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| **UČNI NAČRT PREDMETA / COURSE SYLLABUS** |
| **Predmet:** | **MATEMATIČNE METODE**  |
| **Course title:** | **MATHEMATICAL METHODS**  |
|  |  |  |  |
| **Študijski program in stopnja****Study programme and level** | **Študijska smer****Study field** | **Letnik****Academic year** | **Semester****Semester** |
| ENERGETIKA, 2. stopnja |  | 1 | 1 |
| ENERGY TECHNOLOGY, 2.degree |  | 1 | 1 |
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| **Vrsta predmeta / Course type** | Obvezni/Obligatory |
|  |  |
| **Univerzitetna koda predmeta / University course code:** | M |
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| **Predavanja****Lectures** | **Seminar****Seminar** | **Vaje****Tutorial** | **Klinične vaje****work** | **Druge oblike študija** | **Samost. delo****Individ. work** |  | **ECTS** |
| **30** |  | **45** |  |  | **105** |  | **6** |
| **AV** | **LV** | **RV** |
| **45** |  |  |
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| **Nosilec predmeta / Lecturer:** | **BRIGITA FERČEC** |
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| **Jeziki /** **Languages:** | **Predavanja / Lectures:** | slovenski/Slovene |
| **Vaje / Tutorial:** | slovenski/Slovene |
| **Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:** |  | **Prerequisits:** |
| Priporočeno je znanje iz:* linearne algebre (vektorski prostori in matrike);
* analize funkcij ene in več spremenljivk (uporaba navadnih in parcialnih odvodov, enojni in dvojni integral);
* vektorske analize (krivulje v prostoru);
* vektorskih polj (gradient, rotor, divergenca);
* reševanja linearnih diferencialnih enačb s konstantnimi koeficienti.
 |  | A knowledge of the following mathematical topics is recommended:* linear algebra (vector spaces and matrices);
* calculus of functions of one or several variables ((partial) derivatives, (space) integrals);
* vector analysis (curves in space);
* vector fields (gradient, curl, and divergence);
* solving linear diferential equations with constant coefficients.
 |
| **Vsebina:**  |  | **Content (Syllabus outline):** |
| **1. Fourierova vrsta:** Eulerjeve formule za Fourier-ove koeficiente. Liha in soda periodična razširitev funkcije.  Transformacija Diracove delta ''funkcije'' (distribucije) in Heaviside-ove funkcije. Konvolucija.**2. Navadne diferencialne enačbe (NDE):**- sistemi NDE- reševanje z lastnimi in korenskimi vektorji; teorija stabilnosti; problem linearizacije.- Laplaceova transformacija -transformacije elementarnih funkcij in Diracove delta ''funkcije'' ter Heaviside-ove funkcije. Osnovne formule za transformacijo odvodov. Konvolucija.- specialne funkcije - funkcija Gama, Besselove funkcije, rešitev Besselove DE.**3. Parcialne diferencialne enačbe (PDE):**- klasifikacija - toplotna enačba- valovna enačba - Laplaceova enačba- Laplaceova transformacija za reševanje PDE- Fourierova transformacija za reševanje PDE |  | **1.Fourier series:** Euler's formulas for Fourier's coefficients. Odd and even periodic extension of the function. Transformation of the Dirac delta ''function'' (distribution) and the Heaviside function. Convolution.**2. Ordinary differential equations (ODE's):** - system of ODE's - solution with eigenvectors and root vectors; the theory of stability and the problem of linearization.-Laplace transformation - transformation of elementary functions, Dirac delta ''function'' and Heaviside function. Basic formulas for transformation of derivatives. Convolution.- special functions - Gamma function, Bessel function, solution of Bessel differential equation.**3. Partial differential equations (PDE's):**- classification- heat equation- wave equation- Laplace equation- Laplace transformation for solving PDE's- Fourier transformation for solving PDE's |
| **Temeljni literatura in viri / Readings:** |
| **Osnovna/Basic:**- E. Kreyszig, Advanced Engineering Mathematics, J. Wiley and Sons, 2011.- M. Mencinger, Uvod v parcialne diferencialne enačbe, Fakulteta za gradbeništvo UM, Maribor, 2011.**Dodatna/Additional:** - G. Tomšič, T. Slivnik, Matematika IV. Fakulteta za elektrotehniko, Založba FE in FRI, Ljubljana, 2004. - F. John, Partial differential equations. Springer-Verlag, New York, 1991. |
| **Cilji in kompetence:** |  | **Objectives and competences:** |
| Študenti osvojijo spretnosti matematičnega modeliranja inženirskih problemov, ki se navezujejo na navadne diferencialne enačbe in parcialne diferencialne enačbe. |  | Students learn the basic skills of mathematical modeling of engineering problems which are related to ordinary and partial differential equations. |
| **Predvideni študijski rezultati:** |  | **Intended learning outcomes:** |
| Znanje in razumevanje:Razumeti povezavo med matematiko, fiziko in mehaniko; razumeti aplikativno vrednost matematike.Znanje in uporaba osnovnih matematičnih orodij, ki so nujna pri strokovnih predmetih.  |  | Knowledge and understanding:Understanding the connection between mathematics, physics and mechanics; understanding the applicable value of mathematics.Knowledge and application of basic mathematical tools which are neccessary for other engineering courses. |
| **Metode poučevanja in učenja:** |  | **Learning and teaching methods:** |
| Predavanja, avditorne vaje. |  | Lectures, practical work (exercises). |
| **Načini ocenjevanja:** | Delež (v %) /Weight (in %) | **Assessment:** |
| Način (pisni izpit, ustno izpraševanje, naloge, projekt):* Pisni izpit (reševanje računskih problemov)
* Domača naloga

Ustni zagovor – zagovor teorije (po potrebi, v primeru zviševanja ocene).Za opravljen izpit mora študent vsak del izpita (pisni izpit, domača naloga) opraviti z vsaj 50%. V primeru kolokvijev le-ti ne smejo biti ocenjeni z manj kot 30% (povprečje pa vsaj 50%). |  **70****30** | Type (examination, oral, coursework, project):* Written exam (solving computational problems)
* Homework

Oral exam - theoretica part of exam (if necessarily, in the case of increase of the grade).The student must finish each part of the exam (practical part, homework) with at least 50%. In the case of midterm tests they have has to be done with at least 30% to pass the practical part of exam successfully (on average at least 50%). |
| **Reference nosilca / Lecturer's references:**  |
| FERČEC, Brigita, GINÉ, Jaume. Formal Weierstrass integrability for a Liénard differential system. *Journal of mathematical analysis and applications*, 2021, issue 1, art. 125016, 14 str.FERČEC, Brigita, DUKARIĆ, Maša, AYBAR, Orhan Ozgur, AYBAR, Ilknur Kusbeyzi. Supercritical Hopf bifurcations in two biochemical reaction systems. *Match : communications in mathematical and in computer chemistry*, 2021, 85, str. 525-544.ZALAR, Borut, FERČEC, Brigita, TANG, Yilei, MENCINGER, Matej. Partial qualitative analysis of planar Aq−RiccatiAq−Riccati equations. *Glasnik matematički. Serija 3*, 2020, vol. 55, no. 2, str. 351-366.FERČEC, Brigita, GINÉ, Jaume. Blow-up method to compute necessary conditions of integrability for planar differential systems. *Applied mathematics and computation*, 2019, vol. 358, str. 16-24.ŽULJ, Maja, FERČEC, Brigita, MENCINGER, Matej. The solution of some persistent p : -q resonant center problems. *Electronic journal of qualitative theory of differential equations*, 2018, vol. 2018, no. 99, str. 1-21.FERČEC, Brigita. On integrability conditions and limit cycle bifurcations for polynomial system. *Applied mathematics and computation*, 2015, vol. 263, str. 94-106, FERČEC, Brigita, LEVANDOVSKYY, Viktor, ROMANOVSKI, Valery, SHAFER, Douglas. Bifurcation of critical periods of polynomial systems. *Journal of differential equations*, 2015, vol. 259, iss. 8, str. 3825-3853. FERČEC, Brigita, MENCINGER, Matej. Integer programming and Gröbner bases = Celoštevilsko programiranje in Gröbnerjeve baze. *Journal of energy technology*, 2015, vol. 8, iss. 2, str. 43-58.AYBAR, Ilknur Kusbeyzi, AYBAR, Orhan Ozgur, FERČEC, Brigita, ROMANOVSKI, Valery, SWARUP SAMAL, Satya, WEBER, Andreas. Investigation of invariants of a chemical reaction system with algorithms of computer algebra. *MATCH Communications in Mathematical and in Computer Chemistry*, 2015, vol. 74, issue 3, str. 465-480.  |

