UČNI NAČRT PREDMETA / COURSE SYLLABUS	
Predmet:	**Uvod v plazmo**
Course title:	**Introduction to plasma**

Študijski program in stopnja Study programme and level	Študijska smer Study field	Letnik Academic year	Semester Semester
FIZIKA		1. ali .2	**1. ali 2.**
PHYSICS		1. or 2.	**1. or 2.**

Vrsta predmeta / Course type Izbirni za modula Biofizika in Fizika

Univerzitetna koda predmeta / University course code:

Predavanja Lectures	Seminar Seminar	Vaje Tutorial	Lab. vaje Laboratory work	Mentorstvo Mentorship	Samost. delo Individ. work	ECTS
10	**5**				**165**	**6**

Nosilec predmeta / Lecturer: **Uroš Cvelbar**

Jeziki / Languages:	**Predavanja / Lectures:**	slovenski/Slovenian
	Vaje / Tutorial:	

Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:

Pogoji za vključitev v delo:
Predznanje iz klasične in moderne fizike.

Pogoji za opravljanje študijskih obveznosti:
4 seminarske naloge. Delež posamezne seminarske naloge je 25%, vsaka mora biti ocenjena pozitivno.

Prerequisits:

Conditions for Inclusion in the Course:
Preknowledge of classical and modern physics.

Conditions for Fulfilling Study Obligations:
4 seminar papers. Each seminar paper contributes 25% and each has to be marked positive.

Vsebina:

Obravnavani bodo osnovni in aktualni primeri s področja fizike plazme.

Predavanja bodo pokrivala področja raziskav osnovnih principov kot tudi področje aplikacij.

Izbrane vsebine se bodo prilagajale področju znanstvenoraziskovalnega dela doktorskega študenta. Primeri vsebin: *Osnove fizike plazme*

Content (Syllabus outline):

Underlying principles and recent advances in plasma physics will be studied.

The lectures will cover research of basic principles and also of applications.

Topics will be chosen in accordance with the candidate's research work. Examples of topics: *Fundamentals of plasma physics and plasma*

in plazemske kemije: plazme v naravi, v laboratoriju, v industriji, plazemske aplikacije, elementarni procesi nabitih delcev v plazmi, elementarni procesi vzbujenih molekul in atomov v plazmi, plazemska statistika in kinetika nabitih delcev, kinetika vzbujenih delcev v plazmi, elektrostatika, elektrodinamika in tekočinska mehanika plazme; Fizika in inženiring električnih plinskih razelektritev (obločne razelektritve, neravnovesne hladne atmosferske plinske razelektritve, plazme v visokofrekvenčnih elektromagnetnih poljih, razelektritve v aerosolih, prašnih plazmah in tekočinah, plazme elektronskih snopov)	*chemistry*: plasma in nature, in laboratory, and industry, plasma applications, elementary processes of charged species in plasma, elementary processes of excited molecules and atoms in plasma, plasma statistics and kinetics of charged particles, kinetics of excited particles in plasma, electrostatics, electrodynamics and fluid mechanics of plasma; *Physics and engineering of electric glow discharges* (arc discharges, nonequilibrium cold atmospheric pressure discharges, plasmas in high-frequency electromagnetic fields, discharges in aerosols, dusty plasmas and liquids, electron beam plasmas).

Temeljni literatura in viri / Readings:

1. Kadomtsev, B. B. (1981). Plasma physics. Moscow: Mir. [COBISS.SI-ID 869927] https://plus.cobiss.net/cobiss/si/sl/bib/pefmb/869927

2. Fridman, A. A. (2012). Plasma chemistry. Cambridge: Cambridge University Press. [COBISS.SI-ID 74651649] Celotno besedilo dostopno v EBSCOhost Ebook Academic Collection - World Wide

3. Panel on Plasma Processing. (1995). Plasma processing and processing science. National Academies Press. [ISBN 0-309-57516-8] Celotno besedilo dostopno v EBSCOhost Ebook Academic Collection - World Wide

4. Park, S., Choe, W., Lee, H., Park, J. Y., Kim, J., Moon, S. Y., Cvelbar, U. (2021). Stabilization of liquid instabilities with ionized gas jets. *Nature: the international weekly journal of science*, 592, 49–53. [COBISS.SI-ID 57958403] https://plus.cobiss.net/cobiss/si/sl/bib/pefmb/57958403

Dodatna literatura / Additional readings:

1. Lieberman, M. A., & Lichtenberg, A. J. (2005). Principles of plasma discharges and materials processing (2nd ed.). Hoboken: Wiley-Interscience. [COBISS.SI-ID 19054119]

2. Becker, K. H. (ur.). (2005). Non-equilibrium air plasmas at atmospheric pressure. Bristol; Philadelphia: Institute of Physics Publishing. [COBISS.SI-ID 22608679] Dostopno na: http://www.loc.gov/catdir/enhancements/fy0661/2005276597-d.html

