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| **UČNI NAČRT PREDMETA / COURSE SYLLABUS** |
| **Predmet:** | **MATEMATIČNE METODE**  |
| **Course title:** | **MATHEMATICAL METHODS**  |
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| **Študijski program in stopnja****Study programme and level** | **Študijska smer****Study field** | **Letnik****Academic year** | **Semester****Semester** |
| ENERGETIKA, 2. stopnja |  | 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** |
| **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:** |
| Znanje naslednjih matematičnih vsebin: Linearna algebra (vektorski prostori in matrična algebra), analiza funkcij ene in več spremenljivk (enojni, dvojni in trojni integrali in integrali v prostoru ter uporaba, navadni in parcialni odvodi ter uporaba, vektorska analiza (krivulje v prostoru), vektorska polja (rotor, divergenca in gradient). |  | The knowledge of the following mathematical contents: Linear algebra (vector spaces and matrix algebra, analysis of the functions of one and more variables (single, double and triple integrals and integrals in the space and their applications; ordinary in partial derivatives), vector analysis (curves in the space), vector fields (rotor, divergence and gradient). |
| **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:** |
| E. Kreyszig, Advanced Engineering Mathematics, J. Wiley and Sons.M. Mencinger, Uvod v parcialne diferencialne enačbe, Fakulteta za gradbeništvo UM, Maribor, 2011.G. Tomšič, T. Slivnik, Matematika IV. Fakulteta za elektrotehniko, Založba FE in FRI. |
| **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. |
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| **Metode poučevanja in učenja:** |  | **Learning and teaching methods:** |
| Predavanja (klasična) in vaje (računalniške animacije za ponazarjanje vloge parametrov v posameznih matematičnih modelih) ter domače naloge (obvezne za pristop k izpitu). |  | Lectures (classical) and practical work (computer animations to illustrate the role of parameters of mathematical models) and homework (required for writing the witten examination). |
| **Načini ocenjevanja:** | Delež (v %) /Weight (in %) | **Assessment:** |
| Način (pisni izpit, ustno izpraševanje, naloge, projekt)* Praktični del izpita
* Teoretični del izpita
* Domača naloga
 | **70****20****10** | Type (examination, oral, coursework, project):* Practical part of exam
* Theoretical part of exam
* Homework
 |
| **Reference nosilca / Lecturer's references:**  |
| MENCINGER, Matej, FERČEC, Brigita. The center and cyclicity problems for some analytic maps. *Applied mathematics and computation*, 2017, vol. 306, str. 73-85.MENCINGER, Matej, FERČEC, Brigita, OLIVEIRA, Regilene, PAGON, Dušan. Cyclicity of some analytic maps. *Applied mathematics and computation*, 2017, vol. 295, str. 114-125.SANG, Bo, FERČEC, Brigita, WANG, Qin-Long. Limit cycle bifurcated from a center in a three dimensional system. *Electronic journal of differential equations*, 2016, vol. 2016, no. 109, str. 1-11. FERČEC, Brigita, GINÉ, Jaume, ROMANOVSKI, Valery, EDNERAL, Victor F. Integrability of complex planar systems withhomogeneous nonlinearities. *Journal of mathematical analysis and applications*, 2016, vol. 434, issue 1, str. 894-914,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:** |
| Poglobljena znanja fizike, mehanike, termodinamike |  | Advanced knowledge of physics, mechanics, thermodynamics |
| **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:** |
| **[1]** **H. Požar:** *Osnove energetike 1*, Školska knjiga Zagreb, Sveučilište u Zagrebu, 1992.**[2]** **W. C. Turner, S. Doty:** *Energy Management Handbook*, Sixth Edition, CRC Press, 2006**[3]** **M. Tuma, M. Sekavčnik:** *Energetski sistemi, Preskrba z električno energijo in toploto*, Univerza v Ljubljani, FS, 2004.**[4]** **I. H. Shames:** *Mechanics of Fluids*, McGraw-Hill, International Editions, 1992 **[5]** **H. Sigloch:** *Strömungsmaschinen, Grundlagen und Anwendungen,* 4. aktualisierte Auflage, Hanser Verlag, 2009**[6]** **J. Giesecke, E. Mosonyi:** *Wasserkraftanlagen, Planung, Bau und Betrieb,* 4. aktualisierte und erweiterte Auflage, Springer Verlag, 2005**[7]** **D. Horvat:** *Vodene turbine,* Sveučilište u Zagrebu, Zagreb 1965**[8] A. Predin:** *Črpalke in ventilatorji*, Fakulteta za strojništvo, Univerza v Mariboru, 2000.**[9] C.E. Brennen**: *Hydrodynamics of Pumps*, Concepts ETI, Inc. and Oxford University Press, 1994.**[10] C.E. Brennen:** *Fundamentals of Multiphase flow*, Cambridge University press, 2005.**[11] J.P. Gostelow:** *Cascade Aerodynamics*, Pergaminn press, 1984.**[12] Knapp, Dally, Hammit**: *Cavitation,* McGraw-Hill, 1970.**[13] J.F. Douglas et al.:** *Fluid Mechanics, 3rd edition* LGL press 1995.**[14] Sir Horace Lamb:** *Hydrodynamics*, Cambridge University, 1997. |
| **Cilji in kompetence:** |  | **Objectives and competences:** |
| Osvojitev znanj na področju hidravličnih strojev, sistemov in naprav v energetiki. |  | Futher knowledge in the field of hydraulic machines, systems and devices in the field of energy technology. |
| **Predvideni študijski rezultati:** |  | **Intended learning outcomes:** |
| * Poznavanje hidroenergetskih sistemov
* Celote in delov HES
* Vodenje, upravljanje HES
* Ekonomsko vrednotenje HES.