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| **UČNI NAČRT PREDMETA / COURSE SYLLABUS** |
| **Predmet:** | **NAPREDNE AERO- IN HIDRO-ENERGETSKE TEHNOLOGIJE** |
| **Course title:** | **ADVANCED AERO- AND HYDRO-ENERGY TECHNOLOGIES** |
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| **Študijski program in stopnja****Study programme and level** | **Študijska smer****Study field** | **Letnik****Academic year** | **Semester****Semester** |
| ENERGETIKA, 2. stopnja  |  | **1** | **1** |
| ENERGY TECHNOLOGY, 2.degree |  | **1** | **1** |
|  |
| **Vrsta predmeta / Course type** | Obvezni/Obligatory |
|  |  |
| **Univerzitetna koda predmeta / University course code:** | M |
|  |
| **Predavanja****Lectures** | **Seminar****Seminar** | **Vaje****Tutorial** | **Klinične vaje****work** | **Druge oblike študija** | **Samost. delo****Individ. work** |  | **ECTS** |
| **45** |  | **30** |  |  | **105** |  | **6** |
| **AV** | **LV** | **RV** |  |
| **20** | **10** |  |  |
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| **Nosilec predmeta / Lecturer:** | **ANDREJ PREDIN** |
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| **Jeziki /** **Languages:** | **Predavanja / Lectures:** | slovenski / Slovene |
| **Vaje / Tutorial:** | slovenski / Slovene |
| **Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:** |  | **Prerequisits:** |
| Priporočena so osnovna znanja oz. poznavanje fizike, matematike, mehanike, … |  | Recommended basic knowledge of physics, mathematics, mechanics, ... |
| **Vsebina:**  |  | **Content (Syllabus outline):** |
| * Hidrološke osnove,
* Planiranje in upravljanje z vodnimi viri
* Energetska ocena naravnih vodotokov
* Dizajniranje poplavnih razmer
* Osnove planiranja in projektiranja hidro-energetskih sistemov
* Pregled in razvrstitev hidroenergetskih sistemov
* Dinamika toka v odprtih kanalih in rekah
* Obratovalni parametri hidroenergetskih sistemov:
* hidravlični (tokovni),
* obratovalni,
* proizvodni (dimenzijski);
* Postavitev in značilnosti hidroenergetskih postrojev
* Napredni, konvencionalni aero- in hidro-energetski sistemi
* Pregled razvoja in raziskav v smeri optimiranja konvencionalnih aero- in hidro-energetskih sistemov
* Aero/Hidro-dinamično računalniško oblikovanje energetskih sistemov
* Mikro / Makro svet
* Pregled smeri razvoja: napredne in alternativne tehnologije
* Fluidni alternativni, napredni energetski sistemi
* Plinski alternativni, napredni energetski sistemi
* Kombinirani konvencionalni in napredni, ter alternativni energetski sistemi
* Ekonomsko in tehniško optimiranje obratovanja konvencionalnih, naprednih in alternativnih energetskih sistemov
* Skupno/mrežno ali sestavljeno oz. kombinirano obratovanje KNA ES
* Regulacija KNA ES
* Meritve karakteristik KNA ES
* KNA shranjevalni energetski sistemi in njih kombinacije
* Optimiranje obratovanja in regulacije KNA ES
* Meritve na modelih KNA ES
 |  | * Hydrological bases,
* Planning and managing water resources
* Energy assessment of natural watercourses
* Designing flood conditions
* Basics of planning and design of hydro-energy systems
* Overview and classification of hydropower systems
* Dynamics of flow in open channels and rivers
* Operating parameters of hydropower systems:
* hydraulic (currents),
* operating,
* production (dimensional);
* The layout and characteristics of hydro power plants
* Advanced, conventional aero- and hydro-energy systems
* A review of development and research towards the optimization of conventional aero- and hydro-energy systems
* Aero / Hydro-dynamic computer design of power systems
* Micro / Macro world
* Review of development trends: advanced and alternative technologies
* Fluid Alternative, Advanced Energy Systems
* Gas Alternative, Advanced Energy Systems
* Combined conventional and advanced, and alternative energy systems
* Economic and technical optimization of the operation of conventional, advanced and alternative energy systems
* Common / network or composite combined operation of CAA ES
* Control of CAA ES
* Measurement of CAA EC characteristics
* CAA energy storage systems and their combinations
* Optimizing the operation and control of CAA ES
* Measurements on CAA EC models
 |
| **Temeljni literatura in viri / Readings:** |
| **A. Predin:** *Črpalke in ventilatorji***,** Univerza v Mariboru, Fakulteta za strojništvo, Maribor, 2000.**H. Sigloch:** *Strömungsmaschinen, Grundlagen und Anwendungen,* 4. aktualisierte Auflage, Hanser Verlag, 2009**A. J. Stepanoff:** *Centrifugal and Axial Flow Pumps, 2nd Edition*, Krieger Publishing Company, Malabar, Florida 1993.**D. Florjančič:** *Sulzer Centrifugal Pump Handbook*, ELSEVIER Applied Science, London and New York, 1995**W. E. Forsthoffer:** *Pumps*, Elsevier Science & Technology Books, 2005**J. Giesecke, E. Mosonyi:** *Wasserkraftanlagen, Planung, Bau und Betrieb,* 4. aktualisierte und erweiterte Auflage, Springer Verlag, 2005**Horvat:** *Vodene turbine,* Sveučilište u Zagrebu, Zagreb 1965**C.E. Brennen**: *Hydrodynamics of Pumps*, Concepts ETI, Inc. and Oxford University Press, 1994.**C.E. Brennen:** *Fundamentals of Multiphase flow*, Cambridge University press, 2005.**J.P. Gostelow:** *Cascade Aerodynamics*, Pergamon press, 1984.**Knapp, Dally, Hammit**: *Cavitation,* McGraw-Hill, 1970.**J.F. Douglas et al.:** *Fluid Mechanics, 3rd edition* LGL press 1995.**Sir Horace Lamb:** *Hydrodynamics*, Cambridge University, 1997.**D. Florjančič:** *Priročnik za uporabnike črpalk*, Univerza v Ljubljani, Fakulteta za strojništvo, Ljubljana 2001. |
| **Cilji in kompetence:** |  | **Objectives and competences:** |
| Osvojitev znanj na področju hidravličnih strojev, sistemov in naprav v energetiki. |  | Futher knowledge in the field of hydraulic machines, systems and devices in the field of energy technology. |
| **Predvideni študijski rezultati:** |  | **Intended learning outcomes:** |
| * Poznavanje hidroenergetskih sistemov
* Celote in delov HES
* Vodenje, upravljanje HES
* Ekonomsko vrednotenje HES.
 |  | - Knowledge of hydropower systems- Whole and parts of HES- Keeping, managing HES- Economic evaluation of HES. |
| **Metode poučevanja in učenja:** |  | **Learning and teaching methods:** |
| PredavanjaAvditorne vaje (izvajanje računskih primerov)Laboratorijske vaje (izvajanje meritev) |  | LecturesTutorials (performing calculation cases)Laboratory exercises (measurements) |
| **Načini ocenjevanja:** | Delež (v %) /Weight (in %) | **Assessment:** |
| Ustni izpit - iz teorije (lahko nadomeščen z dvema pozitivnima kolokvijema).Pisni izpit - iz računski primerov (lahko nadomeščen z dvema pozitivnima kolokvijema). | **50****50** | Oral exam – theory (can be replaced by two positive midterm tests).Written exam - calculation examples (can be replaced by two positive midterm tests). |
| **Reference nosilca / Lecturer's references:**  |
| PREDIN, Andrej, FIKE, Matej, PEZDEVŠEK, Marko, HREN, Gorazd. Lost Energy of Water Spilled over Hydropower Dams. *Sustainability*. avg. 2021, iss. 16, art. 9119, str. 1-17. ISSN 2071-1050. DOI: [10.3390/su13169119](https://dx.doi.org/10.3390/su13169119). [COBISS.SI-ID [75580931](https://plus.si.cobiss.net/opac7/bib/75580931?lang=sl)], [[JCR](https://plus.si.cobiss.net/opac7/jcr?c=sc=2071-1050+and+PY=2020&r1=true&lang=sl), [SNIP](https://plus.si.cobiss.net/opac7/snip?c=sc=2071-1050+and+PY=2020&r1=true&lang=sl), [WoS](http://gateway.isiknowledge.com/gateway/Gateway.cgi?GWVersion=2&SrcAuth=Alerting&SrcApp=Alerting&DestApp=WOS&DestLinkType=FullRecord&KeyUT=000690039500001), [Scopus](http://www.scopus.com/inward/record.url?partnerID=2dRBettD&eid=2-s2.0-85113809273)]FIKE, Matej, HREN, Gorazd, PEZDEVŠEK, Marko, PREDIN, Andrej. Izdelava lopatic modelne vetrne turbine = Manufacturing of model size wind turbine blades. V: FINK GRUBAČEVIĆ, Iris (ur.). *Razvoj industrijskega inženiringa (RII6) = Development of industrial engineering (RII6) : priložnosti, potenciali, izzivi = oportunities, potentials, challenges : zbornik recenziranih prispevkov 6. mednarodne konference = proceedings of reviewed papers of 6th international conference : Novo mesto, april 2021*. Novo mesto: Fakulteta za industrijski inženiring: = Faculty of Industrial Engineering, 2021. Str. 81-86, ilustr. ISBN 978-961-7097-03-0. <http://www.fini-unm.si/wp-content/uploads/2021/04/Zbornik-prispevkov_6.-mednarodna-konferenca_lektoriran_sprejeto-Senat.pdf>. [COBISS.SI-ID [81195523](https://plus.si.cobiss.net/opac7/bib/81195523?lang=sl)]FIKE, Matej, HREN, Gorazd, PREDIN, Andrej, PEZDEVŠEK, Marko. Eksperimentalna in numerična določitev integralne karakteristike modelne vetrne turbine = Experimental measurement and numerical prediction of integral characteristic of a model-size wind turbine. V: FINK GRUBAČEVIĆ, Iris (ur.). *Razvoj industrijskega inženiringa : priložnosti, potenciali, izzivi : zbornik recenziranih prispevkov 5. mednarodne konference : [Otočec pri Novem mestu, 9. oktober 2020] = Development of industrial engineering : opportunities, potentials, challenges : proceedings of reviewed papers of 5th International Conference : [Otočec pri Novem mestu, 9 October 2020]*. Novo mesto: Fakulteta za industrijski inženiring: = Faculty of Industrial Engineering, 2020. Str. 105-110, ilustr. ISBN 978-961-7097-01-6. [COBISS.SI-ID [35533315](https://plus.si.cobiss.net/opac7/bib/35533315?lang=sl)]GRGURIĆ, Gordan, MIHALIĆ, Tihomir, PREDIN, Andrej. Design of a train articulation system = Načrtovanje in izračun priklopnikov vagonov. *Journal of energy technology*. [Tiskana izd.]. apr. 2016, vol. 9, iss. 1, str. 29-38, ilustr. ISSN 1855-5748. [COBISS.SI-ID [1024238428](https://plus.si.cobiss.net/opac7/bib/1024238428?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*. 2014, vol. 24, no. 3, str. 545-562. ISSN 0961-5539. <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://dx.doi.org/10.1108/HFF-05-2012-0124). [COBISS.SI-ID [1024162140](https://plus.si.cobiss.net/opac7/bib/1024162140?lang=sl)], [[JCR](https://plus.si.cobiss.net/opac7/jcr?c=sc=0961-5539+and+PY=2014&r1=true&lang=sl), [SNIP](https://plus.si.cobiss.net/opac7/snip?c=sc=0961-5539+and+PY=2014&r1=true&lang=sl), [WoS](http://gateway.isiknowledge.com/gateway/Gateway.cgi?GWVersion=2&SrcAuth=Alerting&SrcApp=Alerting&DestApp=WOS&DestLinkType=FullRecord&KeyUT=000341755900002) do 13. 1. 2022: št. citatov (TC): 10, čistih citatov (CI): 10, čistih citatov na avtorja (CIAu): 3,33, [Scopus](http://www.scopus.com/inward/record.url?partnerID=2dRBettD&eid=2-s2.0-84899992765) do 28. 4. 2022: št. citatov (TC): 10, čistih citatov (CI): 10, čistih citatov na avtorja (CIAu): 3,33]MIHALIĆ, Tihomir, GUZOVIĆ, Zvonimir, PREDIN, Andrej. Performances and flow analysis in the centrifugal vortex pump. *Journal of fluids engineering : Transactions of the ASME*. Jan. 2013, vol. 133, iss. 1, str. 011107-1-011107-7. ISSN 0098-2202. DOI: [10.1115/1.4023198](https://dx.doi.org/10.1115/1.4023198). [COBISS.SI-ID [1024124252](https://plus.si.cobiss.net/opac7/bib/1024124252?lang=sl)], [[JCR](https://plus.si.cobiss.net/opac7/jcr?c=sc=0098-2202+and+PY=2013&r1=true&lang=sl), [SNIP](https://plus.si.cobiss.net/opac7/snip?c=sc=0098-2202+and+PY=2013&r1=true&lang=sl), [WoS](http://gateway.isiknowledge.com/gateway/Gateway.cgi?GWVersion=2&SrcAuth=Alerting&SrcApp=Alerting&DestApp=WOS&DestLinkType=FullRecord&KeyUT=000314762000009) do 18. 3. 2022: št. citatov (TC): 12, čistih citatov (CI): 12, čistih citatov na avtorja (CIAu): 4,00, [Scopus](http://www.scopus.com/inward/record.url?partnerID=2dRBettD&eid=2-s2.0-84872865727) do 17. 3. 2022: št. citatov (TC): 19, čistih citatov (CI): 19, čistih citatov na avtorja (CIAu): 6,33] |

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| **UČNI NAČRT PREDMETA / COURSE SYLLABUS** |
| **Predmet:** | **TERMOMEHANIKA IN VODENJE SISTEMOV KLIMATIZACIJE** |
| **Course title:** | **THERMOMECHANICS AND CONTROL OF AIR-CONDITIONING SYSTEMS** |
|  |  |  |  |
| **Študijski program in stopnja****Study programme and level** | **Študijska smer****Study field** | **Letnik****Academic year** | **Semester****Semester** |
| ENERGETIKA, 2. STOPNJA |  | **1** | **1** |
| ENERGY TECHNOLOGY,2.degree |  | **1** | **1** |
|  |
| **Vrsta predmeta / Course type** | Obvezen/Obligatory |
|  |  |
| **Univerzitetna koda predmeta / University course code:** | M |
|  |
| **Predavanja****Lectures** | **Seminar****Seminar** | **Vaje****Tutorial** | **Klinične vaje****work** | **Druge oblike študija** | **Samost. delo****Individ. work** |  | **ECTS** |
| **45** |  | **30** |  |  | **105** |  | **6** |
| **AV** | **LV** | **RV** |  |
| **20** | **10** |  |  |
|  |
| **Nosilec predmeta / Lecturer:** | **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):** |
| Vsebina predmeta obsega sledeča poglavja1. Termomehanika v energetskih procesih
2. Termoelastičnost
3. Mehanska nihanja v energetskih sistemih
4. Generacija entropije v energetskih procesih
5. Exergijske analize v energetskih procesih
6. Optimiranje procesov s pomočjo eksergijskih analiz
7. Teorija energetskega termodinamičnega optimiranja
8. Termodinamični procesi z vlažnim zrakom.
9. Izhlapevanje.
10. Udobje.
11. Klimatizacijski sistemi v letnem in zimskem obratovanju.
12. Vrste prezračevanja, odvod zraka, dovod zraka
13. Avtomatska regulacija klimatizacijskih sistemov.
14. Klimatizacija daljinskih sistemov.
15. Klimatizacija s pomočjo alternativnih virov
16. Klimatizacija s pomočjo obnovljivih virov
17. Kombinacija klimatizacijskih sistemov s sistemi ogrevanja in hlajenja.
18. Klimatizacijski sistemi transportnih naprav
19. Termodinamični preračun hladilnega stolpa.
20. Procesi sušenja z zrakom.
21. Vzdrževanje klimatizacijskih sistemov, sušilnih naprav in hladilnih stolpov.
 |  | Content of the Subject:1. Thermomechanics in energy processes.
2. Thermoelasticity.
3. Mechanical vibrations in energy systems.
4. Generation of entropy in energy processes.
5. Exergy analysis in energy processes.
6. Optimisation of processes on the basis of exergy analysis.
7. Constructal thermodynamic theory.
8. Thermodynamic processes with moist air.
9. Evaporation processes with moist air.
10. Comfort and health-indoor environmental quality.
11. Air-conditioning systems in summer and winter period.
12. Ventilation processes, air supply to the room.
13. Automatic controls.
14. District air conditioning.
15. Air conditioning on the basis of alternative energy sources.
16. Air conditioning on the basis of renewable energy sources.
17. The combination of air-conditioning systems. with systems for heating and refrigeration.
18. Air conditioning systems of transport devices.
19. Thermodynamic calculation of solar tower.
20. Drying processes with air.
21. Maintenance of air conditioning systems, drying equipments and cooling towers.
 |
| **Temeljni literatura in viri / Readings:** |
| W. P. Jones, Air Conditioning Engineering.J. Avsec, U. Novosel, Control of Air Conditioning, 2017, University of Maribor.F. McQuiston, J.D. Parker, J.D. Spitler, Heating, Ventilating and air conditioning, Sixth Edition, Wiley, 2005.M. G. Simoes, F.A. Farret, Alternative Energy systems, CRC, 2008.G.F. Hundy, A.R. Trott, T.C. Welch, Refrigeration and air conditioning, Fourth Edition, BH, 2008.I. Dincer, M.Rosen, Exergy analysis of heating and air conditioning, 2015, Elsevier.I. Dincer, m. Rosen, Exergy, 2012, Elsevier Science.Y. Cengel, M.Boles, Thermodynamics, 2018, McGraw-Hill Education. |
| **Cilji in kompetence:** |  | **Objectives and competences:** |
| Podati sodobne vsebine na področju termomehanike in vodenju procesov v sodobnih hladilnih, grelnih in klimatizacijskih sistemih.  |  | Basic knowledge in the field of modern themomechanics and control of modern refrigeration, heating plants and Air-Conditioning Systems. |
| **Predvideni študijski rezultati:** |  | **Intended learning outcomes:** |
| Znanje in razumevanje:Študent si pridobi znanja iz napredne termomehanike ter o hladilnih in klimatizacijskih sistemih. |  | Knowledge and Understanding:Student acquires the the knowledges from modern thermomechanics and from refrigeration plants and air-conditioning systems.  |
| Prenesljive/ključne spretnosti in drugi atributi:Optimiranje različnih procesov v energetiki.  |  | Transferable/Key Skills and other attributes:Optimisation of various processes in energy technology. |
| **Metode poučevanja in učenja:** |  | **Learning and teaching methods:** |
| 1. Predavanja 2. Avditorne vaje3. Laboratorijske vaje |  | 1. Lectures, 2. Auditorium exercises3. Laboratory exercises |
| **Načini ocenjevanja:** | Delež (v %) /Weight (in %) | **Assessment:** |
| Način (pisni izpit, ustno izpraševanje, naloge, projekt)* Pisni izpit (računske naloge)
* Seminarska naloga
* Ustni izpit (teorija)
 | **40****10****50** | Type (examination, oral, coursework, project):* Written exam (computational tasks )
* Seminar work
* Oral exam (theory)
 |
| Za opravljen izpit mora študent vsak del izpita (pisni izpit, ustni izpit) opraviti z vsaj 50%.Ustni izpit (lahko nadomeščen z dvema pozitivnima kolokvijema)Pisni izpit (lahko nadomeščen z dvema pozitivnima kolokvijema) |  | To pass the exam, the student must pass each part of the exam (written exam, oral exam) with at least 50%. Oral exam (can be replaced by two positive midterm test)Written exam (can be replaced by two positive midterm test) |
| **Reference nosilca / Lecturer's references:**  |
| 1. STRUŠNIK, Dušan, BRANDL, Daniel, SCHOBER, Helmut, FERČEC, Janko, AVSEC, Jurij. A simulation model of the application of the solar STAF panel heat transfer and noise reduction with and without a transparent plate : a renewable energy review. Renewable & sustainable energy reviews : Elektronski vir, ISSN 1879-0690. [Online ed.], dec. 2020, vol. 134, 17 str.2. AVSEC, Jurij, NOVOSEL, Urška. Analysis of pipeline vibration = Analiza vibracij v cevovodih. Journal of energy technology, ISSN 1855-5748. [Tiskana izd.], apr. 2019, vol. 12, iss. 1, str. 31-39, ilustr 3. AGREŽ, Marko, AVSEC, Jurij, STRUŠNIK, Dušan. Entropy and exergy analysis of steam passing through an inlet steam turbine control valve assembly using artificial neural networks. International journal of heat and mass transfer, ISSN 1879-2189. [Online ed.], 2020, 14 str.4. ŽIVIĆ, Marija, GALOVIĆ, Antun, AVSEC, Jurij, BARAC, Antun. Application of gas condensing boilers in domestic heating. Tehnički vjesnik : znanstveno-stručni časopis tehničkih fakulteta Sveučilišta u Osijeku, ISSN 1330-3651, 2019, vol. 26, no. 3, str. 681-685, graf.5. AVSEC, Jurij, BRANDL, Daniel, SCHOBER, Helmut, STRUŠNIK, Dušan, NOVOSEL, Urška, FERČEC, Janko. LCA analysis of STAF panels and their application for heating : cooling and hydrogen production. V: ROMÁN, Roberto L. (ur.), RENNÉ, David (ur.), MUGNIER, Daniel (ur.). Proceedings of the ISES Solar World Conference 2019 and the IEA SHC Solar Heating and Cooling Conference for Buildings and Industry 2019, ISES Solar World Conference 2019, Santiago de Chile on 04-07 November 2019. Freiburg: International Solar Energy Society. cop. 219, str. 1740-1751. |

