDINGS** |
|  |  |  |  |
| **Študijski program in stopnja****Study programme and level** | **Študijska smer****Study field** | **Letnik****Academic year** | **Semester****Semester** |
| ENERGETIKA, 1. stopnja |  | 3 | 1 |
| ENERGY TECHNOLOGY, 1.degree |  | 3 | 1 |
|  |
| **Vrsta predmeta / Course type** | Izbirni/Elective |
|  |  |
| **Univerzitetna koda predmeta / University course code:** | V |
|  |
| **Predavanja****Lectures** | **Seminar****Seminar** | **Vaje****Tutorial** | **Klinične vaje****work** | **Druge oblike študija** | **Samost. delo****Individ. work** |  | **ECTS** |
| **25** |  | **30** |  |  | **65** |  | **4** |
| **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):** |
| 1. Lesena gradnja (osnove lesene gradnje, les kot konstrukcijski material in določevanje mehanskih lastnosti, vrste konstrukcijskih sistemov).
2. Energetska učinkovitost v leseni gradnji (splošno o energetski učinkovitosti, študija strategije pasivnega delovanja stavbe, energetska učinkovitost lesene stavbe, energetski tokovi in kazalniki rabe energije v stavbi, komponente energetsko učinkovite stavbe, aktivni tehnični sistemi).
3. Zasnova sodobne lesene zgradbe (ideja in koncept, funkcionalna zasnova projekta, konstrukcija, sestava konstrukcijskih elementov, analiza energetske učinkovitosti).
 |  | 1. Timber construction (bases of timber construction, wood as construction material and determination of mechanical properties, sorts of construction systems).
2. Energy efficiency of timber construction (generally about energy efficiency, the study of passive building operation strategy, energy efficiency of timber building, energy streams and criteria of energy building consumption, the components of energy efficiency building, active technical systems).
3. Design of contemporary timber building (idea and concept, functional project design, contruction, structure of construction elements, energy efficiency analysis.
 |
| **Temeljni literatura in viri / Readings:** |
| 1.Feist, W. (1998): Das Passivhaus – Baustandard der Zukunft?.Protokollband Nr. 12, Passivhaus Institut, Darmstadt.2.Feist, W. (2005): Qualitätssicherung beim Bau von Passivhäusern. Protokollband Nr. 18, Passivhaus Institut, Darmstadt.3.Premrov, M., Žegarac L., V. (2013): Energy-Efficient Timber-Glass Houses. Springer, London.Rules on the methodology of construction and issuance of building energy certificates, Official Gazette RS, 77/2009.4.Schnieders, J., Hermelink, A. (2006): CEPHEUS results: Measurements and occupant's satisfaction provide evidence for Passive Houses being an option for sustainable building. In: Energy Policy, 34, pp.151–171.  |
| **Cilji in kompetence:** |  | **Objectives and competences:** |
| Študenti:- podati osnove o uporabi lesa za gradnjo pasivnih zgradb- podati osnovno znanje o konstruiranje lesenih pasivnih zgradb- pridobiti praktična znanja, ki so potrebna za konstruiranje lesenih pasivnih zgradb |  | Students:- to provide the basic knowledge about wood application for timber built up of passive buildings. - to provide the basic knowledge about construction of timber passive buildings. - to provide necessary practical application for timber construction of passive buildings.  |
| **Predvideni študijski rezultati:** |  | **Intended learning outcomes:** |
| Znanje in razumevanje:- spoznavanje osnov o namenski uporabi lesa za konstruiranje pasivnih zgradb - spoznavanje osnovnih postopkov spajanja lesenih komponent za konstruiranje pasivnih zgradb. - razumevanje osnovnih značilnosti lesene gradnje in pogojev obratovanja.  |  | Knowledge and Understanding:- basic knowledge about purpose usage of wood material for passive buildings design, - introduction to basic knowledge of joined wooden materials processes for passive buildings design.- understanding of basic features of process equipment and operation conditions |
| **Prenesljive/ključne spretnosti in drugi atributi:**Uporaba standardov in tehniškega znanja za projektiranje lesenih pasivnih zgradb. |  | **Transferable/Key Skills and other attributes:**Application of standards and technical knowledge for design of timber passive buildings. |
| **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*. Študija gradnje norveških lesenih hiš v Sloveniji : izdelava analiz in študij za projekt*. Krško: Fakulteta za energetiko, 2015. 23 str., ilustr. [COBISS.SI-ID [1024223068](http://cobiss.izum.si/scripts/cobiss?command=DISPLAY&base=COBIB&RID=1024223068) PRAUNSEIS, Zdravko, STROJKO, Renato*. Energetska oskrba objektov*. Univerzitetni učbenik.[1. izd.]. Krško: Fakulteta za energetiko, 2014. XVII, 286 str., ilustr., tabele. ISBN 978-961-6800-11-2. [COBISS.SI-ID [76157441](http://cobiss.izum.si/scripts/cobiss?command=DISPLAY&base=COBIB&RID=76157441)]PRAUNSEIS, Zdravko*. Popolna energetska sanacija atrijske stanovanjske hiše : študija za projekt*. Krško: Fakulteta za energetiko, 2012. III, 90 f., graf. prikazi. [COBISS.SI-ID [1024120668](http://cobiss.izum.si/scripts/cobiss?command=DISPLAY&base=COBIB&RID=1024120668)]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.], May 2013, vol. 6, iss. 2, str. 59-69, ilustr. <http://www.fe.um.si/en/jet.html>. [COBISS.SI-ID [1024143196](http://cobiss.izum.si/scripts/cobiss?command=DISPLAY&base=COBIB&RID=1024143196)] |

|  |
| --- |
| **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, 1. stopnja |  | 3 | 1 |
| ENERGY TECHNOLOGY, 1.degree |  | 3 | 1 |
|  |
| **Vrsta predmeta / Course type** | Izbirni/Elective |
|  |  |
| **Univerzitetna koda predmeta / University course code:** | V |
|  |
| **Predavanja****Lectures** | **Seminar****Seminar** | **Vaje****Tutorial** | **Klinične vaje****work** | **Druge oblike študija** | **Samost. delo****Individ. work** |  | **ECTS** |
| **25** |  | **30** |  |  | **65** |  | **4** |
| **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:** |
| Osnovna znanja fizike, mehanike, termodinamike |  | Basic knowledge of physics, mechanics, thermodynamics |
| **Vsebina:**  |  | **Content (Syllabus outline):** |
| * Konvencionalno VS alternativno?
* Zakaj alternativni tipi energetskih sistemov?
* Okvir odprte termodinamike
* Mikro / Makro svet
* Pregled smeri razvoja
* Tekočinskih alternativni energetski sistemi
* Plinski alternativni energetski sistemi
* Kombinirani alternativni energetski sistemi
* Ekonomika in obratovanje
* Skupno/mrežno ali sestavljeno oz. kombinirano obratovanje
* Regulacija
* Meritve karakteristik
* Shranjevalni energetski sistemi in njih kombinacije
* Vakuumska tehnika/tehnologija
* Obratovanje in regulacija
* Meritve
 |  | - Conventional VS alternatively?- Why alternative types of energy systems?- Open thermodynamics frame- Micro / Macro world- Overview of development trends- Liquid Alternative Energy Systems- Gas Alternative Energy Systems- Combined Alternative Energy Systems- Economics and operation- Common / network or composite combined operation- Regulation- Measurement of characteristics- Storage energy systems and combinations thereof- Vacuum technology / technology- Operation and regulation- Measurements |
| **Temeljni literatura in viri / Readings:** |
| **H. Požar:** *Osnove energetike 1*, Školska knjiga Zagreb, Sveučilište u Zagrebu, 1992.**W. C. Turner, S. Doty:** *Energy Management Handbook*, Sixth Edition, CRC Press, 2006**M. Tuma, M. Sekavčnik:** *Energetski sistemi, Preskrba z električno energijo in toploto*, Univerza v Ljubljani, FS, 2004.**I. H. Shames:** *Mechanics of Fluids*, McGraw-Hill, International Editions, 1992 **H. Sigloch:** *Strömungsmaschinen, Grundlagen und Anwendungen,* 4. aktualisierte Auflage, Hanser Verlag, 2009**J. Giesecke, E. Mosonyi:** *Wasserkraftanlagen, Planung, Bau und Betrieb,* 4. aktualisierte und erweiterte Auflage, Springer Verlag, 2005**D. Horvat:** *Vodene turbine,* Sveučilište u Zagrebu, Zagreb 1965 |
| **Cilji in kompetence:** |  | **Objectives and competences:** |
| Osvojitev znanj na področju hidravličnih strojev, sistemov in naprav v energetiki; |  | 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,
* Izvajanje Računskih primerov;
 |  | - Lectures,- Audit and laboratory exercises, - Worked examples; |
| **Načini ocenjevanja:** | Delež (v %) /Weight (in %) | **Assessment:** |
| * pisni izpit,
* pisna teorija
* kratek ustni zagovor;
 | **40** **50** **10**  | - written examination,- written theory- a brief oral defense; |
| **Reference nosilca / Lecturer's references:**  |