 |  | - Knowledge of hydropower systems- Whole and parts of HES- Keeping, managing HES- Economic evaluation of HES. |
|  |  |  |
| **Metode poučevanja in učenja:** |  | **Learning and teaching methods:** |
| * Predavanja,
* Avditorne in laboratorijske vaje,
* Implementacija računskih primerov.
 |  | - Lectures,- Classroom and laboratory exercises,- Implementationof calculated examples. |
| **Načini ocenjevanja:** | Delež (v %) /Weight (in %) | **Assessment:** |
| * pisni izpit,
* pisni izpit iz teorije,
* kratek ustni zagovor.
 | **40****50** **10** | - written examination,- written exam from theory,- a brief oral defense. |
| **Reference nosilca / Lecturer's references:**  |
| PREDIN, Andrej, GREGORC, Boštjan, BILUŠ, Ignacijo. Cavitation swirl at the entrance of centrifugal pump. *Journal of energy technology*, ISSN 1855-5748. [Tiskana izd.], Aug. 2009, vol. 2, iss. 3, str. 85-97. [COBISS.SI-ID [1024008284](https://plus.si.cobiss.net/opac7/bib/1024008284?lang=sl)]MIHALIĆ, Tihomir, GUZOVIĆ, Zvonimir, PREDIN, Andrej. CFD flow analysis in the centrifugal vortex pump. *International journal of numerical methods for heat & fluid flow*, ISSN 0961-5539, 2014, vol. 24, no. 3, str. 545-562. <http://www.emeraldinsight.com/journals.htm?issn=0961-5539&volume=24&issue=3&articleid=17109922&show=abstract>, doi: [10.1108/HFF-05-2012-0124](https://doi.org/10.1108/HFF-05-2012-0124). [COBISS.SI-ID [1024162140](https://plus.si.cobiss.net/opac7/bib/1024162140?lang=sl)]BILUŠ, Ignacijo, ŠKERGET, Leopold, PREDIN, Andrej, HRIBERŠEK, Matjaž. Eksperimentalno numerična analiza kavitacijskega toka okoli lopatičnega profila = Experimental and numerical analysis of the cavitational flows around a hydrofoil. *Strojniški vestnik*, ISSN 0039-2480, 2005, letn. 51, št. 2, str. 103-118. [COBISS.SI-ID [8153627](https://plus.si.cobiss.net/opac7/bib/8153627?lang=sl)]PREDIN, Andrej, KLASINC, Roman. Emergency gate vibration of the pipe-turbine model. *Shock and vibration*, ISSN 1070-9622, 2000, vol. 7, no. 1, str. 3-13. <https://dk.um.si/IzpisGradiva.php?id=66228>. [COBISS.SI-ID [5422358](https://plus.si.cobiss.net/opac7/bib/5422358?lang=sl)]GREGORC, Boštjan, PREDIN, Andrej, FABIJAN, Drago, KLASINC, Roman. Experimental analysis of the impact of particles on the cavitating flow. *Strojniški vestnik*, ISSN 0039-2480, apr. 2012, vol. 58, no. 4, str. 238-244, SI 50, ilustr., doi: [10.5545/sv-jme.2011.062](https://doi.org/10.5545/sv-jme.2011.062). [COBISS.SI-ID [1024067932](https://plus.si.cobiss.net/opac7/bib/1024067932?lang=sl)]BILUŠ, Ignacijo, PREDIN, Andrej. Experimental analysis of thermodynamical surge at water pump inlet = Eksperimentalna analiza termodinamičnih fluktuacij toka na vstopu v vodno črpalko. *Journal of energy technology*, ISSN 1855-5748. [Tiskana izd.], Aug. 2010, vol. 3, iss. 3, str. 67-74. <http://www.fe.um.si/index.php/sl/jet-opis/jet-on-line.html>. [COBISS.SI-ID [1024036444](https://plus.si.cobiss.net/opac7/bib/1024036444?lang=sl)]BILUŠ, Ignacijo, PREDIN, Andrej, ŠKERGET, Leopold. The extended homogenous cavitation transport model. *Journal of hydraulic research*, ISSN 0022-1686, 2007, vol. 45, no 1, str. 81-87. [COBISS.SI-ID [11114774](https://plus.si.cobiss.net/opac7/bib/11114774?lang=sl)] |

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| **UČNI NAČRT PREDMETA / COURSE SYLLABUS** |
| **Predmet:** | **TERMOMEHANIKA IN VODENJE SISTEMOV KLIMATIZACIJE** |
| **Course title:** | **THERMOMECHANICS AND CONTROL OF AIR-CONDITIONING SYSTEMS** |
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| **Študijski program in stopnja****Study programme and level** | **Študijska smer****Study field** | **Letnik****Academic year** | **Semester****Semester** |
| ENERGETIKA, 2. STOPNJA |  | **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** |  |
| **10** | **20** |  |  |
|  |
| **Nosilec predmeta / Lecturer:** | **JURIJ AVSEC** |
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| **Jeziki /Languages:** | **Predavanja / Lectures:** | slovenski / Slovene |
| **Vaje / Tutorial:** | slovenski / Slovene |
| **Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:** |  | **Prerequisits:** |
| 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:** |
| M. P. Paidoussis, Fluid-structure interactions, Academic Press, 2014B.A. Boley, J.H. Weiner, Theory of thermal Stresses, 1988, Dover.D.J. Inman, Engineering Vibration, , pearson, 2014.A. Bejan, S. Lorente, Design with constructal theory, Wiley, 2008.S. Rao, Mechanical Vibrations, 2003, Pearson.W. P. Jones, Air Conditioning Engineering.J. Avsec, U. Novosel, Control of Air Conditioning, 2017, University of Maribor.M. Marčič, J. Avsec, Hladilna tehnika, Fakulteta za strojništvo, Univerza v Mariboru, 2003.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.B. Sorensen, Renewable Energy, Fourth edition, Academic press, 2012. |
| **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:** |
| Predavanja.Praktično delo pri seminarskih vajah. |  | Lectures.Practical work at tutorials. |
| **Načini ocenjevanja:** | Delež (v %) /Weight (in %) | **Assessment:** |
| Način (pisni izpit, ustno izpraševanje, naloge, projekt)* praktični del izpita v obliki pisnega reševanja nalog
* seminarska naloga