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| **UČNI NAČRT PREDMETA / COURSE SYLLABUS** |
| **Predmet:** | **JEDRSKE IN SEVALNE NAPRAVE** |
| **Course title:** | **NUCLEAR INSTALLATION AND IRRADIATION FACILITIES** |
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| **Študijski program in stopnja****Study programme and level** | **Študijska smer****Study field** | **Letnik****Academic year** | **Semester****Semester** |
| ENERGETIKA, 2. STOPNJA |  | **1** | **1** |
| ENERGY TECHNOLOGY,2.degree |  | **1** | **1** |
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| **Vrsta predmeta / Course type** | Obvezen/Obligatory |
|  |  |
| **Univerzitetna koda predmeta / University course code:** | M |
|  |
| **Predavanja****Lectures** | **Seminar****Seminar** | **Vaje****Tutorial** | **Klinične vaje****work** | **Druge oblike študija** | **Samost. delo****Individ. work** |  | **ECTS** |
| **45** |  | **30** |  |  | **105** |  | **6** |
| **AV** | **LV** | **RV** |  |
| **25** | **5** |  |  |
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| **Nosilec predmeta / Lecturer:** | **BRUNO CVIKL** |
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| **Jeziki /Languages:** | **Predavanja / Lectures:** | slovenski / Slovene |
| **Vaje / Tutorial:** | slovenski / Slovene |
| **Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:** |  | **Prerequisits:** |
| Ni pogojev. |  | None. |
| **Vsebina:**  |  | **Content (Syllabus outline):** |
| Osnove jedrske in reaktorske fizikeNevtroni v sredici termičnega reaktorjaRazvoj jedrskih reaktorjev in skladiščenje odpadkovDetektorji radioaktivnega sevanjaPospeševalniki delcevUporaba jedrskih in sevalnih tehnologij v industriji in mediciniSevalne doze |  | Fundamentals of nuclear and reactor physicsNeutron processes in thermal reactorsModern nuclear reactors and radioactive waste depositionRadiation detectorsParticle acceleratorsApplication of nuclear and radiation techniques in industry and medicineRadiation doses |
| **Temeljni literatura in viri / Readings:** |
| B Cvikl: Jedrske in sevalne naprave, Fakulteta za energetiko, UM , 2014, študijsko gradivo, 188 strani, posodobljeno 2021.R. A. Knief: Nuclear Engineering, Taylor & Francis, ZDA, 1992.J. R. Lamarsh: Introduction to Nuclear Engineering, 3-rd Ed., Prantice Hall, Inc., ZDA , 2001.J. K. Shultis, R. E. Faw, Fundamentals of Nuclear Science and Engineering, Taylor&Francis, ZDA, 2008.G. C. Lowenthal and P. L. Airey, Practical Applications of Radioactivity and Nuclear Radiation, Cambridge,2001 |
| **Cilji in kompetence:** |  | **Objectives and competences:** |
| Pregledna klasifikacija jedrskih in sevalnih naprav, podrobna načela delovanja, osnovne možnosti uporabe. |  | Nuclear installation and irradiation facilities overview, fundamental principles of operation, possibilities of implementation. |
| **Predvideni študijski rezultati:** |  | **Intended learning outcomes:** |
| Znanje in razumevanje:Spoznavanje in razumevanje nevtronskih procesov, ki se odvijajo v termičnih reaktorjih. Seznaniti se z uporabo nekaterih metod sevanja za industrijske namene in v medicini. |  | Knowledge and Understanding:Thorough understanding of principal neutron processes occurring within thermal reactors. To familiarize with the nuclear and radiation techniques in industry and medicine |
| Prenesljive/ključne spretnosti in drugi atributi:Bazično znanje, ki naj omogoči poglobljen študij posamične naprave. |  | Transferable/Key Skills and other attributes:Basic skills enabling in-depth study of a particular device. |
| **Metode poučevanja in učenja:** |  | **Learning and teaching methods:** |
| Predavanja.Avditorne vajeLaboratorijske vaje. |  | Lectures.Auditorium exercises.Laboratory work. |
| **Načini ocenjevanja:** | Delež (v %) /Weight (in %) | **Assessment:** |
| Način (pisni izpit, ustno izpraševanje, naloge, projekt):Poročilo laboratorijskih vaj Pisni izpit Ustno izpraševanje*Sprotne oblike preverjanja znanja (lahko nadomestijo pisni izpit)*1. pisni kolokvij 50 %2. pisni kolokvij 50 %* \*Povprečna ocena 2 kolokvijev večja, kot je 55 %, nadomesti pisni del izpita.
 | **20****30****50** | Type (examination, oral, coursework, project):Report of laboratory exrcisesWritten exam.Oral exam.*Ongoing assessments (can replace the written exam)*1. midterm written test 50 %2. midterm written test 50 %* \*Average grade of 2 tests greater than 55% represents a substitution for the written part of the exam.
 |
| **Reference nosilca / Lecturer's references:**  |
| 1. CVIKL, Bruno. The interface and bulk polarization effect of the single layer ferroelectric-like organic semiconductors on the current-voltage data. *Synthetic metals*. [Print ed.]. 2022, vol. 284, art. 117005, 12 str. ISSN 0379-6779. DOI: [10.1016/j.synthmet.2021.117005](https://dx.doi.org/10.1016/j.synthmet.2021.117005). [COBISS.SI-ID [105488643](https://plus.si.cobiss.net/opac7/bib/105488643?lang=sl)]2. CVIKL, Bruno. The electric field at the hole-injecting metal/organic interface controls the bias dependence of the current-voltage hole mobility. *Journal of physics. Condensed matter*. 2020, vol. 33, no. 3, 11 str. ISSN 0953-8984. DOI: [10.1088/1361-648X/abbcf9](https://dx.doi.org/10.1088/1361-648X/abbcf9). [COBISS.SI-ID [43917059](https://plus.si.cobiss.net/opac7/bib/43917059?lang=sl)] 3. CVIKL, Bruno. The hole drift current induced electric field at hole injecting electrode/organic interface and its influence on Gaussian disordered states. *Thin solid films*. [Print ed.]. 2020, vol. 698, art. 137863, 15 str. ISSN 0040-6090. DOI: [10.1016/j.tsf.2020.137863](https://dx.doi.org/10.1016/j.tsf.2020.137863). [COBISS.SI-ID [33265959](https://plus.si.cobiss.net/opac7/bib/33265959?lang=sl)]4. JECL, Gregor, CVIKL, Bruno. The density-of-states contributions to the negative field charge drift mobility effect in poly(3-hexylthiophene) organic semiconductor. *Thin solid films*. [Print ed.]. 2018, vol. 646, str. 190-198. ISSN 0040-6090. DOI: [10.1016/j.tsf.2017.12.007](https://dx.doi.org/10.1016/j.tsf.2017.12.007). [COBISS.SI-ID [31121959](https://plus.si.cobiss.net/opac7/bib/31121959?lang=sl) |

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| **UČNI NAČRT PREDMETA / COURSE SYLLABUS** |
| **Predmet:** | **TEHNOLOŠKO MODELIRANJE ENERGETSKIH PROCESOV** |
| **Course title:** | **TECHNOLOGICAL MODELLING OF POWER PROCESSES** |
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| **Študijski program in stopnja****Study programme and level** | **Študijska smer****Study field** | **Letnik****Academic year** | **Semester****Semester** |
| ENERGETIKA, 2. stopnja  |  | **1** | **1** |
| ENERGY TECHNOLOGY, 2.degree |  | **1** | **1** |
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| **Vrsta predmeta / Course type** | Obvezni/Obligatory |
|  |  |
| **Univerzitetna koda predmeta / University course code:** | M |
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| **Predavanja****Lectures** | **Seminar****Seminar** | **Vaje****Tutorial** | **Klinične vaje****work** | **Druge oblike študija** | **Samost. delo****Individ. work** |  | **ECTS** |
| **45** |  | **30** |  |  | **105** |  | **6** |
| **AV** | **LV** | **RV** |  |
|  | **15** | **15** |  |
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| **Nosilec predmeta / Lecturer:** | **MIRALEM HADŽISELIMOVIĆ** |
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| **Jeziki /** **Languages:** | **Predavanja / Lectures:** | slovenski / Slovene |
| **Vaje / Tutorial:** | slovenski / Slovene |
| **Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:** |  | **Prerequisits:** |
| Ni pogojev. |  | None. |
| **Vsebina:**  |  | **Content (Syllabus outline):** |
| * Uvod.
* Teorija modeliranja sistemov: osnovni principi modeliranja, statični in dinamični sistemi, metode modeliranja, modeliranje z metodo analogij, prenosne funkcije linearnih sistemov, posplošitev nelinearnih sistemov, linearizacija nelinearnih sistemov, poenostavljanje modelov in vrednotenje modelov.
* Modeliranje in simulacija energetskih sistemov: poenostavljeni dinamični modeli gradnikov elektroenergetskega sistema (izvori električne energije, prenosni vodi, stikalne naprave, bremena), vodnih, parnih in vetrnih turbin, hranilnikov energije, hidravličnih elementov, regulacijskih ventilov, cevovodov, črpalk, rezervoarjev, itd.
* Numerično in eksperimentalno določevanje koncentriranih parametrov v dinamičnih modelih.
 |  | * Introduction.
* Theory of system modelling: general aspects of modelling, static and dynamic systems, modelling methods, modelling based on analogy method, transfer functions of linear systems, generalization to nonlinear systems, linearization of non-linear systems, model simplification and evaluation of models.
* Modelling and simulation of energetic systems: simplified dynamic models of electric power system (sources of electrical energy, transmission lines, switch devices, loads), water, steam and wind turbines, energy storage systems, hydraulic elements, control valves, pipes, pumps, tanks, etc.
* Numerical and experimental determination of lumped parameters in dynamic models.
 |
| **Temeljni literatura in viri / Readings:** |
| D. Flynn (Ed.): Thermal Power Plant Simulation and Control, London, 2003.P .J. Thomas: Simulation of Industrial Processes for Control Engineers, Elsevier Science & Technology Books, 1999.B. Zupančič: Computer Simulations, Univerza v Ljubljani, 2013, (in Slovene).R. Karba: Process modelling, FE in FRI, Ljubljana, 1999, (in Slovene).Software: Matlab/Simulink. |
| **Cilji in kompetence:** |  | **Objectives and competences:** |
| Cilj predmeta je naučiti kako sistematično razviti matematični model industrijskega in energetskega procesa z uporabo osnovnih fizikalnih zakonov in na osnovi merljivih veličin. Predavanja so interdisciplinarno zasnovana in podajajo znanja, ki so uporabna na mnogih področjih. Z namenom predstavit različne tehnike matematičnega modeliranja bodo izvedeni številni praktični primeri modeliranja.  |  | The aim of the course is to teach how to systematically build mathematical models of industrial and power process from basic physical laws and from measured signals. The course is of an interdisciplinary character and will give insights which can be applied in most fields. To illustrate different techniques used in the modelling processes a several specific case studies will be studied. |
| **Predvideni študijski rezultati:** |  | **Intended learning outcomes:** |
| Znanje in razumevanje:* Podrobno opisati različne vrste energetskih procesov in pripadajočih simulacijskih procesov.
* Obvladati različne metode modeliranja in oceniti njihovo primernost za modeliranje različnih procesov.
* Se posvetovati o modeliranju energetskih sistemov in podobnih temah s specialisti s področja modeliranja sistemov.
* Razviti enostavne modele različnih energetskih procesov in jih simulirati s programskim paketom Matlab/Simulink.

Prenesljive/ključne spretnosti in drugi atributi:* Sposobnost multidisciplinarnega pristopa pri reševanju problemov.
* Projektno in timsko delo.
* Poenostavitev, predpostavke in simulacije dobljenih matematičnih modelov.
 |  | Knowledge and Understanding:* Characterize types of processes and simulations relevant to power engineering and energy systems.
* Identify modelling methods and their suitability for various processes.
* Discuss power system modelling relevant issues with a modelling specialist.
* Develop simple models of different power process and simulate them in Matlab/Simulink software package.