| PREDIN, Andrej, GREGORC, Boštjan, BILUŠ, Ignacijo. Cavitation swirl at the entrance of centrifugal pump. *Journal of energy technology*, ISSN 1855-5748. [Tiskana izd.], Aug. 2009, vol. 2, iss. 3, str. 85-97. [COBISS.SI-ID [1024008284](https://plus.si.cobiss.net/opac7/bib/1024008284?lang=sl)]MIHALIĆ, Tihomir, GUZOVIĆ, Zvonimir, PREDIN, Andrej. CFD flow analysis in the centrifugal vortex pump. *International journal of numerical methods for heat & fluid flow*, ISSN 0961-5539, 2014, vol. 24, no. 3, str. 545-562. <http://www.emeraldinsight.com/journals.htm?issn=0961-5539&volume=24&issue=3&articleid=17109922&show=abstract>, doi: [10.1108/HFF-05-2012-0124](https://doi.org/10.1108/HFF-05-2012-0124). [COBISS.SI-ID [1024162140](https://plus.si.cobiss.net/opac7/bib/1024162140?lang=sl)]BILUŠ, Ignacijo, ŠKERGET, Leopold, PREDIN, Andrej, HRIBERŠEK, Matjaž. Eksperimentalno numerična analiza kavitacijskega toka okoli lopatičnega profila = Experimental and numerical analysis of the cavitational flows around a hydrofoil. *Strojniški vestnik*, ISSN 0039-2480, 2005, letn. 51, št. 2, str. 103-118. [COBISS.SI-ID [8153627](https://plus.si.cobiss.net/opac7/bib/8153627?lang=sl)]PREDIN, Andrej, KLASINC, Roman. Emergency gate vibration of the pipe-turbine model. *Shock and vibration*, ISSN 1070-9622, 2000, vol. 7, no. 1, str. 3-13. <https://dk.um.si/IzpisGradiva.php?id=66228>. [COBISS.SI-ID [5422358](https://plus.si.cobiss.net/opac7/bib/5422358?lang=sl)]GREGORC, Boštjan, PREDIN, Andrej, FABIJAN, Drago, KLASINC, Roman. Experimental analysis of the impact of particles on the cavitating flow. *Strojniški vestnik*, ISSN 0039-2480, apr. 2012, vol. 58, no. 4, str. 238-244, SI 50, ilustr., doi: [10.5545/sv-jme.2011.062](https://doi.org/10.5545/sv-jme.2011.062). [COBISS.SI-ID [1024067932](https://plus.si.cobiss.net/opac7/bib/1024067932?lang=sl)]BILUŠ, Ignacijo, PREDIN, Andrej. Experimental analysis of thermodynamical surge at water pump inlet = Eksperimentalna analiza termodinamičnih fluktuacij toka na vstopu v vodno črpalko. *Journal of energy technology*, ISSN 1855-5748. [Tiskana izd.], Aug. 2010, vol. 3, iss. 3, str. 67-74. <http://www.fe.um.si/index.php/sl/jet-opis/jet-on-line.html>. [COBISS.SI-ID [1024036444](https://plus.si.cobiss.net/opac7/bib/1024036444?lang=sl)]BILUŠ, Ignacijo, PREDIN, Andrej, ŠKERGET, Leopold. The extended homogenous cavitation transport model. *Journal of hydraulic research*, ISSN 0022-1686, 2007, vol. 45, no 1, str. 81-87. [COBISS.SI-ID [11114774](https://plus.si.cobiss.net/opac7/bib/11114774?lang=sl)]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)] |

|  |
| --- |
| **UČNI NAČRT PREDMETA / COURSE SYLLABUS** |
| **Predmet:** | **FOTONAPETOSTNI SISTEMI** |
| **Course title:** | **PHOTOVOLTAIC SYSTEMS** |
|  |  |  |  |
| **Študijski program in stopnja****Study programme and level** | **Študijska smer****Study field** | **Letnik****Academic year** | **Semester****Semester** |
| ENERGETIKA, 1. stopnja |  | 3 | 1 |
| ENERGY TECHNOLOGY, 1.degree |  | 3 | 1 |
|  |
| **Vrsta predmeta / Course type** | Izbirni/Elective |
|  |  |
| **Univerzitetna koda predmeta / University course code:** | V |
|  |
| **Predavanja****Lectures** | **Seminar****Seminar** | **Vaje****Tutorial** | **Klinične vaje****work** | **Druge oblike študija** | **Samost. delo****Individ. work** |  | **ECTS** |
| **25** |  | **30** |  |  | **65** |  | **4** |
| **AV** | **LV** | **RV** |  |
|  | **30** |  |  |
|  |
| **Nosilec predmeta / Lecturer:** | **SEBASTIJAN SEME** |
|  |
| **Jeziki /** **Languages:** | **Predavanja / Lectures:** | slovenski / Slovene |
| **Vaje / Tutorial:** | slovenski / Slovene |
| **Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:** |  | **Prerequisits:** |
| Ni pogojev. |  | None. |
| **Vsebina:**  |  | **Content (Syllabus outline):** |
| a) Osnove sončnega sevanja in lastnosti sončne svetlobe.b) Polprevodniški elementi za sončne celice. Okoljski vidiki proizvodnje sončnih celic. c) Izdelava silicijevih sončnih celic.d) Električne lastnosti sončnih celic. Sestavljanje sončnih celic v sončni modul. Tehnične in električne lastnosti sončnih modulov.e) Konstrukcijski sistemi za sončne elektrarne.f) Omrežno in otočno delovanje sončnih elektrarn. |  | a) The basics of solar radiation and the properties of sunlight.b) Semiconductor elements for solar cells. Environmental aspects of solar cell production.c) Production of silicon solar cells.d) Electrical properties of solar cells. Placing solar cells in a solar module. Technical and electrical properties of solar modules.e) Structural systems for solar power plants.f) Network and island operation of solar power plants. |
| **Temeljni literatura in viri / Readings:** |
| D. Lenardič, Fotonapetostni sistemi, druga dopolnjena in razširjena izdaja, priročnik 2012,Planning and Installing Photovoltaic Systems, London 2010J. Furlan, Osnove polprevodniških elementov, Ljubljana 2002H. K. KOTHE: Stromversorgung mit Solarzellen , Franzis, Berlin 2002Kreith, F., Jan F. Kreider, Principles Of Solar Engineering, London, 2000Furlan, J., Primerjava lastnosti amorfnega in kristalnega silicija, 1989Furlan, J., Osnove nelinearnih elementov, Univerza Edvarda Kardelja v Lubljani, Fakulteta za elektrotehniko, Ljubljana 1980 |
| **Cilji in kompetence:** |  | **Objectives and competences:** |
| Cilj in kompetence predmeta so pridobiti poglobljena znanja s področja fotonapetostnih sistemov, katerih glavna dela sta sončni moduli in razsmerniki. Spoznati osnovna delovanja sončnih celic.Razviti sposobnost samostojnega in kreativnega reševanja inženirskih problemov. |  | The objective and competences of the subject are to gain knowledge in the field of photovoltaic systems, whose main works are solar modules and inverters. Get to know the basic actions of solar cells.Develop the ability of independent and creative solving of engineering problems. |
| **Predvideni študijski rezultati:** |  | **Intended learning outcomes:** |
| Znanje in razumevanje:Znanje in razumevanje s področja delovanja fotonapetostnih sistemov. |  | Knowledge and Understanding:Knowledge and understanding from the field of operation of photovoltaic systems. |
| Prenesljive/ključne spretnosti in drugi atributi:Uporaba teoretičnega znanja v praksi. |  | Transferable/Key Skills and other attributes:Using theoretical knowledge in practice. |
| **Metode poučevanja in učenja:** |  | **Learning and teaching methods:** |
| Predavanja.Laboratorijske vaje.Samostojno delo. |  | Lectures.Labor work.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. [COBISS.SI-ID 1024270172], [JCR, SNIP, Scopus do 24. 6. 2017: št. citatov (TC): 0, čistih citatov (CI): 0]SEME, Sebastijan, ŠTUMBERGER, Bojan, HADŽISELIMOVIĆ, Miralem. A novel prediction algorithm for solar angles using second derivative of the energy for photovoltaic sun tracking purposes. Solar energy, ISSN 0038-092X. [Print ed.], nov. 2016, vol. 137, str. 201-211, graf. prikazi, doi: 10.1016/j.solener.2016.08.001. [COBISS.SI-ID 1024235356], [JCR, SNIP, WoS do 23. 10. 2017: št. citatov (TC): 3, čistih citatov (CI): 3, Scopus do 30. 9. 2017: št. citatov (TC): 5, čistih citatov (CI): 5]SEME, Sebastijan, POŽUN, Jože, ŠTUMBERGER, Bojan, HADŽISELIMOVIĆ, Miralem. Energy production of different types and orientations of photovoltaic systems under outdoor conditions. Journal of solar energy engineering : Transactions of the ASME, ISSN 0199-6231, 2015, vol. 137, issue 2, str. 021021-1 - 021021-10, ilustr., doi: 10.1115/1.4029736. [COBISS.SI-ID 81541633], [JCR, SNIP, WoS do 4. 4. 2015: št. citatov (TC): 0, čistih citatov (CI): 0, Scopus do 22. 3. 2015: št. citatov (TC): 0, čistih citatov (CI): 0]LUKAČ, Niko, SEME, Sebastijan, ŽLAUS, Danijel, ŠTUMBERGER, Gorazd, ŽALIK, Borut. Buildings roofs photovoltaic potential assessment based on LiDAR (light detection and ranging) data. Energy, ISSN 0360-5442. [Print ed.], 2014, vol. 66, str. 598-609, doi: 10.1016/j.energy.2013.12.066. [COBISS.SI-ID 17543702], [JCR, SNIP, WoS do 24. 9. 2017: št. citatov (TC): 26, čistih citatov (CI): 24, Scopus do 27. 5. 2017: št. citatov (TC): 25, čistih citatov (CI): 23] |

|  |
| --- |
| **UČNI NAČRT PREDMETA / COURSE SYLLABUS** |
| **Predmet:** | **HRANILNIKI ENERGIJE** |
| **Course title:** | **ENERGY STORAGE SYSTEMS** |
|  |  |  |  |
| **Študijski program in stopnja****Study programme and level** | **Študijska smer****Study field** | **Letnik****Academic year** | **Semester****Semester** |
| ENERGETIKA, 1. stopnja |  | 3 | 1 |
| ENERGY TECHNOLOGY, 1.degree |  | 3 | 1 |
|  |
| **Vrsta predmeta / Course type** | Izbirni/Elective |
|  |  |
| **Univerzitetna koda predmeta / University course code:** | V |
|  |
| **Predavanja****Lectures** | **Seminar****Seminar** | **Vaje****Tutorial** | **Klinične vaje****work** | **Druge oblike študija** | **Samost. delo****Individ. work** |  | **ECTS** |
| **25** |  | **30** |  |  | **65** |  | **4** |
| **AV** | **LV** | **RV** |  |
|  | **30** |  |  |
|  |
| **Nosilec predmeta / Lecturer:** | **PETER VIRTIČ** |
|  |
| **Jeziki /** **Languages:** | **Predavanja / Lectures:** | slovenski / Slovene |
| **Vaje / Tutorial:** | slovenski / Slovene |
| **Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:** |  | **Prerequisits:** |
| Ni pogojev. |  | No conditions. |
| **Vsebina:**  |  | **Content (Syllabus outline):** |
| * Osnovni princip delovanja in izvedbe klasičnih akumulatorjev.
* Osnovni princip delovanja in izvedbe pretočnih akumulatorjev.
* Elektroliza, shranjevanje vodika, gorivne celice.
* Generatorji z velikimi vztrajnostnimi masami: osnovni princip delovanja in izvedbe.
* Prečrpovalne elektrarne: osnovni princip delovanja in izvedbe.
* Sistemi za shranjevanje stisnjenega zraka; osnovni princip delovanja in izvedbe.
* Sistemi za shranjevanje energije s superprevodnimi magneti: osnovni princip delovanja in izvedbe.
* Sistemi za shranjevanje energije s super kondenzatorji magneti: osnovni princip delovanja in izvedbe.
* Optimalno obratovanje hranilnika energije in naprav za proizvodnjo električne energije iz obnovljivih virov.
* Upravljanje s fleksibilnostmi v energetskih sistemih.
* Integracija hranilnikov energije v energetske sisteme.
* Hranilniki energije v električnih vozilih.
 |  | * Energy storage with classic batteries: basic principle and realizations.
* Energy storage with flow batteries: basic principle and realizations.
* Electrolysis, Hydrogen storage and fuel cells.
* Energy storage whit Flywheel generators: basic principle and realizations.
* Pumped hydroelectric energy storage: basic principle and realizations.
* Compressed air energy storage: basic principle and realizations.
* Superconducting magnetic energy storage: basic principle and realizations.
* Supercapacitor energy storage: basic principle and realizations.
* Optimal operation of energy storage devices and devices for electric power generation from renewable energy sources.
* Flexibility management in energy systems.
* Energy storage integration in energy systems.