* teoretični del izpita
 | **40****10****50** | Type (examination, oral, coursework, project):* written examination in the form of practical application
* seminar work
* theoretical examination
 |
| **Reference nosilca / Lecturer's references:**  |
| NATERER, Greg F., SUPPIAH, S., STOLBERG, L., LEWIS, M., FERRANDON, M., WANG, Z., DINÇER, İbrahim, GABRIEL, K., ROSEN, Marc A., SECNIK, E., EASTON, E. B., TREVANI, L., PIORO, I., TREMAINE, P., LVOV, S. N., JIANG, J., RIZVI, G., IKEDA, B. M., LU, L., KAYE, M. H., SMITH, W. R., MOSTAGHIMI, J., SPEKKENS, P., FOWLER, Michael, AVSEC, Jurij. Clean hydrogen production with the Cu-Cl cycle - Progress of international consortium. Part 1, Experimental unit operations. *Int. j. hydrogen energy*. [Print ed.], Dec. 2011, vol. 36, iss. 24, str. 15472-15485,.NATERER, Greg F., SUPPIAH, S., STOLBERG, L., LEWIS, M., FERRANDON, M., WANG, Z., DINÇER, İbrahim, GABRIEL, K., ROSEN, Marc A., SECNIK, E., EASTON, E. B., TREVANI, L., PIORO, I., TREMAINE, P., LVOV, S. N., JIANG, J., RIZVI, G., IKEDA, B. M., LU, L., KAYE, M. H., SMITH, W. R., MOSTAGHIMI, J., SPEKKENS, P., FOWLER, Michael, AVSEC, Jurij. Clean hydrogen production with the Cu-Cl cycle - Progress of international consortium. Part 2, Simulations, thermochemical data and materials. *Int. j. hydrogen energy*. [Print ed.], Dec. 2011, vol. 36, iss. 24, str. 15486-15501, AVSEC, Jurij. The combined analysis of phonon and electron heat transfer mechanism on thermal conductivity for nanofluids. *Int. j. heat mass transfer*. [Print ed.], Sep. 2008, vol. 51, iss. 19/20, str. 4589-4598. |

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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 |
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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** |  |
| **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, 134 strani. 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. I. Bell, S. Glasstone, Nuclear Reactor Theory, Van Nostrand Reinhold Co., New York, 1970.M. G. Stabin, Radiation Protection and Dosimetry, An Introduction to Health Physics, Springer Science+Business Media LLC, 2007. |
| **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.Laboratorijske vaje na FE in ogled raziskovalnega in energetskega reaktorja ter različnih tipov pospeševalnikov. |  | Lectures.Lab work with basic radiation measurements and visits to the research and power reactors well as to certain accelerator sites. |
| **Načini ocenjevanja:** | Delež (v %) /Weight (in %) | **Assessment:** |
| Način (pisni izpit, ustno izpraševanje, naloge, projekt)* pisni in ustni izpit
* seminarska naloga
 | **75****25** | Type (examination, oral, coursework, project):* written and oral examination
* seminar project
 |
| **Reference nosilca / Lecturer's references:**  |
| KOŽELJ, Matjaž, CVIKL, Bruno. The negative mobility: An outcome of the electric field at the hole-injecting metal/organic semiconductor interface that varies as a linear function of the applied bias. *Thin Solid Films*, ISSN 0040-6090. [Print ed.], 2016, vol. 616, str. 786-792. [COBISS.SI-ID [29908775](https://plus.si.cobiss.net/opac7/bib/29908775?lang=sl)]KOŽELJ, Matjaž, CVIKL, Bruno. The inverted distorted parabola-like shape of the bias-dependent electric field at an electron-injecting metal/organic interface deduced using the current-voltage method = Obrnjena, deformirani paraboli podobna odvisnost električnega polja od pritisnjene napetosti na vmesni ploskvi kovina/organski polprevodnik izpeljana z uporabo metode tokovne karakteristike. *Journal of energy technology*, ISSN 1855-5748. [Tiskana izd.], Oct. 2015, iss. 2, vol. 8, str. 17-30, ilustr. [COBISS.SI-ID [29211175](https://plus.si.cobiss.net/opac7/bib/29211175?lang=sl)] CVIKL, Bruno. The electric field at hole injecting metal/organic interfaces as a cause for manifestation of exponential bias-dependent mobility. *Thin Solid Films*, ISSN 0040-6090. [Print ed.], 2014, vol. 573, str, 56-66. [COBISS.SI-ID [28142119](https://plus.si.cobiss.net/opac7/bib/28142119?lang=sl)]. CVIKL, Bruno. Line shapes in the current voltage characteristics of single layer metal/organic semiconductor structures as response to the electric field at the charge injecting interface. *Thin Solid Films*, ISSN 0040-6090. [Print ed.], 2013, vol. 542, str. 380-387. [COBISS.SI-ID [26994727](https://plus.si.cobiss.net/opac7/bib/26994727?lang=sl)]. CVIKL, Bruno. The elimination of interface charge density singularity in single layer organic semiconductor structures. *Journal of applied physics*, ISSN 0021-8979, 2011, vol. 110, issue 3, str. 033723-1-033723-9. [COBISS.SI-ID [24972839](https://plus.si.cobiss.net/opac7/bib/24972839?lang=sl)]. |

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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 |
|  |  |
| **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 |
|  |
| **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:** |
| Recommended reading: 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.Projekt.Laboratorijske vaje.Samostojno delo. |  | Lectures.Project.Labor work.Individual work. |
| **Načini ocenjevanja:** | Delež (v %) /Weight (in %) | **Assessment:** |