Transferable/Key Skills and other attributes:* Ability to analyse problems and find solutions in a multidisciplinary way.
* Project and team work.
* Simplification, assumptions and mathematical model simulations.
 |
| **Metode poučevanja in učenja:** |  | **Learning and teaching methods:** |
| Predavanja.Laboratorijske in računalniške vaje.Samostojno delo. |  | Lectures.Laboratory and computer exercises.Individual work. |
| **Načini ocenjevanja:** | Delež (v %) /Weight (in %) | **Assessment:** |
| Opravljene laboratorijske vaje.Pisni izpit. | **35****65** | Completed lab work.Written examination. |
| **Reference nosilca / Lecturer's references:**  |
| SEME, Sebastijan, ŠTUMBERGER, 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.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.IGREC, Dalibor, ŠTUMBERGER, Bojan, CHOWDHURY, Amor, HADŽISELIMOVIĆ, Miralem. Impact of saturation modelling on the losses of electric drive controlled by QFT. Przeglęad Elektrotechniczny, ISSN 0033-2097, 2013, r. 89, nr. 2b, str. 92-95. 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.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. |

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| **UČNI NAČRT PREDMETA / COURSE SYLLABUS** |
| **Predmet:** | **VODENJE ELEKTROENERGETSKIH SISTEMOV** |
| **Course title:** | **ELECTRIC POWER SYSTEM CONTROL** |
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| **Študijski program in stopnja****Study programme and level** | **Študijska smer****Study field** | **Letnik****Academic year** | **Semester****Semester** |
| ENERGETIKA, 2. stopnja  |  | **1** | **2** |
| ENERGY TECHNOLOGY, 2.degree |  | **1** | **2** |
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| **Vrsta predmeta / Course type** | Obvezni/Obligatory |
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| **Univerzitetna koda predmeta / University course code:** | M |
|  |
| **Predavanja****Lectures** | **Seminar****Seminar** | **Vaje****Tutorial** | **Klinične vaje****work** | **Druge oblike študija** | **Samost. delo****Individ. work** |  | **ECTS** |
| **45** |  | **30** |  |  | **105** |  | **6** |
| **AV** | **LV** | **RV** |  |
|  |  | **30** |  |
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| **Nosilec predmeta / Lecturer:** | **BOJAN ŠTUMBERGER** |
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| **Jeziki /** **Languages:** | **Predavanja / Lectures:** | slovenski / Slovene |
| **Vaje / Tutorial:** | slovenski / Slovene |
| **Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:** |  | **Prerequisits:** |
| Ni pogojev. |  | None. |
| **Vsebina:**  |  | **Content (Syllabus outline):** |
| * Splošni vidiki vodenja elektroenergetskega omrežja: proizvodne enote, prenosno omrežje, distribucijsko omrežje, uravnotežena proizvodnja in poraba električne energije.
* Metode planiranja proizvodnje in prenosa električne energije.
* Kvaliteta električne energije.
* Medsebojno povezani sistemi.
* Dinamični model sinhronskega generatorja.
* Prehodni pojavi sinhronskega stroja
* Regulacija delovne moči in frekvence
* Regulacija frekvenca v medsebojno povezanih sistemih
* Reagulacija napetosti in jalove moči
* Analiza stabilnosti
 |  | * General aspects of the control of the electrical energy network: power generations units, transmission network, electrical power distribution system, production and consumption balance.
* Planning methods for generation and transmission of electric energy
* Quality of electricity supply
* Interconected systems
* Dynamic model of synhronous generator
* Synhronous machine transients
* Load frequency control
* Control of interconected systems
* Voltage and reactive power control
* Stability analysis
 |
| **Temeljni literatura in viri / Readings:** |
| D. Dolinar: Avtomatizacija v energetiki, Maribor, 2004. Yao-nan Yu, Electric Power System Dynamics, Academic Press, 1980.P. M. Anderson, A. A. Foud: Power System Control and Stability, Wiley, 2003.Xi-Fan. Wang, Y.Song, M. Irving: Modern Power System Analysis, Springer, 2008.A. R. Bergen, V. Vitall: Power Systems Analysis, Prentice Hall, 2000.M. E. El-Hawary: Introduction to Electrical Power Systems, Wiley, 2008.N. Tleis: Power System Modeling and Fault Analysis, Elsevier, 2008.J. D. Glover, M. S. Sarma, T. J. Overbye: Power Systems Analysis and Design, Cengage Learning, 2012.H. Bevrani: Robust Power System Frequency Control,Springer, 2009. |
| **Cilji in kompetence:** |  | **Objectives and competences:** |
| Pridobiti potrebna znanja o vodenju elektroenergetskih sistemov.Osvojiti metodologijo in pristope vodenja elektroenergetskih sistemov z uporabo sodobnih orodij in znanj. |  | The main objective is to acquire appropriate skills about control of electric power systems.To learn a methodology and concepts of the electric power system control by the use of modern tools and knowledge. |
| **Predvideni študijski rezultati:** |  | **Intended learning outcomes:** |
| Znanje in razumevanje:Študent pridobi znanje o vodenju elektroenergetskega sistema. Razume probleme stabilnosti v medsebojno povezanih sistemih.  |  | Knowledge and Understanding:Student gains knowledge about the control of electric power system. Student understand the stability problems in the interconnected systems. |
| Prenesljive/ključne spretnosti in drugi atributi:Pridobljena znanja bo znal aplicirati za vodenje elektroenergetskega sistema. |  | Transferable/Key Skills and other attributes:The student’s will be able to apply acquired knowledge for the control of electric power system. |
| **Metode poučevanja in učenja:** |  | **Learning and teaching methods:** |
| Predavanja z uporabo računalniške projekcije in table.Računalniške vaje. |  | Lectures by using powerpoint slides and blackboard.Computer exercises. |
| **Načini ocenjevanja:** | Delež (v %) /Weight (in %) | **Assessment:** |
| Pisni izpit.Ustni izpit.Računalniške vaje. | **40****40****20** | Written exam.Oral exam.Computer exercises. |
| **Reference nosilca / Lecturer's references:**  |
| 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, IGREC, Dalibor, CHOWDHURY, Amor, HADŽISELIMOVIĆ, Miralem. Design of synchronous reluctance generator with dual stator windings and anisotropic rotor with flux barriers. *Prz. Elektrotech.*, 2012, r. 88, nr. 12b, str. 16-19. <http://www.red.pe.org.pl/articles/2012/12b/5.pdf>. [COBISS.SI-ID [1024129372](http://cobiss.izum.si/scripts/cobiss?command=DISPLAY&base=COBIB&RID=1024129372)]MARČIČ, Tine, ŠTUMBERGER, Gorazd, ŠTUMBERGER, Bojan. Analyzing the magnetic flux linkage characteristics of alternating current rotating machines by experimental method. *IEEE trans. magn.*, Sep. 2011, vol. 47, iss. 9, str. 2283-2291, graf. prikazi, doi: [10.1109/TMAG.2011.2146266](http://dx.doi.org/10.1109/TMAG.2011.2146266). [COBISS.SI-ID [67349761](http://cobiss.izum.si/scripts/cobiss?command=DISPLAY&base=COBIB&RID=67349761)]ŠTUMBERGER, Bojan, 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, Gorazd, MARČIČ, Tine, ŠTUMBERGER, Bojan, DOLINAR, Drago. Experimental method for determining magnetically nonlinear characteristics of electric machines with magnetically nonlinear and anisotropic iron core, damping windings, and permanent magnets. *IEEE trans. magn.*, Nov. 2008, vol. 44, no. 11, str. 4341-4344, doi: [10.1109/TMAG.2008.2001537](http://dx.doi.org/10.1109/TMAG.2008.2001537). [COBISS.SI-ID [12570390](http://cobiss.izum.si/scripts/cobiss?command=DISPLAY&base=COBIB&RID=12570390)] |

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| **UČNI NAČRT PREDMETA / COURSE SYLLABUS** |
| **Predmet:** | **OBRATOVANJE ELEKTROENERGETSKIH SISTEMOV** |
| **Course title:** | **ELECTRIC POWER SYSTEM OPERATION** |
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| **Študijski program in stopnja****Study programme and level** | **Študijska smer****Study field** | **Letnik****Academic year** | **Semester****Semester** |
| ENERGETIKA, 2. STOPNJA |  | **1** | **2** |
| ENERGY TECHNOLOGY, 2.DEGREE |  | **1** | **2** |
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| **Vrsta predmeta / Course type** | Obvezni/Obligatory |
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| **Univerzitetna koda predmeta / University course code:** | M |
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| **Predavanja****Lectures** | **Seminar****Seminar** | **Vaje****Tutorial** | **Klinične vaje****work** | **Druge oblike študija** | **Samost. delo****Individ. work** |  | **ECTS** |
| **45** |  | **30** |  |  | **105** |  | **6** |
| **AV** | **LV** | **RV** |  |
| **10** | **10** | **10** |  |
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| **Nosilec predmeta / Lecturer:** | **PETER VIRTIČ** |
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| **Jeziki /Languages:** | **Predavanja / Lectures:** | slovenski / Slovene |
| **Vaje / Tutorial:** | slovenski / Slovene |
| **Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:** |  | **Prerequisits:** |
| Ni pogojev. |  | None. |
| **Vsebina:**  |  | **Content (Syllabus outline):** |
| * Modeli elektroenergetskega sistema in njegovih elementov.
* Matrične metode za izračun spremenljivk v električnih omrežjih.
* Izračun pretokov moči.
* Izračun kratkih stikov.
* Stabilnost in zanesljivost elektroenergetskih omrežij.
* Vključitev razpršenih virov v energetski sistem.
* Upravljanje s fleksibilnostmi v elektroenergetskih sistemih.
* Pregled optimizacijskih metod.
* Vpliv energetskega trga in energetskih politik na načrtovanje, razvoj in optimizacijo elektroenergetskih omrežij.
* Primeri optimizacij v elektroenergetskem sistemu.
* Kakovost energije.
 |   | * Electric power system models.
* Matrix methods for calculation of power system variables.
* Power flow calculation.
* Short circuits calculation.
* Stability and reliability of power systems.
* iItegration of dispersed energy sources in power system.
* Flexibility management in power systems.
* Overview of optimization methods.
* Influence of energy market and energy policy on power system planning, development and optimizaction.
* Multi and single objective function optimization.
* Examples of electric power system optimizations.
* Energy quality.
 |
| **Temeljni literatura in viri / Readings:** |
| J. Voršič, T. Zorič, M. Horvat, Izračun obratovalnih stanj v elektroenergetskih omrežjih, Maribor 2009.J.A. Momoh, Electric Power System Applications of Optimization, Marcel Dekker, 2001.K.V. Price, R.M. Storn, J,A. Lampinen, Differential Evolution - A Practical Approach to Global Optimization, Springer, 2005. |
| **Cilji in kompetence:** |  | **Objectives and competences:** |
| Seznaniti študente z obratovalnimi stanji elektroenergetskih omrežij in metodami za njihov izračun, optimizacijskimi postopki in možnostmi uporabe le teh na področju optimizacije elektroenergetskih sistemov. |  | Students become familiar with power system operation and method for their opreation, optimization procedures and with their use in the field of electric power system optimization. |
| **Predvideni študijski rezultati:** |  | **Intended learning outcomes:** |
| Znanje in razumevanje:Razumevanje obratovanja elektroenergetskih omrežij in optimizacijskih postopkov elektroenergetskega sistema. |   | Knowledge and understanding:Understanding power system operation and optimization processes of power system. |
| Prenesljive/ključne spretnosti in drugi atributi:Poznavanje metod za izračun obratovalnih stanj v elektroenergetskih sistemih in uporabe optimizacijskih postopkov.  |  | Transferable/Key Skills and other attributes:Knowledge about power system operation states calculation method and optimization procedures. |
| **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: in lectures the student learns the theoretical content of the course.Tutorials: in the tutorials the student consolidates theoretical knowledge and learns about application possibilities |
| **Načini ocenjevanja:** | Delež (v %) /Weight (in %) | **Assessment:** |
| Način (pisni izpit, ustno izpraševanje, naloge, projekt):pisni izpit (lahko se delno ali v celoti nadomesti z ustnim izpraševanjem)ocena vaj | **90****10** | Type (examination, oral, coursework, project):written exam (can be partially or fully replaced by an oral examination)assessment of tutorials |
| **Reference nosilca / Lecturer's references:**  |
| 1. PRANJIĆ, Franjo, VIRTIČ, Peter. Designing rotor disks of a coreless axial flux permanent magnet machines by using simplified FEM and an approximation method. IEEE transactions on energy conversion. 2020, vol. 35, issue 3, str. 1505-1512. ISSN 1558-0059. DOI: 10.1109/TEC.2020.2977965. [COBISS.SI-ID 1024385116]
2. PRANJIĆ, Franjo, VIRTIČ, Peter. Development of mathematical models in explicit form for design and analysis of axial flux permanent magnet synchronous machines. Applied sciences. okt. 2020, vol. 10, iss. 21, str. 1-18, ilustr. ISSN 2076-3417. DOI: [10.3390/app10217695](https://dx.doi.org/10.3390/app10217695). [COBISS.SI-ID [35220227](https://plus.si.cobiss.net/opac7/bib/35220227?lang=sl)]
3. LOKAR, Jan, VIRTIČ, Peter. The potential for integration of hydrogen for complete energy self-sufficiency in residential buildings with photovoltaic and battery storage systemstechnologies. International Journal of Hydrogen Energy. [Online ed.]. 2020, vol. 45, issue 60, str. 34566-34578. ISSN 1879-3487 <https://www.sciencedirect.com/science/article/pii/S0360319920315743?via%3Dihub>, DOI: [10.1016/j.ijhydene.2020.04.170](https://dx.doi.org/10.1016/j.ijhydene.2020.04.170). [COBISS.SI-ID [15605507](https://plus.si.cobiss.net/opac7/bib/15605507?lang=sl)]
4. VIRTIČ, Peter, KOVAČIČ LUKMAN, Rebeka. A photovoltaic net metering system and its environmental performance : a case study from Slovenia. Journal of cleaner production. [Online ed.]. 2019, 212, str. 334-342. ISSN 1879-1786. DOI: 10.1016/j.jclepro.2018.12.035. [COBISS.SI-ID 1024330332]
5. MARKOVIČ, Rene, GOSAK, Marko, GRUBELNIK, Vladimir, MARHL, Marko, VIRTIČ, Peter. Data-driven classification of residential energy consumption patterns by means of functional connectivity networks. Applied energy. 2019, vol. 242, str. 506-515, graf. prikazi. ISSN 0306-2619. DOI: [10.1016/j.apenergy.2019.03.134](https://dx.doi.org/10.1016/j.apenergy.2019.03.134). [COBISS.SI-ID [1024346460](https://plus.si.cobiss.net/opac7/bib/1024346460?lang=sl)]
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| **UČNI NAČRT PREDMETA / COURSE SYLLABUS** |
| **Predmet:** | **NUMERIČNO MODELIRANJE V ENERGETIKI** |
| **Course title:** | **NUMERICAL MODELING IN ENERGY TECHNOLOGY** |
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| **Študijski program in stopnja****Study programme and level** | **Študijska smer****Study field** | **Letnik****Academic year** | **Semester****Semester** |
| ENERGETIKA, 2. STOPNJA |  | **1** | **2** |
| ENERGY TECHNOLOGY,2.degree |  | **1** | **2** |
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| **Vrsta predmeta / Course type** | Obvezni/Obligatory |
|  |  |
| **Univerzitetna koda predmeta / University course code:** | M |
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| **Predavanja****Lectures** | **Seminar****Seminar** | **Vaje****Tutorial** | **Klinične vaje****Work** | **Druge oblike študija** | **Samost. delo****Individ. work** |  | **ECTS** |
| **45** |  | **30** |  |  | **105** |  | **6** |
| **AV** | **LV** | **RV** |  |
| 10 |  | 20 |  |
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| **Nosilec predmeta / Lecturer:** | **IVAN ŽAGAR** |
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| **Jeziki /** **Languages:** | **Predavanja / Lectures:** | slovenski / Slovene |
| **Vaje / Tutorial:** | slovenski / Slovene |
| **Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:** |  | **Prerequisits:** |
| Ni pogojev. |  | None. |
| **Vsebina:**  |  | **Content (Syllabus outline):** |
| * Namen numeričnega modeliranja.
* Fizikalni opisi procesov v energetiki: vodilne enačbe, robni in začetni pogoji.
* Matematično modeliranje energetskih procesov
* Osnovne metode numeričnega modeliranja in matematična formulacija.
* Metoda končnih elementov: formulacija, diskretizacija, prednosti in slabosti.
* Metoda robnih elementov: formulacija, diskretizacija, prednosti in slabosti.
* Metoda končnih razlik: formulacija, diskretizacija, prednosti, slabosti.
* Uporaba numeričnega modeliranja ustaljenih in transientnih prenosnih pojavov.
* Možnosti numeričnega modeliranja dvofaznih tokov v energetskih napravah.
* Primeri uporabe numeričnega modeliranja
 |  | * The purpose of numerical modelling
* Physical descriptions of processes in energy: leading equations, boundary and initial conditions.
* Mathematical modeling of energy processes.
* Basic methods of numerical modeling and mathematical formulation.
* Finite element method: formulation, discretization, strengths and weaknesses.
* Boundary element method: formulation, discretization and strengths.
* Finite difference method, formulation, discretization, advantages, weaknesses
* The use of numerical modeling of fixed and transient portable phenomena.
* The possibilities of numerical modeling of two-phase flows in energy devices
* Examples of numerical modeling
 |
| **Temeljni literatura in viri / Readings:** |
| M.Hriberšek, J.Ravnik: Numerično modeliranje in računalniške simulacije; 1 del. Gradniki numeričnega računanja, Fakulteta za strojništvo, UM, 2012B.Orel: Uvod v numerične metode, Fakulteta za računalništvo in informatiko, ULJ, 2021B.Jurčič Zlobec, Numerične metode, Fakulteta za elektrotehniko, ULJ, 2007A.Kaw, E.E.Kalu: Numerical Methods with Applications, 2nd Ed.University of South Florida, 2008 T.Young, M.J.Mohlenkamp: Introduction to Numerical Methods and Matlab Programming for Engineers, Department of Mathematics, Ohio University, 2018S.Calogero: Introduction to finite difference method; Geteborg Univeristet, Chalmers, 2015S.C.Chapra: Applied Numerical Methods with Matlab for Engineers and Scientists, 3rd Ed, Tufts University, McGraw-Hill, 2015 |
| **Cilji in kompetence:** |  | **Objectives and competences:** |
| Študenti se seznanijo z numeričnimi metodami ter postopki modeliranja energetskih procesov. |  | Students get to know about numerical methods and processes for modeling energy processes. |
| **Predvideni študijski rezultati:** |  | **Intended learning outcomes:** |
| Znanje in razumevanje:• pravilne izbire ustreznega postopka  numeričnega modeliranja energetskih  procesov* pravilna interpretacija numeričnih rezultatov ter uporaba v praksi.