* Energy storage in electric vehicles.
 |
| **Temeljni literatura in viri / Readings:** |
| K.Y.C. Cheung S.T.H. Cheung, R.G.N DeSilva, M.P. Juvonen, R. Sing, J.J. Woo, Large-Scale Energy Storage Systems, Imperial College London, 2003R. Baxter, Energy Storage: A Nontechnical Guide,B Kilkis, S. Kakag, Energy storage systems Rechargeable batteries applications handbook, Gates Energy Products |
| **Cilji in kompetence:** |  | **Objectives and competences:** |
| Seznaniti študente s različnimi sistemi za shranjevanje energije, z njihovimi izvedbami in z možnostjo njihove uporabe. Poseben poudarek je dan na sistemih, ki so primerni za shranjevanje energije v kombinaciji s sistemi za proizvodnjo električne energije iz obnovljivih virov in električnimi vozili. |  | Students become familiar with different energy storage systems, with different realizations of energy storage systems and with their advantages and drawbacks. A special attention is paid to the energy storage systems which are appropriate to be used together with units for power generation from renewable energy sources and electric vehicles.  |
| **Predvideni študijski rezultati:** |  | **Intended learning outcomes:** |
| Znanje in razumevanje:Razumevanje osnovnih principov delovanja različnih sistemov za shranjevanja energije |  | Knowledge and Understanding:Understanding basic principles of different energy storage systems.  |
| Prenesljive/ključne spretnosti in drugi atributi:Poznavanje različnih sistemov za shranjevanje energije.  |  | Transferable/Key Skills and other attributes:Knowledge of different energy storage systems. |
| **Metode poučevanja in učenja:** |  | **Learning and teaching methods:** |
| predavanja, projektvodene laboratorijske vajesamostojno delo |  | LecturesProjectGuided laboratory work.individual 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)]  |

|  |
| --- |
| **UČNI NAČRT PREDMETA / COURSE SYLLABUS** |
| **Predmet:** | **MODELIRANJE ELEKTROENERGETSKEGA OMREŽJA** |
| **Course title:** | **ELECTRICAL NETWORK MODELING** |
|  |  |  |  |
| **Študijski program in stopnja****Study programme and level** | **Študijska smer****Study field** | **Letnik****Academic year** | **Semester****Semester** |
| ENERGETIKA, 1. stopnja  |  | 3 | 1 |
| ENERGY TECHNOLOGY, 1.degree |  | 3 | 1 |
|  |
| **Vrsta predmeta / Course type** | Izbirni/Elective |
|  |  |
| **Univerzitetna koda predmeta / University course code:** | V |
|  |
| **Predavanja****Lectures** | **Seminar****Seminar** | **Vaje****Tutorial** | **Klinične vaje****work** | **Druge oblike študija** | **Samost. delo****Individ. work** |  | **ECTS** |
| **25** |  | **30** |  |  | **65** |  | **4** |
| **AV** | **LV** | **RV** |  |
|  |  | **30** |  |
|  |
| **Nosilec predmeta / Lecturer:** | **MIRALEM HADŽISELIMOVIĆ** |
|  |
| **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):** |
| * Pregled programske opreme za reševanje splošnih inženirskih problemov.
* Osnove programske opreme Matlab/Simulink s poudarkom na uporabi v elektroenergetiki.
* Matlabove knjižnice za simbolično računanje , analizo in načrtovanje regulacijskih sistemov in simulacijo elektroenergetskih naprav in sistemov.
* Programiranje v Matlabu.
* Izdelava grafičnih uporabniških vmesnikov v Matlabu.
* Uporaba algoritmov za dinamično simuliranje v programskem paketu Matlab/Simulink.
* Pregled in razlaga modelov osnovnih elementov elektroenergetskega omrežja v programskem paketu Matlab/Simulink.
 |  | * Review of Software for solving general engineer problems.
* Basics of software package Matlab/Simulink with stress to usage in electroenergetics.
* Matlab libraries for symbolic calculation, analysis and planning regulation systems and simulation of electroenergetic devices and systems.
* Programming in Matlab.
* Making graphic user intermediary in Matlab.
* Use of alghorithms for dynamic simulation in Matlab/Simulink software package.
* Review and description of basic electrical network in Matlab/Simulink software package.
 |
| **Temeljni literatura in viri / Readings:** |
| D. C. Hanselman, B. L. Littlefield: Mastering MATLAB 7, Prentice Hall, London, 2005.H. Berger: Automating with SIMATIC, Seond Edition, Publicis Corporate Publishing, Erlangen, 2003.P. Kundur: Power System Stability ang Control, McGraw-Hill, Inc., New York, 1994. |
| **Cilji in kompetence:** |  | **Objectives and competences:** |
| Znanje in razumevanje:* izbrati ustrezno programsko opremo za reševanje problemov v elektrotehniki,
* Izkazati razumevanje delovanja osnovnih programskih orodij namenjenih uporabi v elektroenergetiki,
* Uporabiti programsko opremo za reševanje osnovnih problemov v elektroenergetiki.

Prenesljive/ključne spretnosti in drugi atributi:* spretnosti komuniciranja: ustni zagovor vaj, pisno izražanje pri pisnem izpitu,
* uporaba informacijske tehnologije: uporaba programskih orodij,
* reševanje problemov: reševanje osnovnih problemov v elektroenergetiki s pomočjo programskih orodij.
 |  | Knowledge and understanding:* choose suitable software for solving the problems in electrotechincs,
* show understanding of how basic programme tools in electroenergetics work,
* use software for solving basic problems in electroenergetics.

Transferable/Key Skills and other attributes:* abilty to communicate: oral defense of seminars, written expression at exam,
* usage of information technology: usage of programme tools,
* solving the problems: solving the basic problems in electroenergetics with programme tools.
 |
| **Predvideni študijski rezultati:** |  | **Intended learning outcomes:** |
| Znanje in razumevanje:* izbrati ustrezno programsko opremo za reševanje problemov v elektrotehniki,
* Izkazati razumevanje delovanja osnovnih programskih orodij namenjenih uporabi v elektroenergetiki,
* Uporabiti programsko opremo za reševanje osnovnih problemov v elektroenergetiki.
 |  | Knowledge and understanding:* choose suitable software for solving the problems in electrotechincs,
* show understanding of how basic programme tools in electroenergetics work,
* use software for solving basic problems in electroenergetics.
 |
| Prenesljive/ključne spretnosti in drugi atributi:* spretnosti komuniciranja: ustni zagovor vaj, pisno izražanje pri pisnem izpitu,
* uporaba informacijske tehnologije: uporaba programskih orodij,
* reševanje problemov: reševanje osnovnih problemov v elektroenergetiki s pomočjo programskih orodij.
 |  | Transferable/Key Skills and other attributes:* abilty to communicate: oral defense of seminars, written expression at exam,
* usage of information technology: usage of programme tools,
* solving the problems: solving the basic problems in electroenergetics with programme tools.
 |
| **Metode poučevanja in učenja:** |  | **Learning and teaching methods:** |
| Predavanja.Računalniške vaje.Samostojno delo. |  | Lectures.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:**  |
| 1. SEME, Sebastijan, LUKAČ, Niko, ŠTUMBERGER, Bojan, HADŽISELIMOVIĆ, Miralem. Power quality experimental analysis of grid-connected photovoltaic systems in urban distribution networks. Energy, ISSN 0360-5442. [Print ed.], 2017, str. [1-6].2. CRNKOVIĆ, Damir, HEDERIĆ, Željko, HADŽISELIMOVIĆ, Miralem. Transition to a common 20kV distribution network = Prehod na skupno 20kV distribucijsko omrežje. Journal of energy technology, ISSN 1855-5748. [Tiskana izd.], May 2012, vol. 5, iss. 2, str. 51-633. HADŽISELIMOVIĆ, Miralem, BLAZNIK, Matic, ŠTUMBERGER, Bojan, ZAGRADIŠNIK, Ivan. Magnetically nonlinear dynamic model of a series wound DC motor. Przeglęad Elektrotechniczny, ISSN 0033-2097, 2011, vol. 87, iss. 12b, str. 60-64.4. HADŽISELIMOVIĆ, Miralem, ŠTUMBERGER, Gorazd, ŠTUMBERGER, Bojan, ZAGRADIŠNIK, Ivan. Magnetically nonlinear dynamic model of synchronous motor with permanent magnets. Journal of Magnetism and Magnetic Materials, ISSN 0304-8853. [Print ed.], 2007, vol. 316, iss. 2, str. e257-e260.5. HADŽISELIMOVIĆ, Miralem, ŠTUMBERGER, Gorazd, ŠTUMBERGER, Bojan, ZAGRADIŠNIK, Ivan. Modeling of permanent magnet synchronous motor in d-q coordinates. Przeglęad Elektrotechniczny, ISSN 0033-2097, 2005, letn. 81, št. 12, str. 38-40. |

|  |
| --- |
| **UČNI NAČRT PREDMETA / COURSE SYLLABUS** |
| **Predmet:** | **AGREGATI IN PRETVORNIKI** |
| **Course title:** | **ELECTRICAL GENERATOR SETS AND CONVERTERS** |
|  |  |  |  |
| **Študijski program in stopnja****Study programme and level** | **Študijska smer****Study field** | **Letnik****Academic year** | **Semester****Semester** |
| ENERGETIKA, 1. stopnja  |  | 3 | 1 |
| ENERGY TECHNOLOGY, 1.degree |  | 3 | 1 |
|  |
| **Vrsta predmeta / Course type** | Izbirni/Elective |
|  |  |
| **Univerzitetna koda predmeta / University course code:** | V |
|  |
| **Predavanja****Lectures** | **Seminar****Seminar** | **Vaje****Tutorial** | **Klinične vaje****work** | **Druge oblike študija** | **Samost. delo****Individ. work** |  | **ECTS** |
| **25** |  | **30** |  |  | **65** |  | **4** |
| **AV** | **LV** | **RV** |  |
|  | **20** | **10** |  |
|  |
| **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):** |
| * Proizvodnja električne energije iz obnovljivih virov z enosmernim generatorjem; otočno in paralelno obratovanje; možnosti priklopa na električno omrežje in ustrezna pretvorniška vezja.
* Proizvodnja električne energije iz obnovljivih virov s sinhronskim generatorjem; otočno in paralelno obratovanje; možnosti priklopa na električno omrežje in ustrezna pretvorniška vezja.
* Proizvodnja električne energije iz obnovljivih virov z asinhronskim generatorjem s kratkostično kletko; otočno in paralelno obratovanje; možnosti priklopa na električno omrežje in ustrezna pretvorniška vezja.
* Proizvodnja električne energije iz obnovljivih virov z asinhronskim generatorjem z navitim rotorjem in rotorskim napajanjem; otočno in paralelno obratovanje; možnosti priklopa na električno omrežje in ustrezna pretvorniška vezja.
 |  | * Electric power generation from renewable energy sources using DC machine; stand alone and parallel operation; connection to the electric grid and appropriate power electronic converters.
* Electric power generation from renewable energy sources using synchronous machine; stand alone and parallel operation; connection to the electric grid and appropriate power electronic converters.
* Electric power generation from renewable energy sources using squirrel cage rotor induction machine; stand alone and parallel operation; connection to the electric grid and appropriate power electronic converters.
* Electric power generation from renewable energy sources using wound rotor (rotor fed) induction machine; stand alone and parallel operation; connection to the electric grid and appropriate power electronic converters.