| Pisni izpit.Ustni izpit.Projekt. | **30****50****20** | Written examination.Oral examination.Project. |
| **Reference nosilca / Lecturer's references:**  |
| PIŠEK, Peter, ŠTUMBERGER, Bojan, MARČIČ, Tine, VIRTIČ, Peter. Design analysis and experimental validation of a double rotor synchronous PM machine used for HEV. *IEEE trans. magn.*, Jan. 2013, vol. 49, no. 1, str. 152-155, doi: [10.1109/TMAG.2012.2220338](http://dx.doi.org/10.1109/TMAG.2012.2220338). [COBISS.SI-ID [1024117084](http://cobiss.izum.si/scripts/cobiss?command=DISPLAY&base=COBIB&RID=1024117084)] ŠLAMBERGER, Jan, VIRTIČ, Peter. Design of electrical machines by using conformal mapping = Konstruiranje električnih strojev z uporabo konformnih preslikav. *Journal of energy technology*, feb. 2013, vol. 6, iss. 1, str. 13-18. <http://www.fe.um.si/en/jet.html>. [COBISS.SI-ID [1024132444](http://cobiss.izum.si/scripts/cobiss?command=DISPLAY&base=COBIB&RID=1024132444)] VIRTIČ, Peter. Determining losses and efficiency of axial flux permanent magnet synchronous motor. *Prz. Elektrotech.*, 2013, r. 89, nr. 2b, str. 13-16. <http://pe.org.pl/articles/2013/2b/4.pdf>. [COBISS.SI-ID [1024123484](http://cobiss.izum.si/scripts/cobiss?command=DISPLAY&base=COBIB&RID=1024123484)] PRAUNSEIS, Zdravko, VIRTIČ, Peter. Evaluation of mechanical properties of soft magnetic materials for axial flux permanent magnet synchronous machines. *Prz. Elektrotech.*, 2013, r. 89, nr. 2b, str. 35-37. <http://www.red.pe.org.pl/articles/2013/2b/10.pdf>. [COBISS.SI-ID [1024122460](http://cobiss.izum.si/scripts/cobiss?command=DISPLAY&base=COBIB&RID=1024122460)] ŠLAMBERGER, Jan, VIRTIČ, Peter. Determining energy production of CdTe photovoltaic system. *Prz. Elektrotech.*, 2013, r. 89, nr. 2b, str. 84-87. <http://pe.org.pl/articles/2013/2b/23.pdf>. [COBISS.SI-ID [1024123740](http://cobiss.izum.si/scripts/cobiss?command=DISPLAY&base=COBIB&RID=1024123740)] |

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| **UČNI NAČRT PREDMETA / COURSE SYLLABUS** |
| **Predmet:** | **NUMERIČNO MODELIRANJE V ENERGETIKI** |
| **Course title:** | **NUMERICAL MODELING IN ENERGY TECHNOLOGY** |
|  |  |  |  |
| **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** |  |
| **15** |  | **15** |  |
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| **Nosilec predmeta / Lecturer:** | **IVAN ŽAGAR** |
|  |
| **Jeziki /** **Languages:** | **Predavanja / Lectures:** | slovenski / Slovene |
| **Vaje / Tutorial:** | slovenski / Slovene |
| **Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:** |  | **Prerequisits:** |
| Ni pogojev. |  | None. |
| **Vsebina:**  |  | **Content (Syllabus outline):** |
| * 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:** |
| Richard O. Gilbert: Statistical Methods for Environmental Pollution Monitoring, Wiley, 1987, ISBN: 0471288780.Backer A.J. Finite Element Computational Fluid Mechanis, Hemispeher Publ. Corp., NY, 1983Batchelor, G., K: An Introduction to Fluid Dynamics. Cambridge University Press, 1967 |
| **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:** |
| Predavanja: študent spozna teoretične vsebine predmeta.Vaje: študent utrdi teoretično znanje in spozna aplikativne možnosti reševanja enostavnih primerov iz prakse.Domača naloga: študent izdela krajšo študijo oziroma projekt, ki se navezuje na tematiko predmeta. |  | Lectures: the student gets acquainted with theoretical content of the subject.Tutorial: the student upgrades the theoretical knowledge with practical experience.Homework: conducting a short study or project regarding the thematic of the subject. |
| **Načini ocenjevanja:** | Delež (v %) /Weight (in %) | **Assessment:** |
| Način (pisni izpit, ustno izpraševanje, naloge, projekt)• pisni izpit• ustni izpit• domača naloga | **40****40****20** | Type (examination, oral, coursework, project):• written examination• oral examination• homework |
| **Reference nosilca / Lecturer's references:**  |
| HREN, Gorazd, PREDIN, Andrej, ŽAGAR, Ivan. Generic model of wind turbine blades = Generični model lopatic vetrne turbine. Journal of energy technology, feb. 2013, vol. 6, iss. 1, str. 61-68. [http://www.fe.um.si/en/jet.html. COBISS.SI-ID 1024133468]HREN, Gorazd, ŽAGAR, Ivan. CAD mechanism simulations via web environments = Simulacije mehanizmov CAD sistemov na spletu. Journal of energy technology, Nov. 2012, vol. 5, iss. 4, str. 37-49. http://www.fe.uni-mb.si/images/stories/jet/e-jet/revija\_jet\_-\_volume\_5\_-\_issue\_4\_-\_november\_-\_za\_internet.pdf. [COBISS.SI-ID 1024118620] ŽAGAR, Ivan. The optimization options of water supply systems in terms of energy consumption = Možnosti optimizacije vodovodnih sistemov z vidika porabe energije. Journal of energy technology, ISSN 1855-5748. [Tiskana izd.], Nov. 2014, vol. 7, iss. 4, str. 59-76, graf. prikazi, zvd., ilustr. <http://www.fe.um.si/images/jet/JET_november_2014-koncni.pdf>. [COBISS.SI-ID [1024209756](https://plus.si.cobiss.net/opac7/bib/1024209756?lang=sl)]ŽAGAR, Ivan. Robno-območna integralska metoda za dinamiko tekočin laminarnega in turbulentnega toka : doktorska disertacija. Maribor: [I. Žagar], 1992. 133 str., ilustr. [COBISS.SI-ID [13232133](https://plus.si.cobiss.net/opac7/bib/13232133?lang=sl)] ŽAGAR, Ivan, ŠKERGET, Leopold. The numerical simulation of non-linear separation columns by boundary-domain integral method. Computers & chemical engineering, ISSN 0098-1354. [Print ed.], 1995, 19, supplement 2, str. S785-790. [COBISS.SI-ID [7500548](https://plus.si.cobiss.net/opac7/bib/7500548?lang=sl)] |