Prenesljive/ključne spretnosti in drugi atributi:• uspešno delo na energetskih razvojno  raziskovalnih projektih |  | Knowledge and understanding:* the correct choice of the appropriate

 process of numerical modeling of energy  processes* the correct interpretation of numerical results and application in practice

Transferable/Key Skills and other attributes:* successful work on energy development

  research projects |
| **Metode poučevanja in učenja:** |  | **Learning and teaching methods:** |
| PredavanjaVaje |  | LecturesTutorials |
| **Načini ocenjevanja:** | Delež (v %) /Weight (in %) | **Assessment:** |
| Način (pisni izpit, ustno izpraševanje, naloge, projekt):* pisni izpit - preračuni
* ustni izpit - teorija
* predstavitev seminarske naloge
 | **40****40****20** | Type (examination, oral, coursework, project):* written exam - calculations
* oral exam e-quiz - theory
* coursework presentation
 |
| **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, 2009ŽAGAR, Ivan. Izzivi in rešitve pri izdelavi trajnostnega energetskega akcijskega načrta (SEAP) za Slovensko Bistrico : predavanje na Dnevih Posavske energetike, 12. december 2013, Krško, 2013HREN, Gorazd, PREDIN, Andrej, ŽAGAR, Ivan. Generic model of wind turbine blades = Generični model lopatic vetrne turbine. Journal of energy technology, 2013, vol. 6, iss. 1, str. 61-68ŽAGAR, 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, 2014, vol. 7, iss. 4, str. 59-76ŽAGAR Ivan, Europe on the move: promoting seamless mobilitiy solution, Opinion (CDR 3560/2017) ŽAGAR  Ivan, “Energy efficiency projects in the Municipality of Slovenska Bistrica”, Resilient Cities and Regions Network Regional PartnershipTowards resilient, sustainable and resource-efficient cities and regions, European Week, Bruselj 10. oktober 2017 |

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| **UČNI NAČRT PREDMETA / COURSE SYLLABUS** |
| **Predmet:** | **VISOKONAPETOSTNI SISTEMI V ENERGETIKI** |
| **Course title:** | **HIGH VOLTAGE SYSTEMS IN ENERGY TECHNOLOGY** |
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| **Študijski program in stopnja****Study programme and level** | **Študijska smer****Study field** | **Letnik****Academic year** | **Semester****Semester** |
| ENERGETIKA, 2. stopnja  |  | **1** | **2** |
| ENERGY TECHNOLOGY, 2.degree |  | **1** | **2** |
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| **Vrsta predmeta / Course type**  | Obvezni/Obligatory |
|  |  |
| **Univerzitetna koda predmeta / University course code:** | M |
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| **Predavanja****Lectures** | **Seminar****Seminar** | **Vaje****Tutorial** | **Klinične vaje****work** | **Druge oblike študija** | **Samost. delo****Individ. work** |  | **ECTS** |
| **45** |  | **30** |  |  | **105** |  | **6** |
| **AV** | **LV** | **RV** |  |
|  | **20** | **10** |  |
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| **Nosilec predmeta / Lecturer:** | **SEBASTIJAN SEME** |
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| **Jeziki /** **Languages:** | **Predavanja / Lectures:** | slovenski / Slovene |
| **Vaje / Tutorial:** | slovenski / Slovene |
| **Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:** |  | **Prerequisits:** |
| Ni pogojev. |  | None. |
| **Vsebina:**  |  | **Content (Syllabus outline):** |
| a) Osnovne zakonitosti električnih polj. Izračun enostavnih elektrostatičnih polj z uporabo Maxwellove in Laplaceove enačbe.b) Osnovne las~~n~~tnosti plinastih, tekočih in trdnih dielektrikov.c) Prenapetosti, ki se pojavljajo v elektroenergetskih sistemih, nap~~a~~ravah in aparatih.d) Prenapetostna zaščita s preprečevanjem nastajanja velikih tokov, zniževanje prenapetosti in zaščita zgradb pred posledicami udara strele.e) Načini in vrste preskušanja naprav in aparatov v energetiki. Visoke izmenične in enosmerne preskusne napetosti. |  | a) The basic laws of electric fields. Calculation of simple electrostatic fields using Maxwell and Laplace equations.b) Basic properties of gaseous, liquid and solid dielectrics.c) Overvoltages occurring in power systems, power plants and apparatus.d) Overvoltage protection by preventing the formation of large currents, reducing overvoltages and protecting buildings against the effects of lightning.e) Methods and types of testing of devices and apparatus in the energy sector. High AC and DC test voltages. |
| **Temeljni literatura in viri / Readings:** |
| J. Voršič, J. Pihler, Tehnika visokih napetosti in velikih tokov, Založniška dejavnost FERI Maribor, Maribor, 2008.S. Seme, M. Hadžiselimović, Visokonapetostni sistemi v energetiki, zbirka vaj in nalog. 1. izd. Krško, 2016.A. Küchler, High Voltage Engineering : fundamentals, technology, applications, 2018M. S. Naidu, V. Kamaraju, High- Voltage Engineering, Mc Graww-Hill, 2000.Mazen Abdel-Salam, High-Voltage Engineering, Marcel Dekker, 2000. |
| **Cilji in kompetence:** |  | **Objectives and competences:** |
| Cilj in kompetence predmeta so pridobiti poglobljena znanja s področja visokih napetosti in velikih tokov. Spoznati pomembnosti preskušanja energetskih naprav in aparatov.Razviti sposobnost samostojnega in kreativnega reševanja inženirskih problemov. |  | The objective and competences of the course are to acquire in-depth knowledge in the field of high voltage and large currents. Get to know the importance of testing energy appliances and appliances.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 preskušanja energetskih naprav in aparatov. |  | Knowledge and Understanding:Knowledge and understanding in the field of testing energy appliances and appliances. |
| Prenesljive/ključne spretnosti in drugi atributi:Uporaba teoretičnega znanja v praksi in praktično izvajanje preskušanja. |  | Transferable/Key Skills and other attributes:Application of theoretical knowledge in practice and practical implementation of the testing. |
| **Metode poučevanja in učenja:** |  | **Learning and teaching methods:** |
| Predavanja: pri predavanjih študent spozna teoretične osnove predmeta.Laboratorisjke vaje: pri laboratorijskih vajah študent dodatno utrdi teoretična znanja na praktičnih primerih in spozna uporabnost.Računalniške vaje: pri računalniških vaja študent dodatno utrdi teoretično znanje na simulacijskih primerih. |  | Lectures: during the lectures, the student gets to know the theoretical foundations of the course.Laboratory exercises: during laboratory exercises, the student additionally consolidates theoretical knowledge on practical examples and learns its usefulness.Computer exercises: in computer exercises, the student additionally consolidates theoretical knowledge on simulation examples. |
| **Načini ocenjevanja:** | Delež (v %) /Weight (in %) | **Assessment:** |
| Način (pisni izpit, ustno izpraševanje, naloge, projekt):pisni izpitustni izpitseminar poročilo računalniških vajporočilo laboratorijskih vaj*Sprotne oblike preverjanja znanja (lahko nadomestijo pisni in ustni izpit)*1. kolokvij 15 %2. kolokvij 20 %3. kolokvij 20 % | **45****10****5****15****25** | Type (examination, oral, coursework, project):written examoral examSeminarComputer Exercise ReportLaboratory Exercise Report*Ongoing assessments (can replace the written and oral exam)*1. midterm test 15 %2. midterm test 20 %3. midterm test 20 % |
| **Reference nosilca / Lecturer's references:**  |
| SEME, Sebastijan, LUKAČ, Niko, ŠTUMBERGER, Bojan, HADŽISELIMOVIĆ, Miralem. Power quality experimental analysis of grid-connected photovoltaic systems in urban distribution networks. Energy, ISSN 0360-5442, 2017, vol. 139, str. 1261-1266, graf. prikazi, doi: 10.1016/j.energy.2017.05.088. [COBISS.SI-ID 1024268124]SEME, Sebastijan, SREDENŠEK, Klemen, ŠTUMBERGER, Bojan, HADŽISELIMOVIĆ, Miralem. Analysis of the performance of photovoltaic systems in Slovenia. Solar energy. [Print ed.]. 2019, vol. 180, str. 550-558, ilustr. ISSN 0038-092X. DOI: 10.1016/j.solener.2019.01.062. [COBISS.SI-ID 1024334684]DEŽELAK, Klemen, BRACINÍK, Peter, SREDENŠEK, Klemen, SEME, Sebastijan. Proportional-integral controllers performance of a grid-connected solar PV system with particle swarm optimization and Ziegler-Nichols tuning method. Energies. 2021, vol. 14, issue 9, str. 1-15. ISSN 1996-1073. DOI: 10.3390/en14092516. [COBISS.SI-ID 61414659] |

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| **UČNI NAČRT PREDMETA / COURSE SYLLABUS** |
| **Predmet:** | **ENERGETSKI MENEDŽMENT IN INŽENIRING**  |
| **Course title:** | **ENERGY MANAGEMENT AND ENGINEERING**  |
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| **Študijski program in stopnja****Study programme and level** | **Študijska smer****Study field** | **Letnik****Academic year** | **Semester****Semester** |
| ENERGETIKA, 2. STOPNJA |  | **1** | **2** |
| ENERGY TECHNOLOGY,2.degree |  | **1** | **2** |
|  |
| **Vrsta predmeta / Course type** | Obvezni/Obligatory |
|  |  |
| **Univerzitetna koda predmeta / University course code:** | M |
|  |
| **Predavanja****Lectures** | **Seminar****Seminar** | **Vaje****Tutorial** | **Klinične vaje****work** | **Druge oblike študija** | **Samost. delo****Individ. work** |  | **ECTS** |
| **45** |  | **30** |  |  | **105** |  | **6** |
| **AV** | **LV** | **RV** |  |
|  | **30** |  |  |
|  |
| **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:** |
| Priporočeno osnovno znanje Gradnikov v energetiki |  | Basic knowledge of Materials in energetics is recommended |
| **Vsebina:**  |  | **Content (Syllabus outline):** |
| Uvodni del z definicijo za energetski menedžment in inženiring.Energetski menedžment:* evropski standardi v energetski učinkovitosti stavb
* gradbena fizika in varčevanje z energijo
* principi projektiranja energetsko učinkovitih stavb
* toplotna zaščita stavb in prihranki energije.

