Univerza v Mariboru

Fakulteta za naravoslovje in matematiko

UČNI NAČRT PREDMETA / COURSE SYLLABUS	
Predmet:	**Fizikalni eksperimenti 2**
Course title:	**Physics experiments 2**

Študijski program in stopnja Study programme and level	Študijska smer Study field	Letnik Academic year	Semester Semester
Fizika, 1. stopnja		**2**	**3**
Physics, 1st cycle			

Vrsta predmeta / Course type obvezni/Compulsory

Univerzitetna koda predmeta / University course code:

Predavanja Lectures	Seminar Seminar	Vaje Tutorial	Lab. vaje Laboratory work	Terenske vaje Field work	Samost. delo Individ. work	ECTS
3	**2**		**50**		**65**	**4**

Nosilec predmeta / Lecturer: Robert Repnik

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

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

Priporočljivo je predznanje iz elektromagnetizma, termodinamike, osnove analize in vektorske analize.

Vsaka izmed naštetih obveznosti v načinih ocenjevanja mora biti opravljena s pozitivno oceno. Pozitivno ocenjeno poročilo laboratorijskih vaj z zagovorom, pozitivno ocenjeno preverjanje pripravljenosti na vaji in uspešno izdelan in predstavljen projekt so pogoji za pristop k ustnemu izpitu.

Prerequisites:

Recommended is preknowledge of electromagnetism, thermodynamics, fundamentals of analysis and vector analysis.

Each of the listed obligations in the assessment methods must be completed with a passing grade. A positively evaluated laboratory report with defense, a positively evaluated readiness assessment during the exercise, and a successfully completed and presented project are prerequisites for taking the oral exam.

Vsebina:

Content (Syllabus outline):

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Predavanja teoretični pregled zahtevnejših vsebin laboratorijskih vaj in uporabljenih merilnih tehnik. **Laboratorijske vaje** Študent opravi zahtevnejše vaje s področja termodinamike in elektromagnetizma. Vsebine, ki so zastopane v vajah iz termodinamike so: odvisnost vrelišča vode od tlaka, izparilna in talilna toplota. Vaje z elektromagnetizma vsebujejo: električna vezja, notranji upor, koeficient upora, merilniki električnega toka in napetosti, indukcija in generatorji, elektromotorji, elektroni v električnem in magnetnem polju, Coulombov zakon, Hallov pojav. Uporaba fizikalnih vsebin iz laboratorijskih vaj pri raziskovalnem in razvojnem delu. **Projektno delo** Študent pripravi projektno nalogo: načrtuje in izdela meritev, pripravi navodila za izvajanje meritve, izvede meritev in napiše poročilo. **Seminar** Predstavitev projektnega dela.	**Lectures:** theoretical overview of the demanding experiments and used measuring techniques. **Laboratory work** Student performs advanced experiments from thermodynamics and electromagnetism. The experiments on thermodynamics contain: Clausius Clapeyrone equation, heat of vaporization. The experiments on electromagnetism contain: electrical circuits, internal resistance, current- and voltage-meters, induction and generators, electromotor, electrons in electric and magnetic field, Coulomb law, Hall effect. Use of physical content from laboratory exercises in research and development work. **Project work** Each student works on a project. The work involves planning the experiment, building the experiment, performing the measurements and writing report. **Seminar** Oral presentation of project work.

Temeljni literatura in viri / Readings:

1. Repnik, R., Slavinec, M., & Klemenčič, E. (2022). Fizikalni eksperimenti 2: zbirka laboratorijskih vaj [elektronski vir]. Maribor: Univerza v Mariboru, Univerzitetna založba. ISBN 978-961-286-623-5. [COBISS.SI-ID 114172419] https://plus.cobiss.net/cobiss/si/sl/bib/pefmb/114172419
2. Koškin, N. I., & Širkevič, M. G. (1988). Priročnik elementarne fizike (1. slov. prev. po 3. predelani in izpopolnjeni izd., 6. ponatis). Ljubljana: Tehniška založba Slovenije. ISBN 86-365-0035-4. [COBISS.SI-ID 3996416] https://plus.cobiss.net/cobiss/si/sl/bib/pefmb/3996416

3. Halliday, D., Resnick, R., & Walker, J. (2008). Fundamentals of Physics (8th ed.). Hoboken, NJ: J. Wiley & Sons. ISBN 978-0-470-04472-8. [COBISS.SI-ID 62414337] https://plus.cobiss.net/cobiss/si/sl/bib/pefmb/62414337
4. Strnad, J. (2014). Fizika. Del 1: Mehanika, toplota (12. natis). Ljubljana: DMFA – založništvo. ISBN 978-961-212-047-4. [COBISS.SI-ID 271411200] https://plus.cobiss.net/cobiss/si/sl/bib/pefmb/271411200
5. Strnad, J. (2014). Fizika. Del 2: Elektrika, optika (7. natis). Ljubljana: DMFA – založništvo. ISBN 978-961-212-048-1. [COBISS.SI-ID 271410944] https://plus.cobiss.net/cobiss/si/sl/bib/pefmb/271410944

Dodatna literatura / Additional readings:

1. Elektronska gradiva, objavljena v spletni učilnici / Teaching material available in the e-classroom.

Cilji in kompetence:

Cilj tega predmeta je, da študent usvoji temeljna znanja o merilnih tehnikah in metodah na področju elektromagnetizma in termodinamike ter se usposobi za samostojno varno izvedbo laboratorijskih vaj iz področja elektromagnetizma in termodinamike. Na osnovi eksperimentalno pridobljenih podatkov, v kombinaciji z ustreznim teoretičnim znanjem iz elektromagnetizma in termodinamike in drugimi informacijskimi viri ter računalniškimi simulacijskimi okolji so sposobni smiselno oblikovati končno rešitev problema.

