Univerza v Mariboru

Fakulteta za naravoslovje in matematiko

UČNI NAČRT PREDMETA / COURSE SYLLABUS	
Predmet:	**Nihanje in valovanje**
Course title:	**Oscillation and waves**

Študijski program in stopnja Study programme and level	Študijska smer Study field	Letnik Academic year	Semester Semester
Enovit magistrski študijski program druge stopnje Predmetni učitelj	**Izobraževalna fizika**	**2**	**3**
Five-year master's degree program Subject Teacher	**Educational physics**		

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
60		**30**			**120**	**7**

Nosilec predmeta / Lecturer:	Nataša Vaupotič

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

Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:	**Prerequisits:**
Pogojev ni. Priporočljivo je predznanje iz mehanike, elektromagnetizma, analize in algebre	None. Priporočljivo je preknowledge of Mechanics, Electromagnetism, calculus and algebra

Vsebina:	**Content (Syllabus outline):**

1.*Nihanje*: harmonično nihanje, dušeno nihanje, vsiljeno nihanje in resonanca, sestavljeno nihanje, utripanje. 2. *Valovanje*: longitudinalno in transverzalno, valovna dolžina in frekvenca, hitrost otujočega vala, princip superpozicije, interferenca valovanj, stojno valovanje, zvok, utripanje, Dopplerjev pojav. 3. *Elektromagnetno valovanje*: spekter, izvor; Poytingov vektor; sončni tlak; polarizacija. 4. *Geometrijska optika*: področje veljavnosti in vpeljava žarka; odboj in lom; zrcala in leče; dvojni lom in optična aktivnost; optični elementi. 5. *Valovna optika*: Stefanov in Wienov zakon interferenca, koherentnost, polarizacija, Huygensovo načelo; optična pot; interferenca na dveh režah; interferenca na tankih plasteh, nevidnost, Michelsenov interferometer; Uklon, kvalitativen in kvantitativen opis, ločljivost in Rayleightov kriterij; kombinacija uklona in interference; optična mrežica; uklon x-žarkov.	1. *Oscillations*: harmonic oscillations, damped oscillations, forced oscillations and resonance, coupled oscillation, beats. 2. *Waves*: longitudinal and transverse, wavelength and frequency, speed of a travelling wave, principle of superposition, interference of waves, standing waves, sound, beats, Doppler effect. 3. *Electro-magnetic waves*: spectrum, source, radiation pressure, polarisation. 4. *Geometric optics*: range of validity, ray, refraction, reflection, mirrors and lenses, birefringence and optical activity, optic elements. 5. *Wave optics*: Stefan and Wien law, interference, coherence, polarization, Huygens principle; phase shift; interference on a double slit interference on thin films, invisibility; Michelson interferometer; diffraction, qualitative and quantitative description, Rayleigh criterion; interference and diffraction; diffraction gratings; x-ray diffraction.

Temeljni literatura in viri / Readings:

- D. Halliday, R. Resnick, J. Walker, Fundamentals of Physics, katerakoli izdaja, npr. 10. izdaja, (John Wiley & Sons, Inc., Hoboken, 2014).
- J. Strnad, Fizika, 1. del, (DMFA, Ljubljana, 2002).
- J. Strnad, Fizika, 2. del, (DMFA, Ljubljana, 1995).
- Z. Bradač, Naloge iz fizike (Pedagoška fakulteta Maribor, 1991).
- M. Gros, M. Hribar, A. Kodre, J. Strnad, Naloge iz fizike (DMFA, Ljubljana, 1991).
- B. Majaron, M. Mikuž, A. Ramšak, Kolokvijske naloge iz fizike 1 (DMFA, Ljubljana, 1998).
- J. Žitnik, Univerzitetne fizikalne naloge (TZS, Ljubljana, 2002-2003).

Cilji in kompetence:	**Objectives and competences:**
Študenti usvojijo temeljna teoretična znanja s področja mehanskega nihanja in valovanja, elektromagnetnega valovanja ter valovne in geometrijske optike in jih znajo uporabiti pri reševanju ustreznih problemov z rabo matematičnih orodij.	Students acquire basic theoretical knowledge from mechanical oscillations and waves, electromagnetic waves, wave and geometrical optics and are able to use the knowledge to solve problems with the use of mathematical tools.

Predvideni študijski rezultati:	**Intended learning outcomes:**

Znanje in razumevanje:

Po uspešno zaključeni učni enoti bodo študenti zmožni:

- uporabiti Newtonove zakone in ohranitvene zakone za opis, analizo in vrednotenje periodičnega gibanja telesa/sistema v odvisnosti od spremenljivk in parametrov, od katerih so odvisne lastnosti telesa in okolice;
- opisati razširjanje valovanja v eni, dveh in treh dimenzijah ter ga povezati z lastnostmi snovi, po kateri se valovanje razširja;
- napovedati lastnosti slike po preslikavi z lečami in zrcali v odvisnosti od lastnosti leč in zrcal;
- razlikovati med koherentno in nekoherentno svetlobo;
- uporabiti princip superpozicije valovanj za kvantitativno obravnavo uklona in interference z delitvijo valovnega čela in delitvijo amplitude;
- kvalitativno napovedati lastnosti svetlobe po razširjanju skozi optično anizotropno snov.