Atmosfera in ugodje pri načrtovanju stavb* blowerjev test (test zrakotesnosti)moderne nizkoenergetske in pasivne stavbe
* hiša prihodnosti – dobivanje energije z sinergijo, inteligentna stavba
* energetska bilanca stavbe
* ekonomska analiza obratovalnih režimov in optimizacija delovanja glede na minimalne letne stroške

Projektni management in njegove posebnosti. Vodenje posameznika in skupine. Projektno in razvojno delovanje skupin. Zasnova in organiziranje projektnih skupin. Kadrovska zasedba skupin in delo v skupinah, ter sistemi projektnih ključev.Energetski inženiring:* Vpliv snovanja in konstruiranja izdelka na vzdrževanje izdelka.
* cilji in pomen vzdrževanja, politika vzdrževanja, investicije in stroški v življenjski dobi.
* osnovna terminologija s področja vzdrževanja.
* opis sodobnih metod za nadzor stanja:PGT, nadzor vibracij, termografija, plinska kromatografija, analiza vrtinčastih tokov, ultrazvočna in rentgenska defektoskopija.
* vzdrževanje cevovodov
* vzdrževanje toplotnih prenosnikov, plinskih in parnih turbin. Vzdrževanje črpalk in kompresorjev. Vzdrževanje električnih naprav in strojev. Vzdrževanje motorjev z notranjim zgorevanjem. Vzdrževanje ogrevalnih sistemov in klimatskih naprav
* uporaba računalniškega programa in numeričnega paketa za optimiranje.
 |  | * Introduction part with definition of energy management and engineering.

Energy management:* european standards regarding energy efficiency of buildings
* construction physics and energy saving
* principles of designing energy efficient buildings

heat insulation in buildings and energy saving. Atmosphere and well – being taken into account when designing the buildings* blower door test
* low – energy and passive houses
* house of the future – producing energy with synergy, intelligent building
* energy balance of a building
* economic analysis of operating regimes and optimization of functioning with regard to minimum annual costs

Project management, guidance of successful work process. Project management and specialties. Management of individuals and groups. Project and development group activities. Funding and organizing project groups. Project key systems.Energy Engineering:- the influence of planning and development of product on maintenance.* maintenance terminology.
* maintenance objectives and significance, maintenance policies, investments considerations and LCC.
* basics of modern Condition Monitoring systems: Human Senses, Vibration monitoring, Gas Chromatography, Eddy Current, Ultrasound, X-ray.
* maintenance of pipe systems.
* maintenannce of heat exchangers, gas and vapour turbines. Maintenance of pumps and compressors. Maintenance of electrical equipments and machines. Maintenance of engines with internal combustion. Maintenance of heating systems and systems with air conditioning
* numerical methods use (numerical modeling) for optimizing.
 |
| **Temeljni literatura in viri / Readings:** |
| L. D. Danny Harvey: A handbook on low – energy buildings and district – energy systems: Fundamentals, techniques and examples, Earthscan Publications Ltd, 2006.Barney L. Capehart, Wayne C. Turner, William J. Kennedy: Guide to Energy Management, 4th edition, The Fairmont Press, 2013.Alan Wilson: ASSET ENERGY MANAGEMENT: A Guide to Developing Strategy and Improving Performance; Industrial Press, 2002. Darly Mather: The Maintenance Scorecard – Creating Strategic Advantages; Industrial Press, 2005.John Moubray: Reliability-Centred Maintenance; Elsevir., 2008.Terry Wireman: Developing Performance Indicators for Managing Maintenance; Industrial Press, 1998.En 15341: Maintenance - Maintenance Key Performance Indicators, draft.S. Duffua, A. RoufPlanning and Control of Maintenance Systems, Willey, 1999.R.R. Keith Mobley, L.R. Higgins, D.J. Wirkoff, Maintenance Engineering handbook, Seventh Edition, MCGraw Hill, 2008.Praunseis Z.; *Energetska oskrba objektov*. Univerzitetni učbenik,[1. izd.]. Krško: Fakulteta za energetiko, Praunseis, Z.; Projektni management: zapiski predavanj. Krško: Fakulteta za energetiko, 2015. 78 str., graf.Antončič, B., Hisrich, R., Petrin, T., Vahčič, A., Podjetništvo, Založbe GV, Ljubljana, 2002.Gary R. Heerkens, Project management, McGraw-Hill, U.S.A. 2006.Harold Kerzner; Project Management; John Willey and Sons Ltd.; Ohio, U.S. A., 2016.Ruchard Murch; Project Management; Best Practice for IT Professionals, Printice Hall PTR, Upper Saddle River, New York, U.S. A., 2006.2014. XVII, 286 str., ilustr., tabele. ISBN 978-961-6800-11-2. [COBISS.SI-ID [76157441](https://plus.si.cobiss.net/opac7/bib/76157441?lang=en)] Praunseis, Z.; Inženiring v energetiki : zapiski predavanj. Krško: Fakulteta za energetiko, 2016. 148 str., graf. prikazi. [COBISS.SI-ID [1024222812](https://plus.si.cobiss.net/opac7/bib/1024222812?lang=sl)]  |
| **Cilji in kompetence:** |  | **Objectives and competences:** |
| * razvoj učinkovitega in gospodarno uspešnega načrtovanja energetskega menedžmenta in inženiringa.
* aplikacija tehno – ekonomskih optimizacijskih metod v cilju vrednotenja rentabilnosti investicije v energetske sisteme objektov
* razvoj logičnega razmišljanja, skupinsko delo in ustvarjalen pristop k raziskovalno – aplikativnemu delu
 |  | * to develop efficient and economically successful designing of energy management and engineering.
* application of technical and economic optimization methods with the aim to evaluate rentability of investment into energy systems of the buildings
* development of logical thinking, team work and a creative approach towards research work
 |
| **Predvideni študijski rezultati:** |  | **Intended learning outcomes:** |
| Znanje in razumevanje:* energetsko učinkovitega načrtovanja v energetskem menedžmentu in inženiringu.
* standardnih metod in vključevanje postopkov optimizacije pri reševanju aplikativnih projektov.
* sposobnost uporabe ustrezne programske opreme
 |  | Knowledge and understanding:* of energy efficient design inthe energy managenent in inženiring.
* standard methods and integration of the process of optimization when solving applicable projects
* the ability to use appropriate programme equipment
 |
| Prenesljive/ključne spretnosti in drugi atributi:* z mentorskim reševanjem konkretnih primerov se oblikuje študentova kreativnost, logično razmišljanje in sposobnost ekonomsko učinkovitega načrtovanja
* avtonomnost v strokovnem in raziskovalnem delu
 |  | Transferable/Key Skills and other attributes:* solving concrete examples under supervision and hence developing student’s creativity, logical thinking and the ability of economically efficient designing
* autonomy in professional and research work
 |
| **Metode poučevanja in učenja:** |  | **Learning and teaching methods:** |
| Predavanja: študent spozna teoretične vsebine predmeta.Vaje: študent utrdi teoretično znanje in spozna aplikativne možnosti reševanja enostavnih primerov iz prakse. |  | Lectures: the student gets acquainted with theoretical content of the subject.Tutorial: the student upgrades the theoretical knowledge with practical experience. |
| **Načini ocenjevanja:** | Delež (v %) /Weight (in %) | **Assessment:** |
|  |  |  |
| Način (pisni izpit, ustno izpraševanje, naloge, projekt)* domače naloge
* pisni izpit
* ustni izpit
 | **10****45****45** | Type (examination, oral, coursework, project):* completed coursework
* written examination
* oral examination
 |
| Opomba: Pisni izpit se lahko nadomesti z ustnim izpitom. Note: The written exam may be replaced with oral exam. **Reference nosilca / Course coordinator's references:**  |
| PRAUNSEIS, Zdravko*. Inženiring v energetiki : zapiski predavanj*. Krško: Fakulteta za energetiko, 2016. 148 str., graf. prikazi. [COBISS.SI-ID [1024222812](https://plus.si.cobiss.net/opac7/bib/1024222812?lang=en)] SEME, Sebastijan, SRPČIČ, Gregor, KAVŠEK, Domen, BOŽIČNIK, Stanislav, LETNIK, Tomislav, PRAUNSEIS, Zdravko, ŠTUMBERGER, Bojan, HADŽISELIMOVIĆ, Miralem. Dual-axis photovoltaic tracking system : design and experimental investigation. *Energy*, ISSN 0360-5442. [Print ed.], maj 2017, str. [1-8], graf. prikazi, doi: [10.1016/j.energy.2017.05.153](https://doi.org/10.1016/j.energy.2017.05.153). [COBISS.SI-ID [1024270172](https://plus.si.cobiss.net/opac7/bib/1024270172?lang=sl)], [[JCR](https://plus.si.cobiss.net/opac7/jcr?c=sc=0360-5442+and+PY=2016&r1=true&lang=sl), [SNIP](https://plus.si.cobiss.net/opac7/snip?c=sc=0360-5442+and+PY=2016&r1=true&lang=sl), [Scopus](http://www.scopus.com/inward/record.url?partnerID=2dRBettD&eid=2-s2.0-85020450820) do 24. 6. 2017SREDENŠEK, Klemen, SEME, Sebastijan, ŠTUMBERGER, Bojan, HADŽISELIMOVIĆ, Miralem, CHOWDHURY, Amor, PRAUNSEIS, Zdravko. Experimental validation of a dynamic photovoltaic/thermal collector model in combination with a thermal energy storage tank. *Energies*. 2021, vol. 14, issue 23, str. 1-21. ISSN 1996-1073. DOI: [10.3390/en14238162](https://dx.doi.org/10.3390/en14238162). [COBISS.SI-ID [88681731](https://plus.si.cobiss.net/opac7/bib/88681731?lang=sl)], [[JCR](https://plus.si.cobiss.net/opac7/jcr?c=sc=1996-1073+and+PY=2020&r1=true&lang=sl), [SNIP](https://plus.si.cobiss.net/opac7/snip?c=sc=1996-1073+and+PY=2020&r1=true&lang=sl), [WoS](http://gateway.isiknowledge.com/gateway/Gateway.cgi?GWVersion=2&SrcAuth=Alerting&SrcApp=Alerting&DestApp=WOS&DestLinkType=FullRecord&KeyUT=000735139000001), [Scopus](http://www.scopus.com/inward/record.url?partnerID=2dRBettD&eid=2-s2.0-85120804575)]PRAUNSEIS, Zdravko, PAVLINA, Tadeja. Fracture Testing of Energy Materials for Application in Electrical Engineering. *Przegląd Elektrotechniczny*. 2019, r. 95, nr. 1, str. 161-164, graf. prikazi. ISSN 2449-9544. DOI: [10.15199/48.2019.01.41](https://dx.doi.org/10.15199/48.2019.01.41). [COBISS.SI-ID [1024334172](https://plus.si.cobiss.net/opac7/bib/1024334172?lang=sl)], [[SNIP](https://plus.si.cobiss.net/opac7/snip?c=sc=0033-2097+and+PY=2019&r1=true&lang=sl), [WoS](http://gateway.isiknowledge.com/gateway/Gateway.cgi?GWVersion=2&SrcAuth=Alerting&SrcApp=Alerting&DestApp=WOS&DestLinkType=FullRecord&KeyUT=000456967900041), [Scopus](http://www.scopus.com/inward/record.url?partnerID=2dRBettD&eid=2-s2.0-85059432260)] |

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| **UČNI NAČRT PREDMETA / COURSE SYLLABUS** |
| **Predmet:** | **VIRTUALNI INŽENIRING** |
| **Course title:** | **VIRTUAL ENGINEERING** |
|  |  |  |  |
| **Študijski program in stopnja****Study programme and level** | **Študijska smer****Study field** | **Letnik****Academic year** | **Semester****Semester** |
| ENERGETIKA, 2. STOPNJA |  | **2** | **1** |
| ENERGY TECHNOLOGY,2.degree |  | **2** | **1** |
|  |
| **Vrsta predmeta / Course type** | Obvezen/Obligatory |
|  |  |
| **Univerzitetna koda predmeta / University course code:** | M |
|  |
| **Predavanja****Lectures** | **Seminar****Seminar** | **Vaje****Tutorial** | **Klinične vaje****work** | **Druge oblike študija** | **Samost. delo****Individ. work** |  | **ECTS** |
| **45** |  | **30** |  |  | **105** |  | **6** |
| **AV** | **LV** | **RV** |  |
|  | 5 | 25 |  |
|  |
| **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):** |
| Realnost, modeli, animacije in simulacije. Razvoj in vloga računalniške grafike in CAx sistemov v inženirskem deluPLM sistemi in hkratni inženiring.Inženirske simulacije. Pregled matematično-fizikalnih modelov trdnin in tekočin. Modeliranje geometrije.Metoda končnih elementov in virtualno delo; Metoda končnih volumnov in prenosna enačba. Interpolacijske funkcije in vrste elementov - linijski, ravninski in prostorski problemi. Definicija robnih pogojev in konvergenčnih kriterijev. Načrtovanje in izvedba računalniških simulacij. Vrednotenje ter predstavitev rezultatov.Virtualne tehnologije, aplikacije in trendi razvoja. |  | Reality, models, animations and simulations. Development and role of computer graphics and CAx systems in engineering.PLM systems and concurrent engineering.Engineering simulations. Review of mathematical-physical models of solid and fluid continuum behaviour under different influences. Geometry creation.Finite element method and virtual work; Finite volume method for potential problems.Shape functions and types of finite elements. 1D, 2D and 3D problems.Definition of boundary conditions and convergence criteria. Planning and execution of computer simulations. Evaluation and presentation of results.Virtual technologies, applications and development trends. |
| **Temeljni literatura in viri / Readings:** |
| Hren G.: prosojnice predavanj, dostopno na moodle, 2020Ovtcharova J.G.; Virtual engineering: principles,methods and applications; Design,2010Saqr K.M.: Practical Introduction to Computational Fluid Dynamics, Course Notes, Harvard Dataverse, 2017, researchgate.net/publication/!Practical\_Introduction\_to\_Computational\_Fluid\_DynamicsPDFKurowski P.M.: Finite Element Analysis for Design Engineers, 2.nd Edition, SAE International, 2017, engbookspdf.xyz/FiniteElementAnalysisforDesignEngineers2ndEditionPDFChang, Kuang-Hua: Product design modeling using CAD/CAE, Elsevier Academic Press, 2014S.M.LaValle: Virtual reality, University of Illinois, 2016 (dosegljivo: <http://vr.cs.uiuc.edu/>) |
| **Cilji in kompetence:** |  | **Objectives and competences:** |
| Seznaniti študenta z osnovami numeričnih metod osnovnih ohranitvenih zakonov mehanike trdnin in tekočin, posredovati pravilni pristop h generaciji mrež, pravilni numerični definiciji fizikalnega problema v računalniškem okolju ter uporabi računalniških simulacij za reševanje inženirskih problemov.Vpogled v praktične rešitve. |  | To qualify for individual research work. Student has to gain knowledge of writing of expert papers.The course is intended to introduce students to the fundamentals of computational methods of basic conservation laws in solid and fluid mechanics, to convey the right approach to mesh generation, computational modeling of physical problems, to provide practical experience with computer simulations to solve engineering problems.Knowledge about existing practical solutions. |
| **Predvideni študijski rezultati:** |  | **Intended learning outcomes:** |
| Znanje in razumevanje:Razumevanje osnovnih principov pretvorbe diferencialnih enačb v integralske oblike in sisteme algebrajskih enačbe, primerne za reševanje z računalniki. |  | Knowledge and understanding:Understanding of basic principles for transformation of differential equations into their integral form and systems of algebraic equations, suitable for computer simulations. |
| Praktična uporaba sodobnih računalniških sistemov za reševanje inženirskih problemov. |  | Practical use of modern computer systems for solution of engineering problems. |
| **Metode poučevanja in učenja:** |  | **Learning and teaching methods:** |
| predavanja,vaje v računalniški učilnici,delo v laboratoriju. |  | lectures,computer tutorials,laboratory work. |
| **Načini ocenjevanja:** | Delež (v %) /Weight (in %) | **Assessment:** |
| Način (pisni izpit, ustno izpraševanje, naloge, projekt):* poročilo računalniških in laboratorijskih vaj z zagovorom,
* pisni izpit/poročilo simulacij, računalniška učilnica
* ustni izpit/vprašalnik(e-kviz)

OPOMBE: za pozitivni izpit mora biti vsak del pozitiven (>50%); | **20****40****40** | Type (examination, oral, coursework, project):* computer and laboratory work report with defence,
* written examination/simulation coursework assignment,
* oral examination/questionnaire(e-quiz).