 |
| **Temeljni literatura in viri / Readings:** |
| H. Požar: Osnove energetike 1, 2, 3, Školska knjiga, Zagreb, 1992.A. Dolenc, Sinhronski stroj, Univerza v Ljubljani, 1977N. Jenkins, R. Allan, P. Crossley, D. Kirschen, G. Strbac, Embedded generation, IEE, 2000F.A. Farret, M.G. Simons, Integration of alternative sources of energy, Wiley-interscience, 2006B. Wu, High-power converters and AC drives, Wiley-interscience, 2006R Beith, I.P. Burdon, M. Knowles, Micro energy systems, Professional Engineering Publishing, 2004T. Ackermann, Wind power in power systems, , Wiley, 2005I. Boldea: Variable Speed Generators, CRC Press, 2006.M. H. Rashid: Power Electronics Handbook, Devices, Circuits and Applications, Elsevier, 2011.B. M. Wiliamowski, J. D. Irwin: The Industrial Electronics Handbook, Power Electronics and Motor Drives, CRC Press, 2011. |
| **Cilji in kompetence:** |  | **Objectives and competences:** |
| Seznaniti študente s sistemi za pretvarjanje energije obnovljivih virov v električno energijo, ki vključujejo različne vrste agregatov, različnih pretvorniških vezij in naprav, ki omogočajo priključitev na električno omrežje.  |  | Students get an insight into devices for electricity production from renewable energy sources including different devices for electric power generation, power electronic converters and devices indispensable for connection to the electric grid. |
| **Predvideni študijski rezultati:** |  | **Intended learning outcomes:** |
| Znanje in razumevanje:Razumevanje osnovnih principov delovanja naprav za proizvodnjo električne energije iz obnovljivih virov, pretvorniških vezij in naprav za povezavo na električno omrežje.  |  | Knowledge and Understanding:Understanding basic principles of electric power generation from renewable energy sources, power electronic converters and devices needed for connection to the electric grid.  |
| Prenesljive/ključne spretnosti in drugi atributi:Poznavanje sistemov za proizvodnjo električne energije iz obnovljivih virov.  |  | Transferable/Key Skills and other attributes:Knowledge of systems for electric power generation from renewable energy sources. |
| **Metode poučevanja in učenja:** |  | **Learning and teaching methods:** |
| Predavanja z uporabo računalniške projekcije in tableLaboratorijske vaje.Računalniške vaje. |  | Lectures by using powerpoint slides and whiteboard.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, HADŽISELIMOVIĆ, Miralem, HREN, Gorazd. Design of fractional-slot permanent magnet synchronous motor with concentrated windings and interior permanent magnets. Prz. Elektrotech., 2013, r. 89, nr. 2b, str. 5-8. <http://pe.org.pl/articles/2013/2b/2.pdf>. [COBISS.SI-ID[1024124764](http://cobiss.izum.si/scripts/cobiss?command=DISPLAY&base=COBIB&RID=1024124764)] HADŽISELIMOVIĆ, Miralem, MLAKAR, Matej, ŠTUMBERGER, Bojan. Impact of pole pair number on the efficiency of an induction generator for a mini hydro power plant. Prz. Elektrotech., 2013, r. 89, nr. 2b, str. 17-20. <http://pe.org.pl/articles/2013/2b/5.pdf>. [COBISS.SI-ID [1024125020](http://cobiss.izum.si/scripts/cobiss?command=DISPLAY&base=COBIB&RID=1024125020)] ŠTUMBERGER, Bojan, MARČIČ, Tine, HADŽISELIMOVIĆ, Miralem. Direct comparison of induction motor and line-start IPM synchronous motor characteristics for semi-hermetic compressor drives. IEEE transactions on industry applications, 2012, vol. 48, no 6, str. 2310-2321.<http://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=6352909>, doi: [10.1109/TIA.2012.2227094](http://dx.doi.org/10.1109/TIA.2012.2227094). [COBISS.SI-ID [72594433](http://cobiss.izum.si/scripts/cobiss?command=DISPLAY&base=COBIB&RID=72594433)]ŠTUMBERGER, Bojan, HADŽISELIMOVIĆ, Miralem. Power and cooling capability of synchronous generator with interior permanent magnets : laboratory verification of machine characteristics. Prz. Elektrotech., 2011, vol. 87, iss. 3, str. 183-186. [COBISS.SI-ID [14870294](http://cobiss.izum.si/scripts/cobiss?command=DISPLAY&base=COBIB&RID=14870294)]ŠTUMBERGER, Bojan, ŠTUMBERGER, Gorazd, HADŽISELIMOVIĆ, Miralem, MARČIČ, Tine, VIRTIČ, Peter, TRLEP, Mladen, GORIČAN, Viktor. Design and finite-element analysis of interior permanent magnet synchronous motor with flux barriers. IEEE trans. magn., Nov. 2008, vol. 44, no. 11, str. 4389-4392, doi: [10.1109/TMAG.2008.2002587](http://dx.doi.org/10.1109/TMAG.2008.2002587). [COBISS.SI-ID [12610582](http://cobiss.izum.si/scripts/cobiss?command=DISPLAY&base=COBIB&RID=12610582)]SEME, Sebastijan, POŽUN, Jože, ŠTUMBERGER, Bojan, HADŽISELIMOVIĆ, Miralem. Energy production of different types and orientations of photovoltaic systems under outdoor conditions. *Journal of solar energy engineering : Transactions of the ASME*, ISSN 0199-6231, 2015, vol. 137, issue 2, str. 021021-1 - 021021-10, ilustr., doi: [10.1115/1.4029736](https://doi.org/10.1115/1.4029736). [COBISS.SI-ID [81541633](https://plus.si.cobiss.net/opac7/bib/81541633?lang=sl)] |

|  |
| --- |
| **UČNI NAČRT PREDMETA / COURSE SYLLABUS** |
| **Predmet:** | **NEPORUŠNE JEDRSKE PREISKOVALNE METODE** |
| **Course title:** | **NUCLEAR NONDESTRUCTIVE TESTING METHODS** |
|  |  |  |  |
| **Študijski program in stopnja****Study programme and level** | **Študijska smer****Study field** | **Letnik****Academic year** | **Semester****Semester** |
| ENERGETIKA, 1. stopnja |  | 3 | 1 |
| ENERGY TECHNOLOGY, 1.degree |  | 3 | 1 |
|  |
| **Vrsta predmeta / Course type** | Izbirni/Elective |
|  |  |
| **Univerzitetna koda predmeta / University course code:** | V |
|  |
| **Predavanja****Lectures** | **Seminar****Seminar** | **Vaje****Tutorial** | **Klinične vaje****work** | **Druge oblike študija** | **Samost. delo****Individ. work** |  | **ECTS** |
| **25** |  | **30** |  |  | **65** |  | **4** |
| **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):** |
| 1. Radiometrične metode preiskovanja in uporaba v industriji.2. Autoradiografske metode, (radiografski filmi in nuklearne emuilzije), nevtronsko inducirana autoradiografija, fisionografija in ionska autoradiografija. 3. Radiografske, radioskopske in tomografske metode (uporaba težkih nabitih delcev, delcev beta, pozitronskega sevanja, mehkih žarkov X, žarkov gama in nevtronov).4. Sipanja in uklon jedrskih sevanj (žarki X in nevtroni) in njihova uporaba za določanje notranjih struktur in fizikalnih lastnosti materialov.5.Radioanalitične metode aktivacijske analize z nevtroni, protoni in žarki X in gama. Zakasnele in promptne tehnike instrumentalne aktivacijske analize.6. Pregled preostalih neporušnih metod (ultrazvok) |  | 1. Radiometrical methods of investigation and application in industry.2. Autoradiographic techniques (radiographic films, nuclear emulsions), neutron induced autoradiography, fissionography and ion autoradiography3. Radiographical, radioscopic and tomography methods (use of heavy charged particles, beta particles, positron emission, soft gamma rays, gamma rays and neutrons).4. Scattering and diffraction of nuclear radiation (x-rays and neutrons) and the use for internal structure characterization and physical properties of materials. 5. Radio-analytical activation analysis techniques with neutrons, protons, gamma and x-rays. Delayed and prompt techniques of instrumental activation analyses.6. 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 praktične 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
 | 50 50 | Type (examination, oral, coursework, project):* written examination
* oral examination
 |
| **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].  |
| **UČNI NAČRT PREDMETA / COURSE SYLLABUS** |
| **Predmet:** | **OSNOVE FIZIKE TLAČNOVODNIH REAKTORJEV** |
| **Course title:** | **FUNDAMENTALS OF PWR PHYSICS**  |
|  |  |  |  |
| **Študijski program in stopnja****Study programme and level** | **Študijska smer****Study field** | **Letnik****Academic year** | **Semester****Semester** |
| ENERGETIKA, 1. stopnja |  | 3 | 1 |
| ENERGY TECHNOLOGY, 1.degree |  | 3 | 1 |
|  |
| **Vrsta predmeta / Course type** | Izbirni/Elective |
|  |  |
| **Univerzitetna koda predmeta / University course code:** | V |
|  |
| **Predavanja****Lectures** | **Seminar****Seminar** | **Vaje****Tutorial** | **Klinične vaje****work** | **Druge oblike študija** | **Samost. delo****Individ. work** |  | **ECTS** |
| **25** |  | **30** |  |  | **65** |  | **4** |
| **AV** | **LV** | **RV** |  |
| **30** |  |  |  |
|  |
| **Nosilec predmeta / Lecturer:** | **MARJAN KROMAR** |
|  |
| **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):** |
| * Cepitev jeder
* Nevtronski cikel
* Kinetika reaktorja
* Podkritično pomnoževanje
* Odziv reaktorja pri nizkih in visokih močeh
* Kratkoročne spremembe reaktivnosti
* Srednjeročne spremembe reaktivnosti
* Dolgoročne spremembe reaktivnosti
* Upravljanje z gorivom
* Krmiljenje reaktorja
 |  | * Nuclear fission
* Neutron cycle
* Reactor kinetics
* Subcritical multiplication
* Reactor response at low and high power
* Short term reactivity changes
* Intermediate term reactivity changes
* Long term reactivity changes
* Fuel management
* 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:* Bazično znanje, ki naj omogoči nadaljni bolj poglobljen študij obnašanja jedrskega reaktorja.
* Razvoj veščin in spretnosti v uporabi znanja na svojem konkretnem strokovnem delovnem področju.
 |  | Transferable/Key Skills and other attributes:* Basic skills enabling in-depth study of nuclear reactor.