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| **UČNI NAČRT PREDMETA / COURSE SYLLABUS** |
| **Predmet:** | **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 |
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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** |  |
| **5** | **25** |  |  |
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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.E. Kuffel, W.S. Zaengl, J. Kuffel, High-Voltage Engineering: Fundamentals, Butterworth-Heinemann, 2001.M. 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.Laboratorijske vaje.Samostojno delo. |  | Lectures.Labexercises.Individual work. |
| **Načini ocenjevanja:** | Delež (v %) /Weight (in %) | **Assessment:** |
| Opravljene laboratorijske vaje.Pisni izpit. | **35****65** | Completed lab exercises.Written examination. |
| **Reference nosilca / Lecturer's references:**  |
| POLAJŽER, Boštjan, ŠTUMBERGER, Gorazd, SEME, Sebastijan, DOLINAR, Drago. Generalization of methods for voltage sag source detection using vector space approach. IEEE transactions on industry applications, ISSN 0093-9994, Nov./Dec. 2009, vol. 45, no. 6, str. 2152-2161, doi: 10.1109/08IAS.2008.370. [COBISS.SI-ID 13688086], [JCR, SNIP, WoS do 23. 10. 2017: št. citatov (TC): 21, čistih citatov (CI): 19, Scopus do 21. 3. 2017: št. citatov (TC): 3, čistih citatov (CI): 3]POLAJŽER, Boštjan, ŠTUMBERGER, Gorazd, SEME, Sebastijan, DOLINAR, Drago. Detection of voltage sag sources based on instantaneous voltage and current vectors and orthogonal Clarke's transformation. IET generation, transmission & distribution, ISSN 1751-8687. [Print ed.], Mar. 2008, vol. 2, iss. 2, str. 219-226. http://dx.doi.org/10.1049/iet-gtd:20070114. [COBISS.SI-ID 12231702], [JCR, SNIP, WoS do 23. 10. 2017: št. citatov (TC): 14, čistih citatov (CI): 12, Scopus do 23. 10. 2017: št. citatov (TC): 31, čistih citatov (CI): 29]POLAJŽER, Boštjan, ŠTUMBERGER, Gorazd, SEME, Sebastijan, DOLINAR, Drago. Generalization of methods for voltage sag source detection using vector space approach. V: 2008 IEEE Industry Applications Society Annual Meeting, 5-9 October 2008, Edmonton, Alberta, Canada. Piscatawy: IEEE. cop. 2008, str. [1-8]. [COBISS.SI-ID 12704534]GROŠELJ, Marko. Strelovodna zaščita silosov odpadnih produktov Termoelektrarne Šoštanj bloka 6 : magistrsko delo. Krško: [M. Grošelj], 2014. XVII, 97 f., ilustr. http://dkum.uni-mb.si/IzpisGradiva.php?id=45918. [COBISS.SI-ID 1024188252] |

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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** |  |  |
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| **Nosilec predmeta / Lecturer:** | **ZDRAVKO PRAUNSEIS** |
|  |
| **Jeziki /Languages:** | **Predavanja / Lectures:** | slovenski / Slovene |
| **Vaje / Tutorial:** | slovenski / Slovene |
| **Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:** |  | **Prerequisits:** |
| Ni pogojev. |  | None. |
| **Vsebina:**  |  | **Content (Syllabus outline):** |
| Uvodni del z definicijo za 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:** |
| Karl Gertis, Bauphysik, berichte aus forschung und praxis, Fraunhofer IRB Verlag, 1998.Barney L. Capehart, Wayne C. Turner, William J. Kennedy: Guide to Energy Management, 4th edition, The Fairmont Press, 2003.L. D. Danny Harvey: A handbook on low – energy buildings and district – energy systems: Fundamentals, techniques and examples, Earthscan Publications Ltd, 2006.Alan Wilson: ASSET MAINTENANCE MANAGEMENT: A Guide to Developing Strategy and Improving Performance; Industrial Press, 2002.John Moubray: Reliability-Centred Maintenance; Elsevir., 2008.Terry Wireman: Developing Performance Indicators for Managing Maintenance; Industrial Press, 1998.Darly Mather: The Maintenance Scorecard – Creating Strategic Advantages; Industrial Press, 2005.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.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., 2006.Ruchard Murch; Project Management; Best Practice for IT Professionals, Printice Hall PTR, Upper Saddle River, New York, U.S. A., 2006.Praunseis Z.; *Energetska oskrba objektov*. Univerzitetni učbenik,[1. izd.]. Krško: Fakulteta za energetiko, 2014. XVII, 286 str., ilustr., tabele. ISBN 978-961-6800-11-2. [COBISS.SI-ID [76157441](https://plus.si.cobiss.net/opac7/bib/76157441?lang=en)] Praunseis, Z.; Inženiring v energetiki : zapiski predavanj. Krško: Fakulteta za energetiko, 2016. 148 str., graf. prikazi. [COBISS.SI-ID [1024222812](https://plus.si.cobiss.net/opac7/bib/1024222812?lang=sl)] Praunseis, Z.; Projektni management: zapiski predavanj. Krško: Fakulteta za energetiko, 2015. 78 str., graf. |
| **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
* praktični del izpita v obliki pisnega reševanja izvedbe konstrukcijskega elementa v napravah procesne opreme
* teoretični del pisnega izpita v obliki dopolnjevanja dokumentacije in preračunov.