NOTES: for a positive exam, each part must be positive (>50%); |
| **Reference nosilca / Lecturer's references:**  |
| HREN, Gorazd. Virualni inženiring, prosojnice s predavanj, dostopno na moodle, 2020HREN, Gorazd. Numerical analysis of a wind turbine blade with different software. *Tehnički vjesnik*, ISSN 1848-6339, 2019, vol. 26, iss. 4, str. 1017-1022, JCRŠTALCAR, Matej, HREN, Gorazd. Primerjava simulacij med različnimi CFD-sistemi = Comparison of simulations in different CFD systems. V: FINK GRUBAČEVIĆ, Iris (ur.). Razvoj industrijskega inženiringa (RII6) : priložnosti, potenciali, izzivi: Novo mesto, 2021 .PREDIN, Andrej, FIKE, Matej, PEZDEVŠEK, Marko, HREN, Gorazd. Lost Energy of Water Spilled over Hydropower Dams. Sustainability, iss. 16, art. 9119, str. 1-17, 2021, [JCR](https://plus.si.cobiss.net/opac7/jcr?c=sc=2071-1050+and+PY=2019&r1=true&lang=sl)PEZDEVŠEK, Marko, BILUŠ, Ignacijo, HREN, Gorazd. Comparison of cavitation models for the prediction of cavitation around a hydrofoil = Primerjava kavitacijskih modelov za numerično napoved kavitacije na hidrodinamičnem profilu. Journal of energy technology. [Tiskana izd.]. apr. 2021, vol. 14, iss. 1, str. 41-55PEZDEVŠEK, Marko, FIKE, Matej, PREDIN, Andrej, HREN, Gorazd. Influence of Numerical Mesh Type on Airfoil Aerodynamic Characteristics. V: SEME, Sebastijan (ur.), HADŽISELIMOVIĆ, Miralem (ur.), ŠTUMBERGER, Bojan (ur.). Conference proceedings. 7th Symposium on Applied Electromagnetics SAEM'2018, Podčetrtek, Slovenia, 17-20 June, 2018. 1st ed. Maribor: University of Maribor Press, 2019. Str. 251-255 |

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| **UČNI NAČRT PREDMETA / COURSE SYLLABUS** |
| **Predmet:** | **OPREMA IN DIAGNOSTIKA MOTORJEV Z NOTRANJIM ZGOREVANJEM** |
| **Course title:** | **EQUIPMENT AND DIAGNOSTICS FOR INTERNAL COMBUSTION ENGINES** |
|  |  |  |  |
| **Študijski program in stopnja****Study programme and level** | **Študijska smer****Study field** | **Letnik****Academic year** | **Semester****Semester** |
| ENERGETIKA, 2. STOPNJA |  | **2** | **1** |
| ENERGY TECHNOLOGY,2.degree |  | **2** | **1** |
|  |
| **Vrsta predmeta / Course type** | Obvezen/Obligatory |
|  |  |
| **Univerzitetna koda predmeta / University course code:** | M |
|  |
| **Predavanja****Lectures** | **Seminar****Seminar** | **Vaje****Tutorial** | **Klinične vaje****work** | **Druge oblike študija** | **Samost. delo****Individ. work** |  | **ECTS** |
| **30** |  | **30** |  |  | **90** |  | **5** |
| **AV** | **LV** | **RV** |
| **15** | **15** |  |
|  |
| **Nosilec predmeta / Lecturer:** | **DUŠAN STRUŠNIK** |
|  |
| **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:** |
| Priporočeno predhodno znanje iz matematike, mehanike, termodinamike, toplotnih strojev, motorjev v energetiki in Matlab simulacijskega modeliranja. |  | Completed courses in the following subjects: Mathematics, Mechanics, Thermodynamics, Heat engines Internal combustion engine at energy plant and Matlab simulation modelling |
| **Vsebina:**  |  | **Content (Syllabus outline):** |
| Vsebina predmeta obsega sledeča poglavja:1. Blok diagram podatkov Otto motorja.
2. Blok diagram podatkov Dieslovega motorja.
3. Vžigalni sistemi Otto motorjev.
4. Vplinjači Otto motojev.
5. Vbrizgavanje goriva Otto motorjev.
6. Klasični vbrizgalni sistem Dieselskih motorjev.
7. Vbrizgavanje goriva s skupnim vodom.
8. Injektorsko vbrizgavanje.
9. Tripotni katalizator Otto motorjev.
10. Filter saj Dieselskih motorjev.
11. Selektivna katalitična redukcija NOX pri Dieselskih motorjih.
12. Plinska proga.
13. Mešalni ventil za plinske motorje.
14. Vbrizgavanje tekočega plina pri Otto motorjih.
 |  | Content of the Subject:1. Block diagram of spark ignition engine.
2. Block diagram of Diesel engine.
3. Ignition system of Otto engine.
4. Carburators of spark Ignition engine.
5. Gasolyne injection.
6. Classical Diesel fuel injection system.
7. Common Rail fuel injection system.
8. Unit injector.
9. Three-way catalytic converter.
10. Diesel particulate trap
11. Selective catalytic reduction of NO for diesel engines.
12. Gas rail.
13. Mix valve for Otto engines.
14. LPG injection at spark ignition engines.
 |
| **Temeljni literatura in viri / Readings:** |
| Max Bohner, Rolf Gscheidle,….., Motorno vozilo, ISBN 86-365-0206-3C.F. Taylor, The Internal-Combustion Engine in Theory and Practice, 1985, M.I.T. Press |
| **Cilji in kompetence:** |  | **Objectives and competences:** |
| Podat osnove o opremi Otto motojev na tekoče in plinasto gorivo ter Dieselskih motorjev. Študent se seznani tudi z sodobno diagnostiko motorjev.  |  | Basic knowledge of internal combustion engine control, and fuel injection at Spark Ignition and Diesel Engines. Students are introduced with engine diagnosis. |
| **Predvideni študijski rezultati:** |  | **Intended learning outcomes:** |
| Znanje in razumevanje:Študent si pridobi osnovna znanja o regulaciji Otto in Diesel motorjev ter sistemih za dobavo goriva in katalitično obdelavo izpušnih plinov.Prenesljive/ključne spretnosti in drugi atributi:kombinirana uporaba različnih toplotnih strojev v energetiki |  | Knowledge and Understanding:Student acquires the fundamentals of the modern Spark Ignition and Diesel Engines control, fuel injection systems and catalitic treatment of exhaust gases.Transferable/Key Skills and other attributes:combined use of different heat engines at energy plant |
| **Metode poučevanja in učenja:** |  | **Learning and teaching methods:** |
| 1. Predavanja, 2. Avditorne vaje3. Laboratorijske vaje  |  | 1. Lectures, 2. Auditorium exercises3. Labaoratory exercises |
| **Načini ocenjevanja:** | Delež (v %) /Weight (in %) | **Assessment:** |
| Sprotne oblike preverjanja znanj (kolokviji, domače naloge, kvizi).Seminarske ter računske vaje (predstavitev seminarske naloge, poročilo laboratorijskih vaj, poročilo računskih vaj).Sprotne oblike preverjanja znanj se lahko nadomestijo z izpitom (pisni izpit, ustni izpit).1. Pisni izpit (računske naloge).2. Ustni izpit (teorija).3. Seminarska naloga.Za opravljen izpit mora študent vsak del izpita (praktični del izpita, teoretični del izpita in seminarsko ter računsko vajo) opraviti z najmanj 50%. | **50****30****20** | Real-time forms of knowledge testing (colloquia, homework, quizzes).Seminar and calculation exercises (presentation of seminar work, report of laboratory exercises, report of calculation exercises).Real-time forms of knowledge testing can be replaced by an exam (written exam, oral exam).1. Written exam . (calculation exercises)2. Oral exam (theory).3. Seminar work.To pass the exam, the student must pass each part of the exam (practical part of the exam, theoretical part of the exam and seminar with arithmetic exercises) with at least 50%. |
| **Reference nosilca / Lecturer's references:**  |
| STRUŠNIK Dušan, AGREŽ Marko, AVSEC Jurij. Energy and exergy modelling of a two black start diesel engines integration in the combined cycle gas turbine. *Proceedings of the ASME 2022 Power Conference*, POWER2022-85203, July 18-19, 2022, Pittsburgh, Pennsylvania.STRUŠNIK Dušan, MARČIČ Milan, AVSEC Jurij. Turbine sealing steam heat recovery with dynamic Stirling engines = Izraba toplote tesnilne pare turbine z dinamičnimi Stirling motorji. Journal of energy technology. [Tiskana izd.]. Aug. 2014, vol. 7, iss. 3, str. 17-34, ilustr. ISSN 1855-5748. http://www.fe.um.si/sl/jet-opis/jet-on-line.html. [COBISS.SI-ID 81122305].STRUŠNIK Dušan, AGREŽ Marko, AVSEC Jurij. Black-out diesel engine operation modelling for the CHPP start-up. *International Conference on Innovations in Energy Engineering & Cleaner Production IEECP22,* 21-22 July 2022, Oxford, United Kingdom.STRUŠNIK Dušan, MARČIČ Milan AVSEC, Jurij. Izraba odpadne toplote s Stirling motorjem v toplarni : predavanje na Dnevih Posavske energetike, 13. december 2013, Krško. Krško, 13. dec. 2013. [COBISS.SI-ID 1024173404].STRUŠNIK Dušan, AVSEC Jurij. Exergoeconomic machine-learning method of integrating a thermochemical Cu–Cl cycle in a multigeneration combined cycle gas turbine for hydrogen production*. International Journal of Hydrogen Energy*. [Online ed.]. 2022, vol. 47, iss. 39, str. 17121-17149, graf. prikazi. ISSN 1879-3487. DOI: 10.1016/j.ijhydene.2022.03.230. [COBISS.SI-ID 104668675]. |