* 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
 |
| **Načini ocenjevanja:** | Delež (v %) /Weight (in %) | **Assessment:** |
| Način (pisni izpit, ustno izpraševanje, naloge, projekt)* pisni izpit
* domače naloge
 | **70****30** | Type (examination, oral, coursework, project):* written examination
* coursework
 |
| **Reference nosilca / Lecturer's references:**  |
| MERLJAK, Vid, KROMAR, Marjan, TRKOV, Andrej. Verification of kinetic capabilities of the GNOMER neutron diffusion code. Annals of Nuclear Energy, ISSN 0306-4549. [Print ed.], 2017, vol. 109, str. 431-439, doi: /10.1016/j.anucene.2017.04.037. [COBISS.SI-ID 30552103] ĆALIĆ, Dušan, TRKOV, Andrej, KROMAR, Marjan, SNOJ, Luka. Use of Effective Diffusion Homogenization method with the Monte Carlo code for light water reactor. Annals of Nuclear Energy, ISSN 0306-4549. [Print ed.], 2016, vol. 94, str. 392-398. [COBISS.SI-ID 29443879] KROMAR, Marjan, ĆALIĆ, Dušan, KURINČIČ, Bojan. Analysis of the Krško NPP spent fuel storage criticality safety under hypothetical degraded conditions = Analiza zagotovitve varnostne meje pred kritičnostjo bazena za iztrošeno gorivo Nuklearne elektrarne Krško pri hipotetičnih degradiranih pogojih. Journal of energy technology, ISSN 1855-5748. [Tiskana izd.], apr. 2016, iss. 1, vol. 9, str. 11-27, graf. prikazi. [COBISS.SI-ID 29519399] LENGAR, Igor, TRKOV, Andrej, KROMAR, Marjan, SNOJ, Luka. Digital meter of reactivity for use during zero-power physics tests at the Krško NPP = Uporaba digitalnega merilnika reaktivnosti pri zagonskih testih na ničelni moči v NE Krško. Journal of energy technology, ISSN 1855-5748. [Tiskana izd.], feb. 2012, vol. 5, iss. 1, str. 13-26, graf. prikazi. http://www.fe.uni-mb.si/images/stories/jet/e-jet/jet\_5-1.pdf. [COBISS.SI-ID 1024080988] KROMAR, Marjan, KURINČIČ, Bojan. DRAGON and CORD-2 nuclear calculations of the NPP Krško fuel assembly. V: TRKOV, Andrej (ur.), LENGAR, Igor (ur.). Selected and expanded papers from International Conference Nuclear Energy for new Europe 2010, Portorož, September 6-9, 2010, (Nuclear Engineering and Design, ISSN 0029-5493, Vol. 246). Amsterdam: Elevier. 2012, 7 str. [COBISS.SI-ID 24963111] KROMAR, Marjan, KURINČIČ, Bojan. Fine geometrical modeling of the neutron transport in the NPP Krško's fuel, using the Serpent Monte Carlo transport code = Nevtronski transportni izračun goriva Nuklearne elektrarne Krško z Monte Carlo programom Serpent na fini geometrijski mreži. Journal of energy technology, ISSN 1855-5748. [Tiskana izd.], Aug. 2011, vol. 4, iss. 3, str. 33-44. [COBISS.SI-ID 25205287] SNOJ, Luka, KROMAR, Marjan, ŽEROVNIK, Gašper, RAVNIK, Matjaž. Advanced methods in teaching reactor physics. V: MAVKO, Borut (ur.), HASSAN, Yassin A. (ur.), CIZELJ, Leon (ur.). Special issue on the International Conference Nuclear Energy for New Europe 2009, September 14 and 17, 2009, Bled, Slovenija, (Nuclear engineering and design, ISSN 0029-5493, vol. 241, no. 4, 2011). Amsterdam: North-Holland. 2011, vol. 241, issue 4, str. 1008-1012, doi: 10.1016/j.nucengdes.2010.02.040. [COBISS.SI-ID 23623975] KROMAR, Marjan, KURINČIČ, Bojan. Impact of thicker cladding on the nuclear parameters of the NPP Krško fuel = M. Kromar, B. Kurinčič. V: MAVKO, Borut (ur.), HASSAN, Yassin A. (ur.), CIZELJ, Leon (ur.). Special issue on the International Conference Nuclear Energy for New Europe 2009, September 14 and 17, 2009, Bled, Slovenija, (Nuclear engineering and design, ISSN 0029-5493, vol. 241, no. 4, 2011). Amsterdam: North-Holland. 2011, vol. 241, issue 4, str. 1087-1089, doi: 10.1016/j.nucengdes.2010.04.009. [COBISS.SI-ID 23664167] KROMAR, Marjan, TRKOV, Andrej. Nuclear design calculations of the NPP Krško core. Journal of energy technology, ISSN 1855-5748. [Tiskana izd.], 2009, vol. 2, iss. 4, str. 41-50. [COBISS.SI-ID 23313959] |

|  |
| --- |
| **UČNI NAČRT PREDMETA / COURSE SYLLABUS** |
| **Predmet:** | **OSNOVE JEDRSKE IN REAKTORSKE TEHNIKE** |
| **Course title:** | **FUNDAMENTALS OF NUCLEAR ENGINEERING**  |
|  |  |  |  |
| **Študijski program in stopnja****Study programme and level** | **Študijska smer****Study field** | **Letnik****Academic year** | **Semester****Semester** |
| ENERGETIKA, 1. stopnja |  | 3 | 1 |
| ENERGY TECHNOLOGY, 1.degree |  | 3 | 1 |
|  |
| **Vrsta predmeta / Course type** | Izbirni/Elective |
|  |  |
| **Univerzitetna koda predmeta / University course code:** | V |
|  |
| **Predavanja****Lectures** | **Seminar****Seminar** | **Vaje****Tutorial** | **Klinične vaje****work** | **Druge oblike študija** | **Samost. delo****Individ. work** |  | **ECTS** |
| **25** |  | **30** |  |  | **65** |  | **4** |
| **AV** | **LV** | **RV** |  |
| **30** |  |  |  |
|  |
| **Nosilec predmeta / Lecturer:** | **MARJAN KROMAR** |
|  |
| **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):** |
| * Lastnosti jeder, zgradba jedra (lupinski model, magična števila, razlike in podobnosti med atomsko in jedrsko fiziko)
* Jedrske reakcije (vezavna energija, endotermične in eksotermične reakcije, jedrski presek, absorpcija nevtronov in sipalni presek)
* Radioaktivni razpad in stabilnost jeder (alfa, beta, gama razpad, ostali razpadi, razpadne verige, transmutacija)
* Jedrska cepitev (razcep, verižne reakcija, pomen termičnih nevtronov, enačba štirih faktorjev)
* Termalizacija in transport nevtronov (termični spekter nevtronov, moderacija nevtronov, kritičnost, eno-grupna teorija difuzije nevtronov, več-grupni približek)
* Nadzor verižne reakcije (absorberji, cepitveni produkti, zgorevanje goriva in učinek na potek jedrske reakcije, nadzor reaktivnosti, stabilnost reaktorja)
* Ionizacijsko sevanje, izvori, interakcije in detekcije sevanja, biološki učinki in zaščita.
* Osnove varnega obratovanja reaktorja.
 |  | * Properties of the nucleus (Shell models, magic numbers, contrast between atomic and nuclear physics)
* Nuclear reactions (nuclear binding energy, exothermic and endothermic nuclear reactions, cross-sections, neutron absorption and scattering cross-sections)
* Radioactive decay and stability of nucleus (alpha, beta and gamma decay, decay chains, transmutation)
* Fission (chain reaction, thermal neutron importance, four factor equation)
* Moderation and neutron transport (thermal neutron spectrum, criticality, one-group and multi-group approximation, diffusion)
* Control of chain reaction (absorption, fission products, burnup, reactor control and stability)
* Ionizing radiation, sources, interactions with matter and detection, biological effects, shielding
* Safe operation of fission reactors
 |
| **Temeljni literatura in viri / Readings:** |
| Raymond L. Murray: Nuclear energy – an introduction to the concepts, systems and application of nuclear processes. Elsevier, 6nd Edition, Amsterdam, 2009.John R. Lamarsh, Anthony J. Baratta: Introduction to Nuclear Engineering, 3th Editrion. Prentice Hall, New Jersey, 2001. |
| **Cilji in kompetence:** |  | **Objectives and competences:** |
| Pridobiti znanje za temeljito razumevanje procesov pridobivanja jedrske energije in uporabe jedrskega sevanja, potencialne nevarnosti pri izkoriščanju ter sposobnost vključitve v dejavnosti povezanimi z načrtovanjem, izgradnjo in vzdrževanjem jedrskih in sevalnih naprav v industrijskih in nekaterih zdravstvenih okoljih. |  | Introduce students to nuclear structure, explain how conservation principles (energy, angular momentum, parity) play a role in determining whether decay is possible and how this affects the associated half-life.Introduce students to the concept of a cross-section and most especially neutron interaction cross-sections. Explain how energy from nuclear ractions can be used in nuclear reactors, in industry and in medicine. |
| **Predvideni študijski rezultati:** |  | **Intended learning outcomes:** |
| Znanje in razumevanje:Razumevanje in sposobnost uporabe načela jedrskih reakcij, modela jedra in jedrskega razcepa za energetske potrebe. Poznavanje jedrske strukture uporabijo pri zaščiti pred sevanjem, oblikovanja strategij za varno obratovanje jedrskega reaktorja, skladiščenje radioaktivnih odpadkov in dejavnosti povezanimi z ostalimi sevalnimi napravami. |  | Knowledge and understanding:Students gain knowledge about nuclear structure, radioactive decay and nuclear reactions. They understand how this effects the use of nuclear energy in industry and in medicine. They know how to apply their knowledge for safe use of nuclear energy and for shielding against ionizing radiation (from nuclear waste or other sources of ionizing radiation) . |
| Prenesljive/ključne spretnosti in drugi atributi:Sposobnost uporabe pridobljenega teoretičnega znanja v praksi. |  | Transferable/Key Skills and other attributes:Ability to use gained theory and knowledge in practice. |
| **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:**  |
| MERLJAK, Vid, KROMAR, Marjan, TRKOV, Andrej. Verification of kinetic capabilities of the GNOMER neutron diffusion code. Annals of Nuclear Energy, ISSN 0306-4549. [Print ed.], 2017, vol. 109, str. 431-439, doi: /10.1016/j.anucene.2017.04.037. [COBISS.SI-ID 30552103] ĆALIĆ, Dušan, TRKOV, Andrej, KROMAR, Marjan, SNOJ, Luka. Use of Effective Diffusion Homogenization method with the Monte Carlo code for light water reactor. Annals of Nuclear Energy, ISSN 0306-4549. [Print ed.], 2016, vol. 94, str. 392-398. [COBISS.SI-ID 29443879] KROMAR, Marjan, ĆALIĆ, Dušan, KURINČIČ, Bojan. Analysis of the Krško NPP spent fuel storage criticality safety under hypothetical degraded conditions = Analiza zagotovitve varnostne meje pred kritičnostjo bazena za iztrošeno gorivo Nuklearne elektrarne Krško pri hipotetičnih degradiranih pogojih. Journal of energy technology, ISSN 1855-5748. [Tiskana izd.], apr. 2016, iss. 1, vol. 9, str. 11-27, graf. prikazi. [COBISS.SI-ID 29519399] LENGAR, Igor, TRKOV, Andrej, KROMAR, Marjan, SNOJ, Luka. Digital meter of reactivity for use during zero-power physics tests at the Krško NPP = Uporaba digitalnega merilnika reaktivnosti pri zagonskih testih na ničelni moči v NE Krško. Journal of energy technology, ISSN 1855-5748. [Tiskana izd.], feb. 2012, vol. 5, iss. 1, str. 13-26, graf. prikazi. http://www.fe.uni-mb.si/images/stories/jet/e-jet/jet\_5-1.pdf. [COBISS.SI-ID 1024080988] KROMAR, Marjan, KURINČIČ, Bojan. DRAGON and CORD-2 nuclear calculations of the NPP Krško fuel assembly. V: TRKOV, Andrej (ur.), LENGAR, Igor (ur.). Selected and expanded papers from International Conference Nuclear Energy for new Europe 2010, Portorož, September 6-9, 2010, (Nuclear Engineering and Design, ISSN 0029-5493, Vol. 246). Amsterdam: Elevier. 2012, 7 str. [COBISS.SI-ID 24963111] KROMAR, Marjan, KURINČIČ, Bojan. Fine geometrical modeling of the neutron transport in the NPP Krško's fuel, using the Serpent Monte Carlo transport code = Nevtronski transportni izračun goriva Nuklearne elektrarne Krško z Monte Carlo programom Serpent na fini geometrijski mreži. Journal of energy technology, ISSN 1855-5748. [Tiskana izd.], Aug. 2011, vol. 4, iss. 3, str. 33-44. [COBISS.SI-ID 25205287] SNOJ, Luka, KROMAR, Marjan, ŽEROVNIK, Gašper, RAVNIK, Matjaž. Advanced methods in teaching reactor physics. V: MAVKO, Borut (ur.), HASSAN, Yassin A. (ur.), CIZELJ, Leon (ur.). Special issue on the International Conference Nuclear Energy for New Europe 2009, September 14 and 17, 2009, Bled, Slovenija, (Nuclear engineering and design, ISSN 0029-5493, vol. 241, no. 4, 2011). Amsterdam: North-Holland. 2011, vol. 241, issue 4, str. 1008-1012, doi: 10.1016/j.nucengdes.2010.02.040. [COBISS.SI-ID 23623975] KROMAR, Marjan, KURINČIČ, Bojan. Impact of thicker cladding on the nuclear parameters of the NPP Krško fuel = M. Kromar, B. Kurinčič. V: MAVKO, Borut (ur.), HASSAN, Yassin A. (ur.), CIZELJ, Leon (ur.). Special issue on the International Conference Nuclear Energy for New Europe 2009, September 14 and 17, 2009, Bled, Slovenija, (Nuclear engineering and design, ISSN 0029-5493, vol. 241, no. 4, 2011). Amsterdam: North-Holland. 2011, vol. 241, issue 4, str. 1087-1089, doi: 10.1016/j.nucengdes.2010.04.009. [COBISS.SI-ID 23664167] KROMAR, Marjan, TRKOV, Andrej. Nuclear design calculations of the NPP Krško core. Journal of energy technology, ISSN 1855-5748. [Tiskana izd.], 2009, vol. 2, iss. 4, str. 41-50. [COBISS.SI-ID 23313959] |

|  |
| --- |
| **UČNI NAČRT PREDMETA / COURSE SYLLABUS** |
| **Predmet:** | **TEHNOLOGIJA IN OBRATOVANJE JEDRSKIH NAPRAV** |
| **Course title:** | **TECHNOLOGY AND WORKING OF NUCLEAR INSTALATIONS** |
|  |  |  |  |
| **Študijski program in stopnja****Study programme and level** | **Študijska smer****Study field** | **Letnik****Academic year** | **Semester****Semester** |
| ENERGETIKA, 1. stopnja |  | 3 | 1 |
| ENERGY TECHNOLOGY, 1.degree |  | 3 | 1 |
|  |
| **Vrsta predmeta / Course type** | Izbirni/Elective |
|  |  |
| **Univerzitetna koda predmeta / University course code:** | V |
|  |
| **Predavanja****Lectures** | **Seminar****Seminar** | **Vaje****Tutorial** | **Klinične vaje****work** | **Druge oblike študija** | **Samost. delo****Individ. work** |  | **ECTS** |
| **25** |  | **30** |  |  | **65** |  | **4** |
| **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:** |  | **Prerequisits:** |
| Ni pogojev. |  | None. |
| **Vsebina:**  |  | **Content (Syllabus outline):** |
| * Izvor jedrske energije.
