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| **UČNI NAČRT PREDMETA / COURSE SYLLABUS** | | | | | | | | | | | | | | | | | |
| **Predmet:** | | | Električni pojavi v plazmi in osnove fuzije | | | | | | | | | | | | | | |
| **Course title:** | | | Electrical properties of plasmas and introduction to controlled fusion | | | | | | | | | | | | | | |
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| **Študijski program in stopnja**  **Study programme and level** | | | | | **Študijska smer**  **Study field** | | | | | | | | **Letnik**  **Academic year** | | **Semester**  **Semester** | | |
| doktorski študijski program tretje stopnje Elektrotehnika | | | | | Ni smeri | | | | | | | | 1 | |  | | |
| 3rd cycle: doctoral study programme Electrical Engineering | | | | |  | | | | | | | |  | |  | | |
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| **Vrsta predmeta / Course type** | | | | | | | | | | | | Izbirni / elective | | | | | |
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| **Univerzitetna koda predmeta / University course code:** | | | | | | | | | | | | 64802 | | | | | |
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| **Predavanja**  **Lectures** | **Seminar**  **Seminar** | | | **Vaje**  **Tutorial** | | | **Klinične vaje**  **work** | | | | **Druge oblike študija** | | | **Samost. delo**  **Individ. work** | |  | **ECTS** |
| **45** | **25** | | |  | | |  | | | |  | | | **55** | |  | **5** |
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| **Nosilec predmeta / Lecturer:** | | | | | Izr. prof. dr. Tomaž Gyergyek | | | | | | | | | | | | |
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| **Jeziki /**  **Languages:** | | **Predavanja / Lectures:** | | | | **Slovensko – angleško v primeru vpisa tujih študentov** | | | | | | | | | | | |
| **Vaje / Tutorial:** | | | | **Slovensko – angleško v primeru vpisa tujih študentov** | | | | | | | | | | | |
| **Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:** | | | | | | | | |  | **Prerequisits:** | | | | | | | |
| Vpis v letnik študija.  Opravljena seminar ali domača naloga je pogoj za pristop k ustnemu izpitu. | | | | | | | | |  | Enrollment into the program.  Positive result from a seminar or a homework necessary to enter the oral exam. | | | | | | | |
| **Vsebina:** | | | | | | | |  | | **Content (Syllabus outline):** | | | | | | | |
| * Definicije osnovnih pojmov, kot so Debyeva dožina, plazemski parameter, plazemska frekvenca. * Gibanje nabitih delcev v električnem in magnetnem polju. * Difuzija v plazmi in električna prevodnost plazme. * Kinetično in hidrodinamsko opisovanje plazme * Obravnava plazme kot električno prevodne tekočine (MHD), enačbe magnetohidrodinamike ter nekateri fuzijsko naravnani zgledi uporabe MHD * Valovanja v plazmi. * Trki med delci v plazmi ali bolj učeno: binarne interakcije v plazmi. * Uvod v fuzijo, fuzijske reakcije, energijska bilanca v fuzijskem reaktorju, inercialno in magnetno omejevanje * Nelinearni pojavi v plazmi, plazemski plašči in obravnava stika plazma – površina, ter diagnostika plazme z električnimi sondami – Langmuirjeva in emisijska sonda * Osnove računalniške delčne simulacije pojavov v plazmi | | | | | | | |  | | * Definitions of the Debye length, plasma parameter, plasma frequency * Motion of a charged particle in electric and magnetic field * Diffusion in a plasma and plasma conductivity * Kinetic and hydrodynamic description of a plasma * Basic MHD equations and some fusion oriented examples * Plasma waves * Binary interactions (collisions * Introduction to fusion, fusion reactions, power balance, magnetic and inertial confinement * Nonlinear phenomena: sheaths, electric probes * Introduction to particle-in-cell computer simulations of bounded plasma systems | | | | | | | |

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| **Temeljni literatura in viri / Readings:** | | | | | |
| 1. J. A. Bittencourt, Fundamentals of plasma physics, 3rd edition, Springer 2004 2. U. S. Inan and M. Golkowski, Principles of plasma physics for engineers and scientists, Cambridge University Press, 2011 3. J. Friedberg, Plasma Physics and Fusion energy, Cambridge University Press, 2007 4. J. Wesson, Tokamaks, 4th edition, Oxford University Press, 2011 5. A. Piel, Plasma physics – An introduction to laboratory space and fusion plasmas, Springer 2010 6. F. F. Chen, Introduction to plasma physics and controlled fusion, 2nd edition, Plenum Press, 1984 7. C. K. Birdsall and A. B. Langdon, Plasma physics via computer simulation, IOP publishing 1991 (reprint 1995) 8. R. W. Hockney, J. W. Eastwood, Computer simulation using particles, IOP publishing, 1994 | | | | | |