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| **UČNI NAČRT PREDMETA / COURSE SYLLABUS** |
| **Predmet:** | **METODE IZKORIŠČANJA ENERGETSKIH VIROV** |
| **Course title:** | **METHODS OF ENERGY RESOURCES EXPLOITATION** |
|  |  |  |  |
| **Študijski program in stopnja****Study programme and level** | **Študijska smer****Study field** | **Letnik****Academic year** | **Semester****Semester** |
| ENERGETIKA, 2. STOPNJA |  | **2** | **1** |
| ENERGY TECHNOLOGY, 2.degree |  | **2** | **1** |
|  |
| **Vrsta predmeta / Course type** | Obvezni/Obligatory |
|  |  |
| **Univerzitetna koda predmeta / University course code:** | M |
|  |
| **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:** | **AVSEC JURIJ** |
|  |
| **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):** |
| * splošne značilnosti energetske dejavnosti
* vpliv človeka na intenzivnost energetske dejavnosti
* trajnostni vidiki energetske dejavnosti
* energetsko načrtovanje
* upravljanje z energetskimi viri
* energetska odvisnost
* cene energentov in vpliv geopolitičnih razmer na njihovo oblikovanje
* energetski trendi globalno, v EU in v Sloveniji
* viri in zaloge energentov globalno
* viri in zaloge energentov, pregled slovenske zakonodaje
* vloga strateških rezerv energetskih virov
* vpliv zakonodaje in vloga energetskih bilanc,
* obnovljivi viri energije nekoč in danes
* pomen uporabe najboljših razpoložljivih tehnologij v energetski dejavnosti - BAT
* globalni razvojni trendi v energetiki
* vloga neobnovljivih virov energije v sodobnem svetu, najnovejša spoznanja
* vloga fosilnih goriv v energetski preskrbi
* vloga jedrske tehnologije v energetiki, globalne odločitve, spoznanja in trendi
* prehod v brezoglično družbo
* vloga posameznih obnovljivih virov energije: sonce, voda, veter, geotermalna energija, biomasa, biogoriva, energija oceanov, itd.
* primeri tehnoloških postopkov pridobivanja obnovljivih energetskih virov
* vodik - energent 21. stoletja
* konvencionalni in nekonvencionalni tehnološki postopki pridobivanja energetskih virov
* novi postopki pridobivanja energetskih virov:
	+ hidravlična frakturizacija pri pridobivanju nafte in plina in njene okoljske omejitve
	+ sodobne metode pridobivanja premoga
	+ čiste premogovne tehnologije
	+ podzemno vplinjevanje premoga
* novi postopki transporta energetskih virov
	+ vloga utekočinjenega zemeljskega plina pri decentralizacija energetskih tokov in razbijanju energetskih monopolov
	+ terminali za utekočinjanje zemeljskega plina
* sodobni trendi v energetiki:
	+ povečanja energetske učinkovitosti
	+ mikro proizvodnja energije
	+ samooskrba in energetska samozadostnost
	+ hranilniki energije
	+ tehnološki preskoki, novi patenti
* vloga finančnih vzvodov v energetiki:
	+ podporne sheme za vzpodbujanje vlaganj v obnovljive energetske vire
	+ vloga CO2 kuponov pri omejevanju vplivov energetske dejavnosti na okolje
 |  | * general characteristics of energy activities
* human influences on intensity of energy activities
* sustainable aspects of energetics
* planning in energetics
* energy resources management
* energy dependency
* energy prices and influence of geopolitical decisions on price shaping
* trends in energetics globally, in EU and Slovenia
* resources and reserves of energy resources
* resources and reserves of energy resources, Slovenian legislation
* role of strategic energy reserves
* legislation influence and role of energy balances
* renewable energy resources, past and present
* role of best available and up-to date technology in energetics – BAT
* global development trends is energetics
* role of unrenewable energy resources in modern world, new recognitions
* role of fossil fuels in energy supply
* role of nuclear technology in energetics, global decisions, recognitions and trends
* transition to carbon free society
	+ role of renewable energy resources: sun, water, wind, geothermal, biomass, biofuels, ocean’s energy, etc.
* examples of renewable resources production technologies
* hydrogen - energy resource of 21. Century
* conventional and nonconventional technology procedures of energy resource production
* new procedures of energy resource production:
	+ hydraulic fracturing in oil and natural gas production, influence of environmental restrictions
	+ modern methods and technologies of coal excavation
	+ clean coal technologies
	+ underground coal gasification
* new transport methods of energy resources
	+ role of liquified natural gas for decentralization of energy streams and breaking of global energy monopoles
	+ terminals for natural gas liquefying
* modern trends in energetics
	+ growth of energy efficiency
	+ micro energy production
	+ energy self-supply and energy self-efficiency
	+ electricity storage systems
	+ technology leap and new patents
* role of financial levers in energetics:
	+ support schemes for renewable resources investments uprising
	+ role of CO2 certificates for limiting energetics influence on environment
 |
| **Temeljni literatura in viri / Readings:** |
| 1. BP - Statistical Review of World Energy - all Energy Sources, Yearly Reports 2014 - 2017
2. World Energy Scenarios: Composing energy futures to 2050, World Energy Council, 2017
3. Letna poročila Javne agencije Republike Slovenije za energijo od 2010 do 2016
4. Dolgoročne energetske bilance Slovenije do leta 2030 in strokovne podlage za določanje nacionalnih energetskih cilje
5. Gradivo za energetski koncept Slovenije, RS Ministrstvo za infrastrukturo
6. Medved, M.: Coal - an important energy source of the 21st century, 3rd Int. Conference Energy Technology and Climate Changes, Slovenia, 2013
7. D.A.J. Rand, R.M. Dell, Hydrogen energy, Royal Society of Chemistry,2008
 |
| **Cilji in kompetence:** |  | **Objectives and competences:** |
| * spoznavanje najnovejših dosežkov, spoznanj in usmeritev pri razvoju novih tehnologij za izkoriščanje obnovljivih virov energije
* strokovno interdisciplinarno izobraževanje, raziskovanje, izmenjava informacij ter raziskovalnih rezultatov
* spoznavanje trajnostnega razvoja energetike, varovanje omejenih in prostih energetskih virov
* gospodarjenje z okoljem v povezavi s pridobivanjem, transportom ter pretvorbo energetskih virov
* ekonomika gospodarjenja z energetskimi viri
 |  | * being familiar with the newest achievements and trends in new technologies development for renewable energy sources exploitation
* professional interdisciplinary education, research, exchange of information and of research results
* being familiar with sustainable development of energetics, protection of limited and free energy resources
* environmental management related to generating, transport and transformation of energy resources
* economy of energy resources management
 |
| **Predvideni študijski rezultati:** |  | **Intended learning outcomes:** |
| Znanje in razumevanje:* sodobnih tehnoloških trendov pri izkoriščanju energetskih virov
* kompleksnih problemov gospodarjenja z energetskimi viri
* posledic pomembnih odločitev managerja, planerja, projektanta v gospodarskih družbah na področju gospodarjenja z energetskimi viri
* dogajanj na področju energetskih ter ekoloških trendov, v povezavi z energetskimi viri
* pomena ravnanja z energetskimi viri za prihodnost človeštva
 |  | Knowledge and understanding:* modern technological trends of energy sources exploitation
* complex problems of energy resources management
* consequences of important decisions of the manager, planner, designer in trade companies related to the energy resources management
* activities in the field of energy and ecological trends related to energy resources
* importance of energy resources application for the future of mankind
 |
| Prenosljive/ključne spretnosti in drugi atributi:* analiza člankov s področja gospodarjenja z energetskimi viri
* teamsko delo
* prebiranje podatkov na svetovnih energetskih portalih
* prebiranje energetskih bilanc ter drugih energetskih strateških dokumentov
* analiziranje odločitev vladnih ter drugih organov v zvezi z gospodarjenjem z energetskimi viri
* razumevanje snovi bo podprto s praktičnimi primeri
* podatki bodo letno posodobljeni
 |  | Transferable/Key Skills and other attributes:* analysis of the articles related to the energy resources management
* team work
* examining data from different world energetics portals
* examining the energy balances and other energy strategic documents
* analysis the decisions of governmental and other institutions related to the energy

resources management* understanding the subject matter will be supported by practical examples
* data will be yearly updated
 |
| **Metode poučevanja in učenja:** |  | **Learning and teaching methods:** |
| * 1. Predavanja
* 2. Avditorne vaje
 |  | * 1. Lectures,
* 2. Auditorium exercises
 |
| **Načini ocenjevanja:** | Delež (v %) /Weight (in %) | **Assessment:** |
| Način (pisni izpit, ustno izpraševanje, naloge, projekt)* ustni izpit (teorija)
* pisni izpit (računske naloge)
* seminarska naloga
 | **50****40****10** | Type (examination, oral, coursework,project):* oral exam (theory)
* written exam (computational tasks )
* seminar work
 |
| Za opravljen izpit mora študent vsak del izpita (pisni izpit, ustni izpit) opraviti z vsaj 50%.Ustni izpit (lahko nadomeščen z dvema pozitivnima kolokvijema)Pisni izpit (lahko nadomeščen z dvema pozitivnima kolokvijema) |  | To pass the exam, the student must pass each part of the exam (written exam, oral exam) with at least 50%. Oral exam (can be replaced by two positive midterm test)Written exam (can be replaced by two positive midterm test) |
| **Reference nosilca / Lecturer's references:**  |
| 1.KONOVŠEK, Damjan, PRAUNSEIS, Zdravko, AVSEC, Jurij, BERČIČ, Gorazd, POHAR, Andrej, ZAVŠEK, Simon, MEDVED, Milan. Underground coal gasification - the Velenje coal mine energy and economic calculations. Chemical industry & chemical engineering quarterly, ISSN 1451-9372, 2017, vol. 23, iss. 2, str. 279-289, ilustr.2.NOVOSEL, Urška, ŽIVIĆ, Marija, AVSEC, Jurij. The production of electricity, heat and hydrogen with the thermal power plant in combination with alternative technologies. International Journal of Hydrogen Energy, ISSN 1879-3487. [Online ed.], 2020, 10 str.3.BRICL, Martin, AVSEC, Jurij. Evaluation of system for economically viable thermal power plant operation. Tehnički vjesnik : znanstveno-stručni časopis tehničkih fakulteta Sveučilišta u Osijeku, ISSN 1330-3651, 2019, vol. 26, no. 4, str. 1038-1043, graf. Prikazi.AVSEC, Jurij, WANG, Zhaolin, NATERER, Greg F. Thermodynamic and transport properties of fluids and solids in a Cu-Cl solar hydrogen cycle. Journal of thermal analysis and calorimetry, ISSN 1388-6150. [Print ed.], jan. 2017, vol. 127, issue 1, str. 961-967.4.STRUŠNIK, Dušan, AVSEC, Jurij. Exergoeconomic machine-learning method of integrating a thermochemical Cu%Cl cycle in a multigeneration combined cycle gas turbine for hydrogen production. International Journal of Hydrogen Energy, ISSN 1879-3487. [Online ed.], 2022, vol. 47, iss. 39, str. 17121-17149.5.HOLIK, Mario, ŽIVIĆ, Marija, VIRAG, Zdravko, BARAC, Antun, VUJANOVIĆ, Milan, AVSEC, Jurij. Thermo-economic optimization of a Rankine cycle used for waste-heat recovery in biogas cogeneration plants. Energy conversion and management, ISSN 0196-8904. [Print ed.], mar. 2021, art. 113897, vol. 232, str. 1-11. |

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| **UČNI NAČRT PREDMETA / COURSE SYLLABUS** |
| **Predmet:** | **MAGISTRSKO DELO** |
| **Course title:** | **MA THESIS** |
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| **Študijski program in stopnja****Study programme and level** | **Študijska smer****Study field** | **Letnik****Academic year** | **Semester****Semester** |
| ENERGETIKA, 2. STOPNJA |  | 2 | 2 |
| ENERGY TECHNOLOGY,2.degree |  | 2 | 2 |
|  |
| **Vrsta predmeta / Course type** | Obvezen/Obligatory |
|  |  |
| **Univerzitetna koda predmeta / University course code:** | M |
|  |
| **Predavanja****Lectures** | **Seminar****Seminar** | **Vaje****Tutorial** | **Klinične vaje****work** | **Druge oblike študija** | **Samost. delo****Individ. work** |  | **ECTS** |
|  | **10** |  |  |  | **890** |  | **30** |
| **AV** | **LV** | **RV** |  |
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| **Nosilec predmeta / Lecturer:** |  |
|  |
| **Jeziki /Languages:** | **Predavanja / Lectures:** | slovenski / Slovene |
| **Vaje / Tutorial:** | slovenski / Slovene |
| **Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:** |  | **Prerequisits:** |
|  |  |  |
| **Vsebina:**  |  | **Content (Syllabus outline):** |
| 1. Ovitek.2. Notranja naslovna stran 3. Izjava kandidata o avtorstvu migistrskega dela 4. Zahvala 5. Povzetek magistrskega dela v slovenskem in tujem (angleškem, nemškem) jeziku in ključne besede 6. Pregled vsebine - kazalo7. Pregled slik - kazalo.8. Pregled tabel - kazalo.9. Pregled prilog - kazalo.10.Uvod.11. Teoretične osnove.12. Praktični (problemski) del magistrskega dela.13. Prispevek magistrskega dela k stroki14. Zaključek.15. Literatura in viri (Literatura mora biti navedena po stilu APA).16. Priloge (po potrebi).17. Pojmovnik (po potrebi).18. Kratice in akronimi (po potrebi)19. Življenjepis avtorja, napisan v tretji osebi; vsebuje osnovne podatke avtorja, šolanje, zaposlitve in obsega 15 do 20 vrstic. |  | 1. Cover.2. Inside title page.3. Statement of the candidate about his authorship of the MA thesis.4. Acknowledgement.5. Summary of the MA thesis in Slovene and in a foreign (English or German) language and key words.6. Review of the subject – index.7. Review of the tables – index.9. Review of the supplements – index.10. Introduction.11. Theoretical basis.12. Practical part of the MA thesis concerning a problem.13. Contribution of the MA thesis to the professional field.14. Conclusion.15. Literature and sources. (The literature should be quoted according to the APA style.)16. Supplements (if needed).17. Glossary (if needed).18. Abbreviations and acronyms (if needed)19. Biography |
| **Temeljni literatura in viri / Readings:** |
| Navodilo za izdelavo diplomskega dela na Fakulteti za policijsko -varnostne vede Univerze v Mariboru (2005). Ljubljana, UM FPVV.Južnič, S. (1992). Diplomska naloga: napotki za izdelavo. Ljubljana: Amalietti.Makarovič, J. (1984). Misel in sporočilo: Kako uspešno študirati, raziskovati in predstaviti svoje ideje. Ljubljana: DDU Univerzum.Toporišič, J. (ur.). (1990). Slovenski pravopis, I Pravila. Ljubljana: Slovenska akademija znanosti in umetnosti, Državna založba Slovenije. |
| **Cilji in kompetence:** |  | **Objectives and competences:** |
| Magistrsko delo je pisni dokument, s katerim študent dokaže sposobnost uporabe teoretičnih znanj in v praksi pridobljenih izkušenj za rešitev problema, ki si ga je izbral s prijavo teme diplomskega dela. V magistrskem delu študent pokaže sposobnost izbire in uporabe domače ter tuje strokovne literature in dodatnih virov za potrebe rešitve izbranega problema. |  | The MA thesis is a written document by means of which the student proves his ability to use the theoretical knowledge and in his practical work achieved experiences in resolving a problem chosen by applying for a theme of his MA thesis. In his degree’s work the student presents the ability to choose and use his national and foreign professional literature and additional sources in order to solve the chosen problem. |
| **Predvideni študijski rezultati:** |  | **Intended learning outcomes:** |
| Znanje in razumevanje:Znanje širšega strokovnega področja, v katerega sodi magistrska naloga in ožje znanje ter razumevanje pojmovnika, ki ga zajema tema diplomskega dela. Poudarek je na praktičnih znanjih in enostavnejših metodologijah zajemanja, obdelovanja in prikazovanja podatkov. |  | Knowledge and understanding:Knowledge and Understanding:Knowledge of the broader professional field to which belongs the MA thesis and special knowledge of the glossary concerned by the thesis theme. The emphasis is on the practical skills and relatively more simple methodologies of collecting, processing and presenting data. |
| Prenesljive/ključne spretnosti in drugi atributi:Strokovno zapisovanje in izražanje vsebine, obvladanje reševanja strokovnih problemov, suverena predstavitev ključnih spoznanj in spretnost argumentiranja |  | Transferable/Key Skills and other attributes:Documenting and expressing the subject in a professional way, mastering the solving of the professional problems, independent presentation of the key conclusions and ability in arguing. |
| **Metode poučevanja in učenja:** |  | **Learning and teaching methods:** |
| Mentor na konsultacijah preverja vsebinski in strukturni vidik naloge.Mentor pripravi kandidata na elektronsko predstavitev diplomskega dela in na verjetna okvirna vprašanja pri zagovoru. |  | The content and the structural aspect of the thesis is monitored by tutor during his consultations.The candidate is readied by his tutor to present his thesis electronically and to be able to answer hypothetical questions in defending his thesis. |
| **Načini ocenjevanja:** | Delež (v %) /Weight (in %) | **Assessment:** |
| Način (pisni izpit, ustno izpraševanje, naloge, projekt)* magistrska naloga
* zagovor
 | **70****30** | Type (examination, oral, coursework, project):* MA thesis
* presentation / defense
 |
| **Reference nosilca / Lecturer's references:**  |
|  |