Objectives and competences:

The objective of this course is for student to acquire basic knowledge in measuring techniques and methods used in electromagnetism and thermodynamics and is able to use the knowledge for individual safe laboratory work in the field of electromagnetism and thermodynamics. On the basis of experimentally obtained data combined with their theoretial knowledge in electromagnetism and thermodynamics as well as professional literature and computer simulation tolls student is able to reasonably formulate the final solution of the problem.

Predvideni študijski rezultati:

Znanje in razumevanje:

Po uspešno zaključeni učni enoti je študent zmožen:

- uporabiti teoretična znanja iz področja termodinamike in elektromagnetizma za izvedbo laboratorijskih vaj,

Intended learning outcomes:

Knowledge and understanding:

On completion of this course student will be able to:

- use the knowledge from thermodynamics and electromagnetism to execute laboratory work,

- aplicirati teoretična znanja o merilnih tehnikah, - uporabiti ustrezne metode za obdelavo in analizo podatkov, - ovrednotiti in interpretirati rezultate ter jih povezati s teorijo, - precizno in adekvatno poročati o svojih eksperimentalnih ugotovitvah. **Prenesljive/ključne spretnosti in drugi atributi:** Študent: - pridobi laboratorijske spretnosti potrebne za samostojno delo pri demonstracijah in eksperimentalnih vajah s področja elektromagnetizma in termodinamike, - se priuči rokovanja z merilnimi napravami in laboratorijsko opremo, - prepozna možne vire nevarnosti pri eksperimentalnem delu in pozna postopke za varno delo v laboratoriju, - usvoji znanje potrebno za pripravo kvantitativnega in kvalitativnega eksperimenta s področja elektromagnetizma in termodinamike, - se seznani z iskanjem, sortiranje in ustrezno rabo virov, - pridobi spretnosti uporabe programskih orodij za analizo podatkov eksperimentov s področja elektromagnetizma in termodinamike, - je zmožen presoje smiselnosti uporabe približkov, - je sposoben sodelovalnega učenja.	- apply the knowledge of measuring techniques, - use appropriate methods for processing and analyzing data, - evaluate and interpret results and connect them with theory, - accurate and adequate reporting on their experimental work. - **Transferable/Key Skills and other attributes** Student: - acquires experiences and laboratory skills that are essential for an autonomous execution of demonstrative physics experiments in the field of electromagnetism and thermodynamics, - gains ability of handling with measuring devices and laboratory equipment, - recognizes potential dangers in experimental work and knows procedures for safe laboratory work, - gains knowledge needed to produce quantitative and qualitative experiments, - gets acqainted with searching and sorting information sources and efficient use of sources, - acquires skills to use software tools for analyzing data from experiments in the field of electromagnetism and thermodynamics - is capable to judge the effective use of approximations, - is capable of collaborative learning.

Metode poučevanja in učenja:	**Learning and teaching methods:**
-predavanja (razlaga, razgovor, demonstracija) -laboratorijske vaje (metoda dela s tekstom, pisnih in grafičnih del, metoda praktičnih del, uporaba simulacij in programskih orodij za obdelavo podatkov, sodelovalno učenje, diskusija rezultatov)	-lectures (explanation, discussion, demonstration) -laboratory exercises (work with text, work with graphic elements, practical work, use of simulations and software tools for data

-projektno delo (individualizacija poučevanja) -seminar (razlaga, razgovor) - elementi obrnjenega poučevanja	processing, collaborative learning, discussion of results) -project work (individualization in teaching) -seminar work (explanation, discussion) -elements of flipped learning

Načini ocenjevanja:	Delež (v %) / Weight (in %)	**Assessment:**
Laboratorijsko delo	**80**	Laboratory work
Projekt	**10**	Project
Ustni izpit	**10**	Oral exam

Reference nosilca / Lecturer's references:

HAUKO, Robert, DAJNKO, Matic, GAČEVIĆ, Dino, MARINKO, Peter, POTRČ, Melani, REPNIK, Robert. From speed of sound to vapour pressure : an undergraduate school experiment as an example of systematic error research. *European journal of physics*. 2022, vol. 43, no. 4, str. 1-14. ISSN 0143-0807. DOI: 10.1088/1361-6404/ac6cb9. [COBISS.SI-ID 117802755]

PANAHI, Shirin, NAZARIMEHR, Fahimeh, JAFARI, Sajad, SPROTT, Julien Clinton, PERC, Matjaž, REPNIK, Robert. Optimal synchronization of circulant and non-circulant oscillators. *Applied mathematics and computation*. [Print ed.]. Apr. 2021, vol. 394, art. no. 125830, str. 1-8. ISSN 0096-3003. DOI: 10.1016/j.amc.2020.125830. [COBISS.SI-ID 43339779]

OSRAJNIK, Damjan, GRUBELNIK, Vladimir, REPNIK, Robert. Multirhythmicity but no deterministic chaos in vibrating strings. *Chaos, solitons and fractals*. [Print ed.]. Sep. 2021, vol. 150, str. 1-5. DOI: 10.1016/j.chaos.2021.111206. [COBISS.SI-ID 73698819]

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