| **Cilji in kompetence:** | |  | | **Objectives and competences:** | |
| **Cilji:** Pridobiti osnovno teoretično in deloma tudi praktično znanje iz procesov v plinskih plazmah.  **Kompetence:** Temeljno znanje na področju plazemske fizike in tehnologije ter razumevanje izzivov pri razvoju fuzijskih reaktorjev. | |  | | **Objectives:** Gaining basic theoretical and practical knowledge of processes in gaseous plasmas.  **Competences:** Knowledge of fundamental areas of plasma physics and technology and understanding of the challenges in the fusion reactor development. | |
| **Predvideni študijski rezultati:** | | |  | **Intended learning outcomes:** | |
| **Znanje in razumevanje**  Razumevanje fizikalnih procesov, ki potekajo v plinskih plazmah, ter na tej osnovi sposobnost uporabe fizikalnih modelov in analitičnih metod za določevanje ključnih parametrov plazme v dani plazemski napravi.  **Uporaba** Pridobljeno znanje naj bi omogočilo spremljanje in tudi eventuelno lažje vključevanje v strokovno delo pri osvajanju in razvoju novih plazemskih tehnologij ali pa tudi vključitev v fuzijske raziskave.  **Refleksija** Razumevanje pomena plinskih plazem v tehnologiji in energetiki  **Prenosljive spretnosti - niso vezane le na en predmet** Podrobno poznavanje elektromagnetnih interakcij med delci, gibanja nabitih delcev v magnetnem in električnem polju, radiofrekvenčno valovanje, interakcija plazme z material, reševanje transportnih enačb, valovnih enačb. | | |  | **Knowledge and understanding:**  Understanding of the physical in plasmas, ability to use physical models andanalytical methods for determination and evaluation of key parameters of a plasma in a given plasma device.  **Application:**  Acquired knowledge should help the the student in following of the development in various plasma technologies and better integration in possible scientific work related to either plasma technology or energy production based on nuclear fusion.  **Reflection:**  Understanding of the role of gaseous plasmas in technology and energy production.  **Transferable skills:**  Comprehensive knowledge in electromagnetic interactions between charged particles, charged particle motion in electric and magnetic field, radiofrequency waves, interaction between a plasma and a solid material, solving transport and wave equations. | |
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| **Metode poučevanja in učenja:** | | |  | **Learning and teaching methods:** | |
| Predavanja, seminarji, obiski nekaterih laboratorijev na IJS | | |  | Lectures, seminars, visits of some laboratories at the Jozef Stefan Institute | |
| **Načini ocenjevanja:** | Delež (v %) /  Weight (in %) | | | | **Assessment:** |
| Seminar ali domača naloga  Ustni izpit  ocene: 1-5 (negativno), 6-10 (pozitivno) (po Statutu UL) | 80 %  20 % | | | | Seminar or homework  Oral exam  grading: 1-5 (fail), 6-10 (pass) (according to the Statute of UL) |
| **Reference nosilca / Lecturer's references:** | | | | | |
| **izred. prof. dr. Tomaž Gyergyek:**  1. Gruenwald J, Tskhakaya D, Kovačič J, Čerček M, Gyergyek T, Ionita C, Schrittwieser R (2013) Comparison of measured and simulated electron energy distribution functions in low-pressure helium plasmas. Plasma Sources Sci. Technol*.*, 22:015023  2. Gyergyek T, Kovačič J (2012) Saturation of a floating potential of an electron emitting electrode with increased electron emission : a one-dimensional kinetic model and particle-in-cell simulation. *Phys. Plasmas*, 19: 013506  3. Gyergyek T, Jurčič-Zlobec B, Čerček M, Kovačič J (2009) Sheath structure infront of an electron emitting electrode immersed in a two-electron temperature plasma: a fluid model and numerical solutions of the Poisson equation. Plasma Sources Sci. Technol., 18:035001  4. Gyergyek T, Kovačič J (2015) Fluid model of the sheath in front of a floating electrode immersed in a magnetized plasma with oblique magnetic field: Some comments on ion source terms and ion temperature effects. Phys. Plasmas, 22:043502  5. Gyergyek T, Kovačič J (2015) A self-consistent two-fluid model of a magnetized plasma-wall transition. Phys. Plasmas, 22:093511 | | | | | |