 | **10****45****45** | Type (examination, oral, coursework, project):* completed coursework
* written examination in the form of practical solution for structural parts of process equipment
* theoretical examination in the form of completing technical documentation and calculations.
 |
| **Reference nosilca / Lecturer's references:**  |
| 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)] PRAUNSEIS, Zdravko, STROJKO, Renato*. Energetska oskrba objektov*. [1. izd.]. Krško: Fakulteta za energetiko, 2014. XVII, 286 str., ilustr., tabele. ISBN 978-961-6800-11-2. [COBISS.SI-ID [76157441](https://plus.si.cobiss.net/opac7/bib/76157441?lang=en)]PRAUNSEIS, Zdravko*. Snovanje in konstruiranje jeklenega mostu : študijska naloga*. Krško: Fakulteta za energetiko, 2014. 26 str., graf. prikazi. [COBISS.SI-ID [1024223836](https://plus.si.cobiss.net/opac7/bib/1024223836?lang=en)]KROPE, Jurij, TROP, Peter, GORIČANEC, Darko. Flow-pressure analysis of loop gas networks. *Int. j. syst. appl. eng. dev.*. [Online ed.], 2011, vol. 5, iss. 4, str. 477-484. <http://www.universitypress.org.uk/journals/saed/20-501.pdf>. [COBISS.SI-ID [15154198](http://cobiss.izum.si/scripts/cobiss?command=DISPLAY&base=COBIB&RID=15154198)]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. 2017PRAUNSEIS, Zdravko*. Projektni management: zapiski predavanj*. Krško: Fakulteta za energetiko, 2015. 78 str., graf. prikazi. [COBISS.SI-ID [1024222556](https://plus.si.cobiss.net/opac7/bib/1024222556?lang=en)]  |

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| **UČNI NAČRT PREDMETA / COURSE SYLLABUS** |
| **Predmet:** | **VIRTUALNI INŽENIRING** |
| **Course title:** | **VIRTUAL 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 |  | **2** | **1** |
| ENERGY TECHNOLOGY,2.degree |  | **2** | **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** |  |
|  | **10** | **20** |  |
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| **Nosilec predmeta / Lecturer:** | **GORAZD HREN** |
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| **Jeziki /** **Languages:** | **Predavanja / Lectures:** | slovenski / Slovene |
| **Vaje / Tutorial:** | slovenski / Slovene |
| **Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:** |  | **Prerequisits:** |
| Ni pogojev. |  | None. |
| **Vsebina:**  |  | **Content (Syllabus outline):** |
| 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:** |
| * Zienkiewicz, O.C., Taylor, R.L., Zhu, J.Z.: The finite element method: Its Basis and Fundamentals, 6.ed., Elsevier 2005
* Peiro J., Sherwin S.: Finite Difference, Finite Element and Finite Volume Methods For Partial Differential Equations, in Handbook of Materials Modeling. Volume I: Methods and Models, Springer, 2005.