3. Fridman, A. A., & Kennedy, L. A. (2021). Plasma physics and engineering (1st ed.). Boca Raton; Abingdon: CRC Press, Taylor & Francis. [COBISS.SI-ID 182516739]

4. Lu, X. (2021). Nonequilibrium atmospheric pressure plasma jets: Fundamentals, diagnostics, and medical applications (1st paperback ed.). Boca Raton: CRC Press. [COBISS.SI-ID 186600195]

5. Becker, K. H. (ur.). (2005). Non-equilibrium air plasmas at atmospheric pressure. Bristol; Philadelphia: Institute of Physics Publishing. [COBISS.SI-ID 22608679]

6. Znanstvenoraziskovalni članki s področja obravnavanih tem / Scientific research papers from chosen topics.

Cilji in kompetence:	**Objectives and competences:**
Namen predmeta je študente usposobiti za raziskovalno delo na izbranem področju fizike plazme.	The objective of this course is to teach students how to carry out research work on a selected field within plasma physics.

Predvideni študijski rezultati:	**Intended learning outcomes:**
Znanje in razumevanje: Po zaključku tega predmeta bo študent zmožen: - razumeti osnovne principe plazemske fizike, - analizirati, vrednotiti in primerjati najnovejše raziskave na izbranem področju fizike plazme; - uporabiti napredno fizikalno znanje in matematične metode na danem področju za analizo in vrednotenje fizikalnih pojavov v odvisnosti od relevantnih fizikalnih parametrov in spremenljivk; - prepoznati analogije med različnimi pojavi in jih uporabiti za obravnavo novih pojavov ter jih uporabiti. - Prenesljive/ključne spretnosti in drugi atributi: - *Spretnosti komuniciranja:* ustno in pisno izražanje pri predstavitvi izbrane teme. - *Uporaba informacijske tehnologije:* uporaba programskih orodij za modeliranje in obdelavo podatkov. - *Reševanje problemov:* prepoznavanje univerzalnosti, analogij in celosten pristop k reševanju problemov.	Knowledge and understanding: On completion of this course the student will be able to: - to understand basic principles of plasma physics, - analyse, evaluate and compare the latest research on a chosen field of plasma physics; - use advanced physical knowledge and mathematical methods from a specific field for an analysis and evaluation of physical effects as a function of physical parameters and variables; - recognise analogies among different effects and apply them to describe novel physical effects and apply them. Transferable/Key Skills and other attributes: - *Communication skills:* manner of expression at written and oral presentation of a chosen topic. - *Use of information technology:* use of software tools for modelling and data manipulation. - *Problem solving:* ability to recognize universalities, analogies, and global approach to solving problems.

Metode poučevanja in učenja:	**Learning and teaching methods:**
Predavanja, seminarji, konzultacije, razlaga, razgovor, delo s tekstom, metoda pisnih in grafičnih del, problemsko učenje, študija primera, raziskovalno učenje, uporaba programskih orodij.	Lectures, seminars, tutorials, explanation, discussion, work with text, work with graphic elements, case study, problem based learning, inquiry based learning, use of software tools.

Načini ocenjevanja:	Delež (v %) / Weight (in %)	**Assessment:**
~~Način (pisni izpit, ustno izpraševanje, naloge, projekt)~~ ~~4 seminarji~~ Seminarska naloga ~~Delež posameznega seminarja je 25%, vsak mora biti ocenjen pozitivno.~~	**100%**	~~Type (examination, oral, coursework, project):~~ 4 seminars Seminar paper ~~Each seminar contributes 25% and each has to be marked positive.~~

Reference nosilca / Lecturer's references:

