UČNI NAČRT PREDMETA / COURSE SYLLABUS	
Predmet:	Jedrska fuzija kot okolju prijazen alternativni vir energije
	Nuclear Fusion as an Environmentally Friendly Source of Energy

Študijski program in stopnja Study programme and level	Študijska smer Study field	Letnik Academic year	Semester Semester
Ekotehnologije, 3. stopnja	/	1	1
Ecotechnologies, 3rd cycle	/	1	1

Vrsta predmeta / Course type	Izbirni / Elective
Univerzitetna koda predmeta / University course code:	EKO3-351

Predavanja Lectures	Seminar Seminar	Vaje Tutorial	Klinične vaje work	Druge oblike študija	Samost. delo Individ. work	ECTS
15	15			15	105	5

**Navedena porazdelitev ur velja, če je vpisanih vsaj 15 študentov. Drugače se obseg izvedbe kontaktnih ur sorazmerno zmanjša in prenese v samostojno delo. / This distribution of hours is valid if at least 15 students are enrolled. Otherwise the contact hours are linearly reduced and transfered to individual work.*

Nosilec predmeta / Lecturer:	Prof. dr. Miran Mozetič

Jeziki / Languages:	**Predavanja / Lectures:**	slovenščina, angleščina / Slovenian, English
	Vaje / Tutorial:	slovenščina, angleščina / Slovenian, English

Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:	**Prerequisits:**
Znanje, ki je ekvivalentno izobrazbi druge stopnje ali univerzitetni izobrazbi s področja naravoslovja ali tehnologije.	Knowledge, which is equivalent to a second level or university degree from natural sciences or technology.

Vsebina:	**Content (Syllabus outline):**
• Zgodovinski pregled. • Zlivanje jeder in razpoložljiva energija. • Sonce in vroča termonuklearna plazma. • Tokamaki in stelaratorji. • Tehnološki problemi pri fuzijskih reaktorjih. • Interakcija vroče plazme s trdnimi materiali. • Ekološki vidiki fuzije in varnost reaktorjev. • ITER (International Thermonuclear Experimental Reactor). • DEMO (Demonstration Fusion Reactor).	• Historical overview. • Nuclear fusion and available energy. • Sun and hot thermonuclear plasma. • Tokamaks and stellarators. • Technological problems in fusion reactors. • Interaction of hot plasma with solid materials. • Ecological aspects and safety measures. • ITER (International Thermonuclear Experimental Reactor). • DEMO (Demonstration Fusion Reactor).

Temeljni literatura in viri / Readings:

Knjigi / Books:

- Kikuchi, Mitsuru, Azumi, Masafumi, Frontiers in Fusion Research II, Springer International Publishing Switzerland, 2015, ISBN 978-3-319-18905-5

- Ciullo, Giuseppe, Engels, Ralph, Büscher, Markus, Vasilyev, Aleksander, Nuclear Fusion with Polarized Fuel, Springer Proceedings in Physics, 2016, ISBN 978-3-319-39471-8

Revije / Journals:

- Nuclear Fusion
- Journal of Nuclear Materials

Plasma Physics and Controlled Fusion

Cilji in kompetence:	Objectives and competences:
Vpeljati študente v znanstveno področje jedrske fizike: • pregled nad preteklimi, sedanjimi in predvidenimi prihodnjimi aktivnostmi na področju razvoja fuzijskih reaktorjev za proizvodnjo električne energije, • presoja ekoloških vidikov pridobivanja energije iz zlivanja jeder lahkih elementov in ugotovitev, da fuzijski reaktorji niso primerljivi s konvencionalnimi jedrskimi reaktorji za pridobivanje energije s cepitvijo jeder težkih elementov, • seznanitev z možnostmi vključevanja v velike mednarodne projekte s področja fuzije kot so EUROfusion (European Consortium for the Development of Fusion Energy), ITER (International Thermonuclear Experimental Reactor) in DEMO (Demonstration Fusion Reactor). Kompetence: • presoditi vlogo jedrske fuzije kot bodočega vira energije, • razlikovati med jedrskimi elektrarnami in fuzijskimi reaktorji, • ugotoviti možnosti segrevanja plina do temperatur višjih od temperature sredice sonca, • razlikovati med tokamaki, stelaratorji in Z-pinchi, • presoditi ekološke vidike jedrske fuzije, • ugotoviti ključne tehnološke probleme jedrske fuzije.	To introduce students to the basics of nuclear fusion: • overview on past, current and planned activities in development of fusion reactors for electrical energy production, • evaluation of the ecological aspects of energy production from fusion of light element nuclei and find that fusion reactors are not comparable with conventional nuclear reactors for energy production from fission of heavy element nuclei, • information on possibilities for joining large international projects on fusion such as EUROfusion (European Consortium for the Development of Fusion Energy), ITER (International Thermonuclear Experimental Reactor) and DEMO (Demonstration Fusion Reactor). Competencies: • judging nuclear fusion as the future source of energy, • distinguishing between fission and fusion reactors, • discovering abilities to heat gas above the temperature in the centre of the sun • distinguishing between tokamaks, stellarators and Z-pinches, • evaluation of ecological aspects of nuclear fusion, • evaluation of currently crucial technological problems.