* Chang, Kuang-Hua: Product design modeling using CAD/CAE, Elsevier Academic Press, 2014
* S.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:** |
| frontalna predavanja, e-učenje,delo v laboratoriju. |  | frontal lectures,e-learning,laboratory work. |
| **Načini ocenjevanja:** | Delež (v %) /Weight (in %) | **Assessment:** |
| Način (pisni izpit, ustno izpraševanje, naloge, projekt):Poročilo računalniških in laboratorijskih vaj, poročilo projekta,pisni/ustni teoretični izpit – e-kviz. | **20****40****40** | Type (examination, oral, coursework, project):computer and laboratory work report,coursework assignment report,written/oral theoretical examination or e-quiz. |
| **Reference nosilca / Lecturer's references:**  |
| HREN, Gorazd, JEZERNIK, Anton. Računalniške tehnologije za podporo konstruiranju : CAx in PxM : zbrano gradivo. Maribor: Fakulteta za strojništvo, 2005. 120 str., ilustr. ISBN 86-435-0704- 0. http://lates.fs.uni-mb.si/gradivo. [COBISS.SI-ID 54832385]HREN, Gorazd. Web-based environment for mechanism simulation integrated with CAD system. Engineering with computers, ISSN 0177-0667, 2010, vol. 26, no. 2, str. 137-148, doi: 10.1007/s00366-009- 0146-1. [COBISS.SI-ID1024017244], JCRHREN, Gorazd, JEZERNIK, Anton. A framework for collaborative product review. Int. j. adv. manuf. technol., June 2009, vol. 42, no 7/8, str. 822-830, JCRŠTUMBERGER, Bojan, HADŽISELIMOVIĆ, Miralem, HREN, Gorazd. Design of fractional-slot permanent magnet synchronous motor with concentrated windings and interior permanent magnets. Prz. Elektrotech., 2013, r. 89, nr. 2b, str. 5-8. [JCR](http://www.cobiss.si/scripts/cobiss?command=SEARCH&base=jcr&select=%28sc=0033-2097+and+PY=2011%29)PREDIN, Andrej, HREN, Gorazd. Simulacija karakterističnih situacij pri polnjenju jeklenke s kisikom : poročilo o rezultatih numeričnega modeliranja. Krško: Fakulteta za energetiko, Inštitut za energetiko, Laboratorij za aero- in hidro-energetske tehnologije, 2011. 35 str.HREN, Gorazd, PREDIN, Andrej, ŽAGAR, Ivan. Generic model of wind turbine blades = Generični model lopatic vetrne turbine. Journal of energy technology, ISSN 1855-5748. [Tiskana izd.], feb. 2013, vol. 6, iss. 1, str. 61-68, ilustr. http://www.fe.um.si/en/jet.html. [COBISS.SI-ID 1024133468]JEZERNIK, Anton, HREN, Gorazd. A solution to integrate computer-aided design (CAD) and virtual reality (VR) databases in design and manufacturing processes. The international journal of advanced manufacturing technology, ISSN 0268-3768, Dec. 2003, vol. 22, no 11/12, str. 768-774. [COBISS.SI-ID 8517398], JCR |

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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** |
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| **Študijski program in stopnja****Study programme and level** | **Študijska smer****Study field** | **Letnik****Academic year** | **Semester****Semester** |
| ENERGETIKA, 2. STOPNJA |  | **2** | **1** |
| ENERGY TECHNOLOGY,2.degree |  | **2** | **1** |
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| **Vrsta predmeta / Course type** | 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** |  |
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| **Nosilec predmeta / Lecturer:** | **MILAN MARČIČ** |
|  |
| **Jeziki /** **Languages:** | **Predavanja / Lectures:** | Slovenski in angleški jezik ; Slovene and English |
| **Vaje / Tutorial:** | Slovenski in angleški jezik ; Slovene and English |
| **Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:** |  | **Prerequisits:** |
| Zahtevano predhodno znanje iz matematike, mehanike, termodinamike in toplotnih strojev in motorjev v energetiki |  | Completed courses in the following subjects: Mathematics, Mechanics, Thermodynamics and Heat engines and internal combustion engine at energy plant |
| **Vsebina:**  |  | **Content (Syllabus outline):** |
| Vsebina predmeta obsega sledeča poglavja:1. 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. Avditorna predavanja, 2. Praktično delo pri avditornih vajah |  | 1. Lectures, 2. Practical work at tutorials |
| **Načini ocenjevanja:** | Delež (v %) /Weight (in %) | **Assessment:** |
| Način (pisni izpit, ustno izpraševanje, naloge, projekt)1. Praktični del izpita v obliki pisnega reševanja nalog.2. Teoretični del izpita. | **40****60** | Type (examination, oral, coursework, project):1. Written examination in the form of practical application. 2. Theoretical examination |
| **Reference nosilca / Lecturer's references:**  |
| GERŠAK, Jelka, MARČIČ, Milan. The effect of clothing on thermoregulatory responses of human body in a hot environment. *Journal of fiber bioengineering and informatics*, ISSN 1940-8676, March 2017, vol. 10, iss. 1, str. 1-12. STRUŠNIK, Dušan, MARČIČ, Milan, GOLOB, Marjan, HRIBERNIK, Aleš, ŽIVIĆ, Marija, AVSEC, Jurij. Energy efficiency analysis of steam ejector and electric vacuum pump for a turbine condenser air extraction system based on supervised machine learning modelling. *Applied energy*, ISSN 0306-2619, jul. 2016, vol. 173, str. 386-405, graf. prikazi, doi: [10.1016/j.apenergy.2016.04.047](https://doi.org/10.1016/j.apenergy.2016.04.047). [ MARČIČ, Simon, MARČIČ, Milan, PRAUNSEIS, Zdravko. Computer simulation of the common rail accumulator fuel-injection system. *Journal of mechanical and automobile engineering*, ISSN 2472-6281, Jan. 2016, vol. 1, iss. 1, str. 1-15. MARČIČ, Simon, MARČIČ, Milan, PRAUNSEIS, Zdravko. Electricity and heat production by biomass. *Natural resources*, ISSN 2158-706X, November 2016, vol. 7, no. 11, str. 666-675. MARČIČ, Simon, MARČIČ, Milan, PRAUNSEIS, Zdravko. Mathematical model for the injector of a common rail fuel-injection system. *Engineering*, ISSN 1947-3931. [Print ed.], June 2015, vol. 7, no. 6, str. 307-321.  |