* Jedrsko gorivo – pridobivanje urana in torija, cepljivi izotopi.
* Tipi jedrskih reaktorjev.
* Pridobivanje cepljivih izotopov v jedrskih reaktorjih (oplodni reaktorji).
* Cepitveni produkti v izrabljenem gorivu, reprocesiranje goriva in jedrske lastnosti radioaktivnih odpadkov.
 |  | * Source of nuclear power.
* Nuclear fuels – uranium and thorium resources, fissile isotopes.
* Nuclear reactor types.
* Fissile material breeding (breeder reactors).
* Fission products in burnt fuel, reprocessing and nuclear properties of radioactive waste.
 |
| **Temeljni literatura in viri / Readings:** |
| J. R. Lamarsh, »Introduction to Nuclear Engineering«, Addison Wesley 1975.B Cvikl: Jedrske in sevalne naprave, Fakulteta za energetiko, UM , 2014, študijsko gradivo, 134 strani. J. K. Shultis, R. E. Faw, Fundamentals of Nuclear Science and Engineering, Taylor&Francis, ZDA, 2008.S. Glasstone, A. Sesonske, »Nuclear Reactor Engineering«, Van Nostrand, 1967. |
| **Cilji in kompetence:** |  | **Objectives and competences:** |
| Seznanitev s fizikalnimi osnovami jedrske energetike. |  | Familiarisation with the basic technicalities of nuclear power utilisation. |
| **Predvideni študijski rezultati:** |  | **Intended learning outcomes:** |
| Znanje in razumevanje:* znanje o osnovah jedrske energetike
* sposobnost uporabe pridobljenega teoretičnega znanja v praksi
* avtonomnost v svojem strokovnem delu in zavezanost profesionalni etiki
 |  | Knowledge and understanding:* knowledge on fundamental principles of the nuclear power utilisation
* ability to use theoretical knowledge in practice
* independence in professional work and obligation to professional ethics
 |
| Prenesljive/ključne spretnosti in drugi atributi:razvoj veščin in spretnosti v uporabi znanja na svojem konkretnem strokovnem delovnem področju. |  | Transferable/Key Skills and other attributes:development of skills and expertise in the use of knowledge in a specific technical working area. |
| **Metode poučevanja in učenja:** |  | **Learning and teaching methods:** |
| * Predavanja
* 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
 | 7030 | 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] 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] 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] SIN, M., CAPOTE, R., HERMAN, M., TRKOV, Andrej. Modelling neutron-induced reactions on [sup]232-237U from 10 keV up to 30 MeV. Nuclear data sheets, ISSN 0090-3752, 2017, vol. 139, str. 138-170. [COBISS.SI-ID 30188327] TRKOV, Andrej, RADULOVIĆ, Vladimir. Nuclear reactions and physical models for neutron activation analysis. Journal of radioanalytical and nuclear chemistry, ISSN 0236-5731, 2015, iss. 2, vol. 304, str. 763-778. [COBISS.SI-ID 28476455]TRKOV, Andrej, CAPOTE, R., PRONYAEV, V.G. Current issues in nuclear data evaluation methodology: : [sup]235U prompt fission neutron spectra and multiplicity for thermal neutrons. Nuclear data sheets, ISSN 0090-3752, 2015, vol. 123, str. 8-15. [COBISS.SI-ID 28385831] ŽEROVNIK, Gašper, TRKOV, Andrej, KODELI, Ivan Aleksander, CAPOTE, R., SMITH, D. L. Random sampling of correlated parameters - a consistent solution for unfavourable conditions. Nuclear data sheets, ISSN 0090-3752, 2015, vol. 123, str. 185-190. [COBISS.SI-ID 28314919] |

|  |
| --- |
| **UČNI NAČRT PREDMETA / COURSE SYLLABUS** |
| **Predmet:** | **MATERIALI V JEDRSKI ENERGETIKI** |
| **Course title:** | **NUCLEAR ENGINEERING MATERIALS** |
|  |  |  |  |
| **Študijski program in stopnja****Study programme and level** | **Študijska smer****Study field** | **Letnik****Academic year** | **Semester****Semester** |
| ENERGETIKA, 1. stopnja  |  | 3 | 1 |
| ENERGY TECHNOLOGY, 1.degree |  | 3 | 1 |
|  |
| **Vrsta predmeta / Course type** | Izbirni/Elective |
|  |  |
| **Univerzitetna koda predmeta / University course code:** | V |
|  |
| **Predavanja****Lectures** | **Seminar****Seminar** | **Vaje****Tutorial** | **Klinične vaje****work** | **Druge oblike študija** | **Samost. delo****Individ. work** |  | **ECTS** |
| **25** |  | **30** |  |  | **65** |  | **4** |
| **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):** |
| 1. Pregled znanosti o materialih, 2. Jedrska energija in materiali, 3. Lastnosti in zahteve reaktorskih materialov, 4. Osnove sevalnih poškodb, 5. Sevalne poškodbe reaktorskih materialov, 6. Korozija, Jedrski gorivni krog fisijskih reaktorjev, 8. Uran, 9. Torij, 10. Plutonij in aktinidi,11 Pridobivanje urana iz rud, 12. Izotopska obogatitev, 13. Izdelava gorivnih elementov, 14. Lastnosti obsevanega goriva, 15. Predelava jedrskega goriva, 16. Shranjevanje jedrskega goriva, 17. Jedrski gorivni krog fuzijskih reaktorjev, 18. Separacija vodika in drugih lahkih elementov, 19. Interakcija plazme s prvo steno fuzijskih reaktorjev, 20. Strukturni materiali jedrski reaktorjev: kovine, keramike, kovino-keramike, 21. Materiali za moderatorje, reflektorje, obloge in hladila, 22. Materiali za kontrolo, zaščito in varnostne sisteme, 23. Materiali za gorivne elemente, hladilne sisteme in reaktorske posode fisijskih reaktorjev, 24. Strukturni materiali za hitre fisijske reaktorje. |  | 1. Introduction into material sciences
2. Material sciences and nuclear energy
3. Nuclear reactor properties and material requirements
4. Fundamentals of radiation damage
5. Radiation damage of reactor materials
6. Corrosion
7. Fission reactor fuel cycle
8. Uranium
9. Thorium
10. Plutonium and actinides
11. Uranium mining and extraction
12. Enrichment
13. Fuel elements manufacturing
14. Properties of irradiated fuel
15. Fuel reprocessing
16. Irradiated fuel storage
17. Fusion reactor fuel cycle
18. Separation of hydrogen and other light elements
19. Plasma interaction with first wall
20. Structural materials of nuclear reactors: metals, ceramics, composites
21. Moderator, reflector and cooling materials
22. Control, shielding and protection materials
23. Fuel element cladding, calling system and vessel internals materials
24. Fast fission reactor structural materials
 |
| **Temeljni literatura in viri / Readings:** |
| B. M. Ma, Nuclear Reactors Materials and Applications, Van Nostrand Reinhold, New York, 1983.R. Istenič, B. Cvikl, R. Ilić, Materiali v jedrski energetiki, 90 strani, Univerza v Mariboru in Inštitut “Jožef Stefan”, Ljubljana, 2010.K. Hellan, Introduction to fracture mechanics, McGraw Hill Book Co – Singapore, 1985. |
| **Cilji in kompetence:** |  | **Objectives and competences:** |
| Dopolniti znanje o znanosti o materialih, ki obravnava notranjo strukturo materialov in njeno povezavo s karakteristikami materialov in njihovim obnašanjem pri različnih pogojih. Spoznati sevalne poškodbe, korozijo, jedrska goriva, lastnosti in zahteve reaktorskih materialov in materialov za strukturne dele jedrskih elektrarn. |  | To supplement knowledge of materials, that deals with inside structure of materials and its connection with characteristics of materials and their behaviour under different conditions. To gain knowledge of radiation damage, corrosion, nuclear fuels, characteristics and demands of reactor materials and materials for structual parts of nuclear plants. |
| **Predvideni študijski rezultati:** |  | **Intended learning outcomes:** |
| Znanje in razumevanje:Poznavanje lastnosti pogostih materialov, ki se uporabljajo v jedrski elektrarni, pozna osnovne termodinamske, toplotne in sevalne učinke na te materiale, pozna osnovne efekte korozije. |  | Knowledge and understanding:Knowledge of characteristic of repeated materials that are used in nuclear energy, knowledge of basics of thermodinamics, heat and radiation effects on these materials, knowledge od basic corrosion effects. |
| Prenesljive/ključne spretnosti in drugi atributi:Pozna glavne načine odpovedi jedrskega goriva in ostalih materialov, pozna vpliv plinastih cepitvenih produktov, pozna termično in vibracijsko utrujanje materialov. |  | Transferable/Key Skills and other attributes:Knowledge of main methods of denunciation of nuclear fuel and other materials, knowledge of influence over gas splitting products, knowledge of termic and vibratrational fatigue of materials. |
| **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.  |  | Lectures: the students gets acquainted with theoretical content of the subject.Tutorial: the student upgrades the theoretical knowledge with practical experience. |
| **Načini ocenjevanja:** | Delež (v %) /Weight (in %) | **Assessment:** |
| Način (pisni izpit, ustno izpraševanje, naloge, projekt)* pisni izpit
* ustni izpit
 | **50****50** | Type (examination, oral, coursework, project):written examinationoral examination |
| **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]. |

|  |
| --- |
| **UČNI NAČRT PREDMETA / COURSE SYLLABUS** |
| **Predmet:** | **SEVANJE IN VARSTVO PRED SEVANJI** |
| **Course title:** | **FUNDAMENTALS OF RADIATION PROTECTION** |
|  |  |  |  |
| **Študijski program in stopnja****Study programme and level** | **Študijska smer****Study field** | **Letnik****Academic year** | **Semester****Semester** |
| ENERGETIKA, 1. stopnja |  | 3 | 1 |
| ENERGY TECHNOLOGY, 1.degree |  | 3 | 1 |
|  |
| **Vrsta predmeta / Course type** | Izbirni/Elective |
|  |  |
| **Univerzitetna koda predmeta / University course code:** | V |
|  |
| **Predavanja****Lectures** | **Seminar****Seminar** | **Vaje****Tutorial** | **Klinične vaje****work** | **Druge oblike študija** | **Samost. delo****Individ. work** |  | **ECTS** |
| **25** |  | **30** |  |  | **65** |  | **4** |
| **AV** | **LV** | **RV** |  |
| **20** | **10** |  |  |
|  |
| **Nosilec predmeta / Lecturer:** | **BRUNO CVIKL** |
|  |
| **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. Izvori sevanja, 2. Interakcija sevanja s snovjo, 3. Transport energije sevanja, 4. Dozimetrija, 5. Učinki sevanja, 6. Postopki in načini zaščite pred sevanjem, 7. ALARA pristop8. Radiobiologija, 9. Meritev sevanja, 10. Mednarodna priporočila in standardi11. Zakonodaja s področja varstva pred sevanji |  | 1. Radiation sources
2. Interaction with matter
3. Radiation propagation
4. Dosimetry
5. Radiation effects
6. Radiation protection means and procedures
7. ALARA approach
8. Radiobiology
9. Radiation detection
10. International recommendations
11. Radiation protection legislation
 |
| **Temeljni literatura in viri / Readings:** |
| A. E. Profio, Radiation Shielding and Dosimetry, John Wiley Sons, New York, 1979.H H. Cember, T. E. Johnson, Introduction to Health Physics, McGraw-Hill, 2009.M. G. Stabin, Radiation Protection and Dosimetry, An Introduction to Health Physics, Springer Science+Business Media LLC, 2007.M. Koželj, Delo z viri sevanj. 1. izd. Ljubljana: Ministrstvo za okolje in prostor, Uprava RS za jedrsko varnost, 2006.M. Koželj, I. Jenčič, V. Slapar Borišek, T. Bučar, Varstvo pred sevanji za delavce v industriji in ostalih dejavnostih, Ljubljana: Izobraževalni center za jedrsko tehnologijo Milana Čopiča IJS , 2016.  |
| **Cilji in kompetence:** |  | **Objectives and competences:** |
| Podati osnove zaščite pred sevanji, navesti osnovne vplive sevanja na organizme, podati uporabe različnih materialov za zaščito pred sevanji. Spoznati osnovne načine detekcije in meritve sevanja. |  | To introduce the students with the field of radiation protection. Explain how radiation reacts with materials. Explain how biological effects take place and what the effects of radiation on living organisms are. Explain what the basis for radiation detection and measurements are. |
| **Predvideni študijski rezultati:** |  | **Intended learning outcomes:** |
| Znanje in razumevanje:Slušatelj je sposoben spoznati osnovna načela zaščite pred sevanji, pozna osnovne metode zaščite pred sevanji. |  | Knowledge and understanding:Students gain knowledge about radiation, radiation detection and protection. Ability to use gained theory and knowledge in practice |
| Prenesljive/ključne spretnosti in drugi atributi: |  | Transferable/Key Skills and other attributes: |
| **Metode poučevanja in učenja:** |  | **Learning and teaching methods:** |
| Predavanja, pri katerih študent spozna teoretične vsebine predmeta. Pri praktičnih vajah v sevalno opremljenem laboratoriju FE, UM študent spozna detekcijo sevanja in zaščito pred sevanji v praksi. Razširitev znanj na reaktorju TRIGA Inštituta »J. Stefan«. |  | Lectures, seminars and demonstrations at radiation laboratory and TRIGA research reactor.Experience gained during the obligatory project work in the FE, UM radiation laboratory. |
| **Načini ocenjevanja:** | Delež (v %) /Weight (in %) | **Assessment:** |
| Način (pisni izpit, ustno izpraševanje, naloge, projekt)* ustni izpit
* pisni izpit
* končana praktična naloga v sevalnem laboratoriju FE, UM
 | **40****40****20** | Type (examination, oral, coursework, project):* oral exam
* written exam
* written report on experiment performed in the FE laboratory.