Predvideni študijski rezultati:	Intended learning outcomes:
• presoditi jedrsko fuzijo kot alternativni domala neizčrpni vir energije za bodočnost, • presoditi prednosti jedrske fuzije v primerjavi s klasičnimi jedrskimi reaktorji za pridobivanje energije,	• understanding nuclear fusion as an alternative almost inexhaustible energy source for future, • judging advantages of nuclear fusion as compared to classical nuclear reactors for energy extraction,

• oceniti ekološko neoporečnost tehnologije, majhno količino goriva, zanemarljivo količino radioaktivnih odpadkov, visoko stopnjo varnosti, • kritično oceniti pomanjkljivosti jedrske fuzije: finančno in strokovno izredno zahtevna tehnologija in nerešeni tehnološki problemi, • ugotoviti možnosti sodelovanja v tekočih in bodočih raziskovalno – tehnoloških projektih.	• estimating ecological aspects of fusion technology, small fuel quantity, negligible radioactive waste, high security level, • evaluating drawbacks of fusion technology: commercially and expertly demanding technology and unsolved technical problems, • finding possibilities for collaboration in current and future research and technological projects.

Metode poučevanja in učenja:	**Learning and teaching methods:**
• kratka predavanja • interaktivno laboratorijsko delo • seminarska naloga	• short courses • interactive laboratory work • seminar

Načini ocenjevanja:	Delež (v %) / Weight (in %)	**Assessment:**
Ocena laboratorijskega dela oziroma eksperimentalnih spretnosti	20 %	Experimental skills and ability for working in a laboratory
Seminarska naloga	40 %	Seminar
Ustni zagovor seminarske naloge	40 %	Oral justification of the seminar

Reference nosilca / Lecturer's references:

- BREZINŠEK, Sebastijan, ČADEŽ, Iztok, ČEKADA, Miha, DRENIK, Aleksander, GOSAR, Žiga, KELEMEN, Mitja, MARKELJ, Sabina, MOZETIČ, Miran, NEMANIČ, Vincenc, PANJAN, Matjaž, PELICON, Primož, PRIMC, Gregor, VAVPETIČ, Primož, ZALOŽNIK, Anže, ZAPLOTNIK, Rok, et al. Plasma-wall interaction studies within the EUROfusion Consortium: progress on plasma-facing components development and qualification. Nuclear fusion, ISSN 0029-5515, Aug. 2017, vol. 57, no. 11, str. 116041-1-116041-9, doi: 10.1088/1741-4326/aa796e.
- DRENIK, Aleksander, MOURKAS, Angelos, ZAPLOTNIK, Rok, PRIMC, Gregor, MOZETIČ, Miran, PANJAN, Peter, ALEGRE, Daniel, TABARÉS, Francisco L. Erosion of a-C:H in the afterglow of ammonia plasma. Journal of nuclear materials, ISSN 0022-3115. [Print ed.], 2016, vol. 475, str. 237-242, doi: 10.1016/j.jnucmat.2016.04.011.
- MOZETIČ, Miran, VESEL, Alenka, STOICA, Silviu-Daniel, IONUT VIZIREANU, Sorin, DINESCU, Gheorghe, ZAPLOTNIK, Rok. Oxygen atom loss coefficient of carbon nanowalls. Applied Surface Science, ISSN 0169-4332. [Print ed.], 2015, vol. 333, str. 107-213, doi: 10.1016/j.apsusc.2015.02.020.
- DRENIK, Aleksander, MOZETIČ, Miran, et al., JET EFDA Contributors. Mass spectrometry analysis of the impurity content in N2 seeded discharges in JET-ILW. Journal of nuclear materials, ISSN 0022-3115, 2015, vol. 463, p.684-687, doi: 10.1016/j.jnucmat.2014.12.084.
- MOZETIČ, Miran, VESEL, Alenka, KOVAČ, Janez, ZAPLOTNIK, Rok, MODIC, Martina, BALAT-PICHELIN, Marianne. Formation and reduction of thin oxide films on a stainless steel surface upon subsequent treatments with oxygen and hydrogen plasma. Thin solid films, ISSN 0040-6090., 2015, vol. 591, part B, str. 186-193, doi: 10.1016/j.tsf.2015.02.007