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| **UČNI NAČRT PREDMETA / COURSE SYLLABUS** |
| **Predmet:** | **METODE IZKORIŠČANJA ENERGETSKIH VIROV** |
| **Course title:** | **METHODS OF ENERGY RESOURCES EXPLOITATION** |
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| **Študijski program in stopnja****Study programme and level** | **Študijska smer****Study field** | **Letnik****Academic year** | **Semester****Semester** |
| ENERGETIKA, 2. STOPNJA |  | **2** | **1** |
| ENERGY TECHNOLOGY, 2.degree |  | **2** | **1** |
|  |
| **Vrsta predmeta / Course type** | 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:** | **MILAN MEDVED** |
|  |
| **Jeziki / Languages:** | **Predavanja / Lectures:** | slovenski / Slovene |
| **Vaje / Tutorial:** | slovenski / Slovene |
| **Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:** |  | **Prerequisits:** |
| Ni pogojev. |  | None. |
| **Vsebina:**  |  | **Content (Syllabus outline):** |
| * 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. BP - Energy Outlook 2035
3. World Energy Outlook, International Energy Agency, Yearly Reports 2010 - 2017
4. Key World Energy Statistics, 2014 - 2017
5. World Energy Scenarios: Composing energy futures to 2050, World Energy Council, 2017
6. Letna poročila Javne agencije Republike Slovenije za energijo od 2010 do 2016
7. Dolgoročne energetske bilance Slovenije do leta 2030 in strokovne podlage za določanje nacionalnih energetskih cilje
8. Gradivo za energetski koncept Slovenije, RS Ministrstvo za infrastrukturo
9. Medved, M.: Coal - an important energy source of the 21st century, 3rd Int. Conference Energy Technology and Climate Changes, Slovenia, 2013
10. Medved, M., Konovšek, D.: Energetski viri, Fakulteta za energetiko, gradivo za predavanja 2014 – 2017
11. Publikacije SOPO, SODO in slovenskih proizvajalcev ter dobaviteljev energije
12. Referati in ostala gradiva s svetovnih energetskih portalov
 |
| **Cilji in kompetence:** |  | **Objectives and competences:** |
| * 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:** |
| * predavanja s pomočjo uporabe različnih AV sredstev,
* uvodno podajanje snovi, razprava o dojemanju vsebine, predstavitev študentskih pogledov na izpostavljene probleme ali značilnosti; predstavitev praktičnih primerov s področja energetskih surovin, samostojno delo študentov pri izdelavi seminarske naloge
* avditorne vaje so namenjene pripravam na pisni izpit; asistent uvodoma povzame bistvo snovi, nato vaje potekajo v obliki reševanja primerov izpitnih nalog, ki jih študenti ob pomoči asistenta rešujejo v zapiske ali na šolsko tablo.
* strokovne ekskurzije
 |  | * lectures supported by different AV equipment
* introductory lecture, discussion on perception of the issues, presentation of student's opinion on exposed or characteristics, presentation of practical examples related to the energy management, individual work of students on seminar tasks
* tutorials are dedicated to preparation of students for written examination; initially assistant explain substance; by assistant help students together solve examples of examination tasks in notes or on board
* professional excursions
 |
| **Načini ocenjevanja:** | Delež (v %) /Weight (in %) | **Assessment:** |
| Način (pisni izpit, ustno izpraševanje, naloge, projekt)* ustni izpit
* pisni izpit
 | **50****50** | Type (examination, oral, coursework,project):* oral examination
* written examination
 |
| **Reference nosilca / Lecturer's references:**  |
| KONOVŠEK, Damjan, PRAUNSEIS, Zdravko, AVSEC, Jurij, BERČIČ, Gorazd, POHAR, Andrej, ZAVŠEK, Simon, MEDVED, Milan. Underground coal gasification - the Velenje coal mine energy and economic calculations. Chemical industry & chemical engineering quarterly, ISSN 1451-9372, 2017, str. 1-28, [COBISS.SI-ID 5975834], [JCR, SNIP]MEDVED, Milan, KONOVŠEK, Damjan. Underground coal gasification - possibilities in Slovenia. Journal of energy technology, ISSN 1855-5748. [Tiskana izd.], aug. 2016, vol. 9, iss. 2, str. 27-38, ilustr. [COBISS.SI-ID 1024237660]MEDVED, Milan. Coal - an important energy source of the 21st century, 3rd International Conference Energy Technology and Climate Changes, [Slovenija, Velenje, 20.-21. 6. 2013]. str. 47-48. [COBISS.SI-ID 9002663]MEDVED, Milan, RISTOVIĆ, Ivica, ROŠER, Janez, VULIĆ, Milivoj. An overview of two years of continuous energy optimization at the Velenje coal mine. *Energies (Basel)*, 2012, vol. 5, no. 6, str. 2017-2029.[COBISS.SI-ID [1217631](http://cobiss.izum.si/scripts/cobiss?command=DISPLAY&base=COBIB&RID=1217631)] LIKAR, Jakob, MEDVED, Milan, LENART, Marjan, MAYER, Janez, MALENKOVIĆ, Vladimir, JEROMEL, Gregor, DERVARIČ, Evgen. Analysis of geomechanical changes in hanging wall caused by longwall multi top caving in coal mining. *J. min. sci.*, 2012, vol. 48, no. 1, str. 135-145. [COBISS.SI-ID [1215327](http://cobiss.izum.si/scripts/cobiss?command=DISPLAY&base=COBIB&RID=1215327)]  |

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| **UČNI NAČRT PREDMETA / COURSE SYLLABUS** |
| **Predmet:** | **MAGISTRSKO DELO** |
| **Course title:** | **MA THESIS** |
|  |  |  |  |
| **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** |  |
|  |  |  |  |
|  |
| **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:**  |
|  |