 |
| **Reference nosilca / Lecturer's references:**  |
| **1.** KOŽELJ, Matjaž, CVIKL, Bruno. The negative mobility : An outcome of the electric field at the hole-injecting metal/organic semiconductor interface that varies as a linear function of the applied bias. *Thin Solid Films*, ISSN 0040-6090. [Print ed.], 2016, vol. 616, str. 786-792. [COBISS.SI-ID [29908775](https://plus.si.cobiss.net/opac7/bib/29908775?lang=sl)]**2.** KOŽELJ, Matjaž, CVIKL, Bruno. The inverted distorted parabola-like shape of the bias-dependent electric field at an electron-injecting metal/organic interface deduced using the current-voltage method = Obrnjena, deformirani paraboli podobna odvisnost električnega polja od pritisnjene napetosti na vmesni ploskvi kovina/organski polprevodnik izpeljana z uporabo metode tokovne karakteristike. *Journal of energy technology*, ISSN 1855-5748. [Tiskana izd.], Oct. 2015, iss. 2, vol. 8, str. 17-30, ilustr. [COBISS.SI-ID [29211175](https://plus.si.cobiss.net/opac7/bib/29211175?lang=sl)] **3.** CVIKL, Bruno. The electric field at hole injecting metal/organic interfaces as a cause for manifestation of exponential bias-dependent mobility. *Thin Solid Films*, ISSN 0040-6090. [Print ed.], 2014, vol. 573, str, 56-66. [COBISS.SI-ID [28142119](https://plus.si.cobiss.net/opac7/bib/28142119?lang=sl)]. **4.** CVIKL, Bruno. Line shapes in the current voltage characteristics of single layer metal/organic semiconductor structures as response to the electric field at the charge injecting interface. *Thin Solid Films*, ISSN 0040-6090. [Print ed.], 2013, vol. 542, str. 380-387. [COBISS.SI-ID [26994727](https://plus.si.cobiss.net/opac7/bib/26994727?lang=sl)]. **5.** CVIKL, Bruno. The elimination of interface charge density singularity in single layer organic semiconductor structures. *Journal of applied physics*, ISSN 0021-8979, 2011, vol. 110, issue 3, str. 033723-1-033723-9. [COBISS.SI-ID [24972839](https://plus.si.cobiss.net/opac7/bib/24972839?lang=sl)].**6.** KOŽELJ, Matjaž, JENČIČ, Igor, SLAPAR BORIŠEK, Vesna, BUČAR, Tinkara, Varstvo pred sevanji za delavce v industriji in ostalih dejavnostih, Ljubljana: Izobraževalni center za jedrsko tehnologijo Milana Čopiča IJS , 2016. 167 str.**7.** JENČIČ, Igor, KOŽELJ, Matjaž. Osnove varstva pred sevanji. Ljubljana: Izobraževalni center za jedrsko tehnologijo Milana Čopiča IJS, 2010. 64 str. [COBISS.SI-ID 24262439]**8.** KOŽELJ, Matjaž. Delo z viri sevanj. 1. izd. Ljubljana: Ministrstvo za okolje in prostor, Uprava RS za jedrsko varnost, 2006. ISBN 961-91914-0-4. ISBN 978-961-91914-0-8. [COBISS.SI-ID 229970944]. |

|  |
| --- |
| **UČNI NAČRT PREDMETA / COURSE SYLLABUS** |
| **Predmet:** | **JEDRSKE REAKTORSKE MERITVE** |
| **Course title:** | **NUCLEAR INSTRUMENTATION LABORATORY** |
|  |  |  |  |
| **Študijski program in stopnja****Study programme and level** | **Študijska smer****Study field** | **Letnik****Academic year** | **Semester****Semester** |
| ENERGETIKA, 1. stopnja |  | 3 | 1 |
| ENERGY TECHNOLOGY, 1.degree |  | 3 | 1 |
|  |
| **Vrsta predmeta / Course type** | Izbirni/Elective |
|  |  |
| **Univerzitetna koda predmeta / University course code:** | V |
|  |
| **Predavanja****Lectures** | **Seminar****Seminar** | **Vaje****Tutorial** | **Klinične vaje****work** | **Druge oblike študija** | **Samost. delo****Individ. work** |  | **ECTS** |
| **25** |  | **30** |  |  | **65** |  | **4** |
| **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:** |  | **Prerequisits:** |
| Ni pogojev. |  | None. |
| **Vsebina:**  |  | **Content (Syllabus outline):** |
| * Definicije (nevtronski fluks, spekter, reakcijska hitrost, moc).
* Jedrske lastnosti nevtronskih detektorjev (ionizacijske celice, aktivacijske metode).
* Reaktorska kinetika in reaktivnost.
* Meritve porazdelitve fluksa in spektra nevtronov v reaktorju.
* Meritve reaktivnosti.
 |  | * Definitions (neutron flux, spectrum, reaction rate, power).
* Nuclear properties of neutron detectors (ionisation chambers, activation methods).
* Reactor kinetics and reactivity.
* Measurements of neutron flux distribution, and neutron spectrum in a reactor.
* Reactivity measurements.
 |
| **Temeljni literatura in viri / Readings:** |
| A. F. Henry, »Nuclear Reactor Analysis«, MIT Press, 1975.J. Shaw, Reactor operation, Pergamon press, 1969.B Cvikl: Jedrske in sevalne naprave, Fakulteta za energetiko, UM , 2014, študijsko gradivo, 134 strani. J. K. Shultis, R. E. Faw, Fundamentals of Nuclear Science and Engineering, Taylor&Francis, ZDA, 2008. |
| **Cilji in kompetence:** |  | **Objectives and competences:** |
| Spoznavanje merljivih količin in merskih metod za določanje fizikalnih lastnosti sredice jedrskih reaktorjev. |  | Measurables and measuring techniques for the determination of physical properties of nuclear reactor cores. |
| **Predvideni študijski rezultati:** |  | **Intended learning outcomes:** |
| Znanje in razumevanje:Spoznavanje merskih postopkov za določanje fizikalnih lastnosti sredice jedrskih reaktorjev. |  | Knowledge and understanding:Measurables and measuring techniques for the determination of physical properties of nuclear reactor cores. |
| Prenesljive/ključne spretnosti in drugi atributi:Spoznavanje merskih postopkov za določanje fizikalnih lastnosti sredice jedrskih reaktorjev. |  | Transferable/Key Skills and other attributes:Measurables and measuring techniques for the determination of physical properties of nuclear reactor cores. |
| **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] 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] 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] SIN, M., CAPOTE, R., HERMAN, M., TRKOV, Andrej. Modelling neutron-induced reactions on [sup]232-237U from 10 keV up to 30 MeV. Nuclear data sheets, ISSN 0090-3752, 2017, vol. 139, str. 138-170. [COBISS.SI-ID 30188327] TRKOV, Andrej, RADULOVIĆ, Vladimir. Nuclear reactions and physical models for neutron activation analysis. Journal of radioanalytical and nuclear chemistry, ISSN 0236-5731, 2015, iss. 2, vol. 304, str. 763-778. [COBISS.SI-ID 28476455]TRKOV, Andrej, CAPOTE, R., PRONYAEV, V.G. Current issues in nuclear data evaluation methodology: : [sup]235U prompt fission neutron spectra and multiplicity for thermal neutrons. Nuclear data sheets, ISSN 0090-3752, 2015, vol. 123, str. 8-15. [COBISS.SI-ID 28385831] ŽEROVNIK, Gašper, TRKOV, Andrej, KODELI, Ivan Aleksander, CAPOTE, R., SMITH, D. L. Random sampling of correlated parameters - a consistent solution for unfavourable conditions. Nuclear data sheets, ISSN 0090-3752, 2015, vol. 123, str. 185-190. [COBISS.SI-ID 28314919] |

|  |
| --- |
| **UČNI NAČRT PREDMETA / COURSE SYLLABUS** |
| **Predmet:** | **RAVNANJE Z RADIOAKTIVNIMI ODPADKI IN IZRABLJENIM JEDRSKIM GORIVOM** |
| **Course title:** | **RADIOACTIVE WASTE AND SPENT FUEL MANAGMENT** |
|  |  |  |  |
| **Študijski program in stopnja****Study programme and level** | **Študijska smer****Study field** | **Letnik****Academic year** | **Semester****Semester** |
| ENERGETIKA, 1. stopnja  |  | 3 | 1 |
| ENERGY TECHNOLOGY, 1.degree |  | 3 | 1 |
|  |
| **Vrsta predmeta / Course type** | Izbirni/Elective |
|  |  |
| **Univerzitetna koda predmeta / University course code:** | V |
|  |
| **Predavanja****Lectures** | **Seminar****Seminar** | **Vaje****Tutorial** | **Klinične vaje****work** | **Druge oblike študija** | **Samost. delo****Individ. work** |  | **ECTS** |
| **25** |  | **30** |  |  | **65** |  | **4** |
| **AV** | **LV** | **RV** |  |
| **30** |  |  |  |
|  |
| **Nosilec predmeta / Lecturer:** | **TOMAŽ ŽAGAR** |
|  |
| **Jeziki /** **Languages:** | **Predavanja / Lectures:** | slovenski / Slovene |
| **Vaje / Tutorial:** | slovenski / Slovene |
| **Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:** |  | **Prerequisits:** |
| Vpis v letnik.Opravljene seminarske naloge in udeležba pri ogeldu na terenu so pogoj za pristop k opravljanju izpita. |  | Enrollment into the program. Completed seminar assignment and participation on field visit are necessary to enter the exam. |
| **Vsebina:**  |  | **Content (Syllabus outline):** |
| **Radioaktivni odpadki, obsevano jedrsko gorivo in odpadki iz jedrskega gorivnega kroga:**- viri in vrste radioaktivnih odpadkov- izrabljeno jedrsko gorivo in radioaktivni odpadki iz jedrskega gorivnega kroga - obdelava in priprava radioaktivnih odpadkov;- skladiščenje radioaktivnih odpadkov; - ravnanje z izrabljenim jedrskim gorivom pred odlaganjem;- odlaganje radioaktivnih odpadkov in izrabljenega jedrskega goriva in tehnologije odlaganja;- ocenjevanje lastnosti odlagališča in varnostne analize;- transport radioaktivnih odpadkov in transport izrabljenega jedrskega goriva,- ponovna uporaba radioaktivnih snovi- radioaktivne snovi kot viri za prihodnost**Razgradnja jedrskih objektov:**- osnovni pojmi in zahteve za razgradnjo,- vrste načini tehnologije razgradenj,- radioaktivni odpadki iz razgradnje,- od programa razgradnje do izvedbe,- tehnične izkušnje zaključenih razgradenj- praktični zgledi in primeri. |  | **Radioactive waste, irradiated fuel waste from nuclear fuel cycle:**- Sources and types of radioactive wastes- Spent fuel and fuel cylce waste- Pre-processing and processing of radioactive waste.- Preparation of radioactive waste.- Storage of radioactive waste.- The management of spent nuclear fuel before disposal (processing, storage).- Disposal of radioactive waste and spent fuel and disposal technology.- Assessing the performance of the landfill and the safety analysis.- Transport of radioactive waste and spent fuel.- Reuse of irradiated materials .- Radioactive material as future resource**Decommissioning of Nuclear Facilities:**- Basic concepts and requirements of decommissioning.- Decommissioning methods and technologies.- Radioactive waste from decommissioning.- Decommissioning program and execution.- Practical examples |
| **Temeljni literatura in viri / Readings:** |
| 1. Tomaž Žagar, Metka Kralj, Učbenik: Ravnanje z odpadki, Zbirka Zelena Slovenija, Učbenik založbe Fit media, 2015, poglavje 3.3.4; Odpadki pri rabi jedrske energije.