1. PARK, Sanghoo, CHOE, Wonho, LEE, Hyungyu, PARK, Joo Young, KIM, Jinwoo, MOON, Se Youn, CVELBAR, Uroš. Stabilization of liquid instabilities with ionized gas jets. *Nature: the international weekly journal of science*. [Print ed.]. 2021, vol. 592, str. 49-53. ISSN 0028-0836. DOI: 10.1038/s41586-021-03359-9. [COBISS.SI-ID 57958403]
2. ~~PARK, Sanghoo, CVELBAR, Uroš, CHOE, Wonho, MOON, Se Youn. The creation of electric wind due to the electrohydrodynamic force. *Nature communications*. 2018, vol. 9, str. 371-1-371-8. ISSN 2041-1723. DOI: 10.1038/s41467-017-02766-9. [COBISS.SI-ID 31159079],~~
3. ~~WELTMANN, Klaus-Dieter, CVELBAR, Uroš, et al. The future for plasma science and technology. *Plasma processes and polymers*. 2019, vol. 16, no. 1, str. e1800118-1-e1800118-29. ISSN 1612-8850. DOI: 10.1002/ppap.201800118. [COBISS.SI-ID 32084263]~~
4. ~~OSTRIKOV, Kostya, CVELBAR, Uroš, MURPHY, Anthony B. Plasma nanoscience: setting directions, tackling grand challenges. *Journal of physics. D, Applied physics*. 2011, vol. 44, str. 174001-1-174001-29. ISSN 0022-3727. DOI: 10.1088/0022-3727/44/17/174001. [COBISS.SI-ID 24638503]~~
~~BARANOV, Oleg B., BAZAKA, Kateryna, KERSTEN, Heinrich, KEIDAR, Michael, CVELBAR, Uroš, XU, S. F., LEVCHENKO, Igor. Plasma under control : advanced solutions and perspectives for plasma flux management in material treatment and nanosynthesis. *Applied physics reviews*. 2017, vol. 4, no. 4, str. 041302-1-041302-33. ISSN 1931-9401. DOI: 10.1063/1.5007869. [COBISS.SI-ID 31010599]~~
5. ~~BAZAKA, Kateryna, BARANOV, Oleg B., CVELBAR, Uroš, PODGORNIK, Bojan, WANG, Yingjun, HUANG, S., XU, L., LIM, J. W. M., LEVCHENKO, Igor, XU, S. Oxygen plasmas : a sharp chisel and handy trowel for nanofabrication. *Nanoscale*. 2018, vol. 10, iss. 37, str. 17494-17511, ilustr. ISSN 2040-3364. DOI: 10.1039/C8NR06502K. [COBISS.SI-ID 31694375]~~
2. SANTHOSH, Neelakandan Marath, FILIPIČ, Gregor, KOVAČEVIĆ, Eva, JAGODAR, Andrea, BERNDT, Johannes, STRUNSKUS, Thomas, KONDO, Hiroki, HORI, Masaru, TATAROVA, Elena, CVELBAR, Uroš. N-graphene nanowalls via plasma nitrogen incorporation and substitution : the experimental evidence. *Nano-micro letters*. 2020, vol. 12, no. 1, str. 53-1-53-17. ISSN 2311-6706. DOI: 10.1007/s40820-020-0395-5. [COBISS.SI-ID 33211943]
6. ~~CVELBAR, Uroš. Towards large-scale plasma-assisted synthesis of nanowires. *Journal of physics. D, Applied physics*. 2011, vol. 44, str. 174014-1-174014-9. ISSN 0022-3727. DOI: 10.1088/0022-3727/44/17/174014. [COBISS.SI-ID 24638759]~~
7. ~~CVELBAR, Uroš, CHEN, Zhiqiang, LEVCHENKO, Igor, SHEETZ, R. Michael, JASINSKI, Jacek B., MENON, Madhu, SUNKARA, Mahendra K., OSTRIKOV, Kostya. Sub-oxide-to-metallic, uniformly nanoporous crystalline nanowires by plasma oxidation and electron reduction. *Chemical communications*. 2012, vol. 48, no. 90, str. 11070-11072. ISSN 1359-7345. DOI: 10.1039/C2CC35151J. [COBISS.SI-ID 26404903]~~

3. SANTHOSH, Neelakandan Marath, CVELBAR, Uroš. Carbon nanostructures for high-frequency line-filtering supercapacitors. Frontiers in nanotechnology. 2024, vol. 6, [article no.] 1463972, str. 1–8. ISSN 2673-3013. https://www.frontiersin.org/articles/10.3389/fnano.2024.1463972/full, DOI: 10.3389/fnano.2024.1463972. [COBISS.SI-ID 211986947]

4. SHVALYA, Vasyl, OLENIK, Jaka, VENGUST, Damjan, ZAVAŠNIK, Janez, ŠTRBAC, Jelena, MODIC, Martina, BARANOV, Oleg, CVELBAR, Uroš. Nanosculptured tungsten oxide: high-efficiency SERS sensor for explosives tracing. Journal of Hazardous Materials. Sep. 2024, vol. 476, [article no.] 135171, str. 1–10. https://www.sciencedirect.com/science/article/pii/S0304389424017503, DOI: 10.1016/j.jhazmat.2024.135171. [COBISS.SI-ID 201763843]

5. KOŠIČEK, Martin, ZAVAŠNIK, Janez, BARANOV, Oleg, CVELBAR, Uroš. In search of the limits of CuO thermal oxidation nanowire growth by combining experiment and theory. Applied Physics Letters. 2023, vol. 123, str. 041601-1–041601-7. ISSN 1077-3118. https://doi.org/10.1063/5.0151293. DOI: 10.1063/5.0151293. [COBISS.SI-ID 159860483]