Knowledge and understanding:

On completion of this course students will be able to:

- use Newton's laws and conservation laws to describe, analyse and evaluate periodic motion of a body/system as a function of variables and parameters, which determine properties of the system and surrounding;
- describe wave propagation in one, two and three dimensions and relate it to the properties of the medium;
- predict properties of an image obtained by a lens and mirror imaging as a function of properties of lenses and mirrors;
- differentiate between the coherent and incoherent light;
- use the principle of superposition of waves to quantitatively study diffraction and interference of waves obtained by splitting a wave front or division of amplitude;
- qualitatively predict properties of light upon transition through an optically anisotropic medium.

Prenesljive/ključne spretnosti in drugi atributi:

Po uspešno zaključeni učni enoti bodo študenti zmožni:

- pripravljati miselne vzorce in risbe ter smiselno poročati (vzrok/posledica) o izbrani temi;
- uporabiti osnovno znanje linearne algebre in analize za obravnavo fizikalnih problemov.

Transferable/Key Skills and other attributes:

On completion of this course students will be able to:

- prepare mind flowcharts and sketches and report (cause/consequence) on a selected topic;
- use elementary knowledge from linear algebra and linear analysis to tackle physical problems.

Metode poučevanja in učenja:

eksperimentalna predavanja
teoretične vaje
razlaga
razgovor
demonstracija
delo s tekstom
metoda pisnih in grafičnih del
uporaba simulacij
elementi obrnjenega poučevanja

Learning and teaching methods:

lectures with experiments
theoretical exercises
explanation
discussion
demonstration
work with text
work with graphic elements
use of simulations
elements of flipped learning

Poučevanje in učenje potekata z didaktično uporabo informacijsko-komunikacijske tehnologije.	Teaching and learning are done through the didactic use of ICT.

Načini ocenjevanja:	Delež (v %) / Weight (in %)	**Assessment:**
Način (pisni izpit, ustno izpraševanje, naloge, projekt):		Type (examination, oral, coursework, project):
pisni izpit (lahko se nadomesti z dvema pisnima kolokvijema)	**50**	written exam (can be replaced by two written tests)
ustni izpit (lahko se nadomesti z dvema ustnima kolokvijema)	**50**	oral exam (can be replaced by two oral tests)
Za uspešno zaključeno učno enoto mora vsak del posebej biti pozitiven.		For a successfully finished course, both oral and written exams have to be positive.

Reference nosilca / Lecturer's references:

1. SALAMONCZYK, Miroslaw, VAUPOTIČ, Nataša, POCIECHA, Damian, WALKER, Rebecca, STOREY, John M. D., IMRIE, Corrie T., WANG, Cheng, ZHU, Chenhui, GÓRECKA, Ewa. Multi-level chirality in liquid crystals formed by achiral molecules. *Nature communications*, ISSN 2041-1723, 2019, vol. 8, str. 1922-1-1922-8, doi: 10.1038/s41467-019-09862-y. [COBISS.SI-ID 32322855.

2. VAUPOTIČ, Nataša, ALI, Muhammad, MAJEWSKI, P., GÓRECKA, Ewa, POCIECHA, Damian. Polarization gratings spontaneously formed from a helical twist-bend nematic phase. *ChemPhysChem : a European journal of chemical physics and physical chemistry*, ISSN 1439-4235. [Print ed.], [in press] 2018, 15 str., doi: 10.1002/cphc.201800360. [COBISS.SI-ID 31667751].

3. POCIECHA, Damian, CRAWFORD, Catriona A., PATERSON, Daniel A., STOREY, John M. D., IMRIE, Corrie T., VAUPOTIČ, Nataša, GÓRECKA, Ewa. Critical behavior of the optical birefringence at the nematic to twist-bend nematic phase transition. *Physical review. E*, ISSN 2470-0045, 2018, vol. 98, no. 5, str. 052706-1-052706-5, doi: 10.1103/PhysRevE.98.052706. [COBISS.SI-ID 31948071].

4. SALAMONCZYK, Miroslaw, VAUPOTIČ, Nataša, POCIECHA, Damian, WANG, Cheng, ZHU, Chenhui, GÓRECKA, Ewa. Structure of nanoscale-pitch helical phases : blue phase and twist-bend nematic phase resolved by resonant soft X-ray scattering. *Soft matter*, ISSN 1744-683X, 2017, vol. 13, no. 38, str. 6694-6699, doi: 10.1039/c7sm00967d. [COBISS.SI-ID 30804519].

5**.** GÓRECKA, Ewa, VAUPOTIČ, Nataša, ZEP, Anna, POCIECHA, Damian. From sponges to nanotubes : a change of nanocrystal morphology for acute-angle bent-core molecules. *Angewandte Chemie*, ISSN 1521-3773. [Online ed.], 2016, vol. 55, no. 40, str. 12238-12242, doi: 10.1002/anie.201604915. [COBISS.SI-ID 29763367].

6. VAUPOTIČ, Nataša, CURK, Samo, OSIPOV, Mikhail, ČEPIČ, Mojca, TAKEZOE, Hideo, GÓRECKA, Ewa. Short-range smectic fluctuations and the flexoelectric model of modulated nematic liquid crystal. *Physical review. E, Statistical, nonlinear, and soft matter physics*, ISSN 1539-3755, 2016, vol. 93, no. 2, str. 022704-1-022704-5, doi: 10.1103/PhysRevE.93.022704. [COBISS.SI-ID 29301799].