2. Tomaž Žagar, Leon Kegel, Matej Rupret, “Slovenian Approach to Strategy and Planning for High Level Waste and Spent Fuel Deep Geological Disposal”, Chapter 17, Chapter published in "International Approaches for Nuclear Waste Disposal in Geological Formations: Geological Challenges in Radioactive Waste Isolation—Fifth Worldwide Review”, 2017-04-26, ed:, Faybishenko, Boris; Birkholzer, Jens; Sassani, David; Swift, Peter; DOI: 10.2172/1353043, LBNL-1006984, 2016 / 2017.
3. Radioactive waste in Perspective, OECD, ISBN 9789264092617, 2010
4. Advanced Nuclear Fuel Cycles and Radioactive Waste Management, OECD, ISBN 9789264024854, 2006
5. The Economics of the Back End of the Nuclear Fuel Cycle, OECD, 7061, Paris France, 2013
6. Timing of High-level Waste Disposal, OECD, NEA, 6244, Paris, France, 2008.
7. Decommissioning Nuclear Power Plants, OECD-NEA, 2003
 |
| **Cilji in kompetence:** |  | **Objectives and competences:** |
| **Cilji:**Pridobiti osnovno znanje o radioaktivnih odpadkih in izrabljenem jedrskem gorivu in o razgradnjah jedrskih objektov. Seznaniti se z možnimi načini in tehnološkimi postopki za okoljsko ustrezno, družbeno sprejemljivo in varno ravnanje z radioaktivnimi odpadki in izrabljenim gorivom in za razgrajevanje jedrskih objektov. Spoznati konkretne primere ravnanja z radioaktivnimi odpadki in izrabljenim jedrskim gorivom od nastanka do trajne odložitve in primere razgradnje jedrskih objektov. Razvijati odgovoren odnos do okolja in družbe na področju ravnanja z radioaktivnimi odpadki. |  | **Objectives:**To acquire basic knowledge about radioactive waste, spent fuel, and decommissioning of nuclear facilities. To become familiar with arrangements and processes for the safe management of radioactive waste and spent fuel management and decommissioning of nuclear facilities. To recognize specific examples of safe management of radioactive waste and spent fuel from generation to permanent disposal and decommissioning of the nuclear facilities. To develop a responsible attitude towards environment and society in the field of radwaste management.  |
| **Predvideni študijski rezultati:** |  | **Intended learning outcomes:** |
| **Znanje in razumevanje**Razumevanje osnovnih lastnosti radioaktivnih odpadkov, principov ravnanja z radioaktivnimi odpadki in izrabljenim jedrskim gorivom; razumevanje zahtev in omejitev, ki izhajajo iz varnostne analize;ločevati med končnim odlaganjem in skladiščenjem, razumeti možnosti ponovne rabepoznavanje in razumevanje osnovnih načinov razgradnje jedrskih objektov**Uporaba**Pridobljeno znanje se lahko uporabi neposredno v praksi za ravnanje z radioaktivnimi odpadki ali pri razgradnji jedrskih objektov.**Refleksija**Primer uporabe podobnih principov ravnanja in odgovornega odnosa tudi z drugimi vrstami odpadkov (toksični odpadki), princip planiranja in izvajanja razgradnje tudi za druge okoljsko tvegane objekte in za industrijske objekte nasploh.**Prenosljive spretnosti - niso vezane le na en predmet**Principi ravnanja z radioaktivnimi odpadki so enaki in uporabni v vseh fazah jedrskega gorivnega cikla. Ravnanje z odpadki in razgradnje jedrskih objektov dobivajo pomembno težo tudi pri razvoju in načrtovanju novih jedrskih tehnologij in nove generacije reaktorjev. |  | **Knowledge and understanding**Understanding of thebasic principlesof radioactive wasteand spent fuel.Understanding of the requirementsand constraintsderived from the safetyanalysis.Understand difference between final repository and storage. Understand the difference between waste and future resources.To knowand to understand thebasic principles ofnuclear decommissioning.**Application**Knowledge can be used directly in practice for the management of radioactive waste and the decommissioning of nuclear facilities.**Reflection**An example ofthe use ofsimilarprinciplesofa responsible attitudewith othertypes of waste(toxic waste),for the planningandexecution of processfor otherenvironmentallyhazardousfacilitiesandindustrial plantsin general.**Transferableskills**Principlesof radioactive wasteare the same andare applicable inall stagesof the nuclear fuelcycle.Waste management anddecommissioning of nuclear facilitiesreceivesignificant weightin the developmentanddesign of newnuclear technologies anda new generation ofreactors. |
|  |  |  |
| **Metode poučevanja in učenja:** |  | **Learning and teaching methods:** |
| Predavanja: študent spozna teoretične vsebine predmeta. Vaje: obravnavani so konkretni praktični primeri iz industrijske prakse ali bolj podrobno obravnavane izbrane vsebine.Te ure vključujejo 5 ur obiska in dela na terenu, kjer študent utrdi teoretično znanje in spozna možnosti in primere uporabe znanja. Na vajah se študenti spoznajo tudi z demonstracijo različnih primerov ravnanja z odpadki. |  | Lectures: students learn about the theory. Exercises: avditorial exercisee present practical examples and discuss in more detail selected content. These hours of exercises include also 5 hours of field visiti and work where students consolidate their theoretical knowledge during visti to a radioactive waste managment facility. Demonstration of practical work with radiaoctive waste is includeed in the field visit. |
| **Načini ocenjevanja:** | Delež (v %) /Weight (in %) | **Assessment:** |
| Način (pisni izpit, ustno izpraševanje, naloge, projekt)Ustni izpit, opravljena seminarska naloga | **50****50** | Type (examination, oral, coursework, project):Oral exam, seminar project |
| **Reference nosilca / Lecturer's references:** |
| 1. Žagar T., Kegel L., Rupret M., “Slovenian Approach to Strategy and Planning for High Level Waste and Spent Fuel Deep Geological Disposal”, Chapter 17, Chapter published in "International Approaches for Nuclear Waste Disposal in Geological Formations: Geological Challenges in Radioactive Waste Isolation—Fifth Worldwide Review”, 2017-04-26, ed:, Faybishenko, Boris; Birkholzer, Jens; Sassani, David; Swift, Peter; DOI: 10.2172/1353043, LBNL-1006984, 2016 / 2017. 2. Žagar T., Kralj M., Učbenik: Ravnanje z odpadki, Zbirka Zelena Slovenija, Učbenik založbe Fit media, 2015, poglavje 3.3.4; Odpadki pri rabi jedrske energije.3. Žagar, T., Buršič, A., Špiler, J., Kim, D., Chiguer, M., David, G., Gillet, P., Recycling as an option of used nuclear fuel management strategy, Nuclear Engineering and Design, 20104. Žagar T., Galy, J., Magill, J., Pulsed Neutron Source with Tabletop Laser – Accelerated Protons, In: H.Schwoerer, et al., Lasers and Nuclei, Lect. Notes Phys. 694, Springer Verlag, Berlin Heidelberg 2006, pp. 109 - 1275. Magill, J., Galy, J., Žagar, T., Laser Transmutation of Nuclear Materials, In: H. Schwoerer, et.sl., Lasers and Nuclei, Lect. Notes Phys. 694, Springer Verlag, Berlin Heidelberg 2006, pp.131 - 1466. Žagar, T., Galy, J., Magill, J., Kellett, M., Laser – generated nanosecond pulsed neutron sources: scaling from VULCAN to table – top. New journal of physics (online ed), 2005, vol. 7, pp. 2537. Žagar, T., Božič, M., Ravnik, M., Long – lived activation products in TRIGA mark II research reactor concrete shield: calculation and experiment. Jour. of Nuc..Mat., 2004, vol. 335/3, pp. 379 - 3868. Žagar, T., Ravnik, M., Determination of long – lived neutron activation products in reactor shielding concrete samples. Nucl. Technol., 2002, vol. 140, pp. 113 - 1269. J. Avsec, P. Virtič, T. Žagar, L. Štrubelj, Economy Analysis of Electricity Production from Hydrogen in Combination with Nuclear Power Plant, Proceedings of the International Conference on Power Engineering POWER 2011, July 12-14, 2011, Denver, Colorado, USA10. T. Žagar, R. Bergant, S.Furst, Nuclear Renaissance as a Viable Solution for Reducing Greenhouse Gases – the Environmental Impact of Different Energy Technologies, Journal of Energy Technology, JET Volume 2 (2009), Issue 3, pp. 11- 28 |