GDAŃSK UNIVERSITY OF TECHNOLOGY

Subject card

Subject name and code	Waves and optics, PG_00020718		
Field of study	Technical Physics		
Date of commencement of studies	October 2025	Academic year of realisation of subject	2026/2027
Education level	first-cycle studies	Subject group	Obligatory subject group in the field of study Subject group related to scientific research in the field of study
Mode of study	Full-time studies	Mode of delivery	at the university
Year of study	2	Language of instruction	Polish
Semester of study	3	ECTS credits	5.0
Learning profile	general academic profile	Assessment form	exam
Conducting unit	Department Of Physics Of Electronic Phenomena -> Faculty Of Applied Physics And Mathematics -> Wydziały Politechniki Gdańskiej		
Name and surname of lecturer (lecturers)	Subject supervisor	dr hab. inż. Jędrzej Szmytkowski	
	Teachers		

Lesson types and methods of instruction

Lesson type	Lecture	Tutorial	Laboratory	Project	Seminar	SUM
Number of study hours	30.0	30.0	0.0	0.0	0.0	60

E-learning hours included: 0.0

Learning activity and number of study hours

Learning activity	Participation in didactic classes included in study plan	Participation in consultation hours	Self-study	SUM
Number of study hours	60	5.0	60.0	125

Subject objectives

Teach students and strengthen their knowledge about the nature of mechanical and electromagnetic waves, their generation, theoretical models and applications. Special attention is paid to optical waves and laws of optical geometry.

Learning outcomes

Course outcome	Subject outcome	Method of verification
[K6_U01] learns independently, obtains information from literature, databases and other properly selected sources	Student knows how to use literature and databases id waves and optics	[SU2] Assessment of ability to analyse information
[K6_W01] understands the importance of physics and its applications in connection to civilization	Student knows hao to seperate wave phenomena in daily life	[SW1] Assessment of factual knowledge
[K6_W02] has systematized knowledge of the basics of physics, including mechanics, thermodynamics, electricity and magnetism, optics, atomic and particle physics, solid-state physics, nuclear and elementary particle physics	The knowledge allows to analyze problems concerning waves and optics in the real world	[SW1] Assessment of factual knowledge

<table>
<tr><td>Subject contents</td><td>LECTURES Introduction: kinds of waves, eye and ear as wave detectors, acoustic and electromagnetic spectra. Oscillations of simple physical systems: basic terms, mathematical pendulum, transverse and longitudinal oscillations of the mass on two springs, oscillations of electric circuits, simple harmonic oscillator, damped harmonic oscillator, beats. String. The Classical Wave Equation: uniform string, harmonic oscillations, dispersion relations. Wave motion: phase and group velocity, acoustic wave velocity in Newton’s model and in adiabatic model, phase velocity of electromagnetic waves in a transmission line, Maxwell equations, wave equation for electromagnetic waves. Refractive index of waves: dependence of refractive index on frequency, normal and anomalous dispersion. Wave impedance and wave energy flux: mechanical impedance, generator output power, sound waves, sound intensity level, impedance and energy flux of electromagnetic wave, examples. Reflection of waves: amplitude and energy reflection coefficient at the interface of two media, transmission coefficient, Brewster angle, total internal reflection. antireflection coating. Polarization of wave: description of polarization, circular polarization, elliptical polarization, classical approach to superposition of oscillations perpendicular to each other, experimental methods of polarization of waves, polarization of waves by controlled emission, polaroid, double refraction in crystals, Nicole prism, slow and fast axis, quarter-wave plate, elastooptics, optical activity, Kerr and Faraday effect. Interference and diffraction: coherent sources of radiation, basics of interference, interference between two independent sources, dimensions of paint source, angular width of a beam of travelling waves, Rayleigh criterion, superposition of N harmonic waves, diffraction pattern of a single slit, diffraction pattern of N narrow slits, diffraction grating, diffraction at space grating. Geometrical optics: Fermat’s principle, Snell’s law, mirrors, prisms, lenses, optical fibers, telescope, microscope, Abbe’s law, resolving power, spectroscopes, refractometers, interferometers. Optical emission: Bohr’s model, hydrogen optical spectrum, photon absorption and emission, atom excitation during collisions, ionization of atoms, forced emission and forced absorption, lasers, molecular spectra, black body radiation, Planck’s formula, natural and artificial light sources, currents in glasses, filament and discharge tubes. Optical radiation detection: phenomena used for light detection, internal and external photoelectric effect, photomultiplier tubes, photodiodes and photovoltaic cells, thermal detectors, other methods of detection of thermal, optical and ionizing radiation, photometric units.

EXERCISES Simple harmonic oscillator. Oscillations of systems with two degrees of freedom Beats. Damped harmonic oscillator. String. The classical wave equation. Dispersion relations. Wave motion. Phase and group velocity. Wave energy flux and impedance. Refractive index. Reflection of waves. Wave polarization. Interference and diffraction. Geometrical optics. Emission and detection of optical radiation.</td></tr>
<tr><td>Prerequisites and co-requisites</td><td>Course credit "Mechanics and heat"(07053) and "Mathematical analysis" (07053)</td></tr>
<tr><td>Assessment methods and criteria</td><td>
<table>
<tr><th>Subject passing criteria</th><th>Passing threshold</th><th>Percentage of the final grade</th></tr>
<tr><td>Oral exam</td><td>35.0%</td><td>30.0%</td></tr>
<tr><td>Midterm colloguium</td><td>45.0%</td><td>40.0%</td></tr>
<tr><td>Written exam</td><td>65.0%</td><td>30.0%</td></tr>
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<tr><td>Recommended reading</td><td>
<table>
<tr><td>Basic literature</td><td>1. Crawford F.C., Fale, PWN W-wa 1973 2. Jaworski B., Dietłaf A., Procesy falowe, optyka, fizyka atomowa i jądrowa, PWN W-wa 1974 3. Godlewski J., Generacja i detekcja promieniowania optycznego, PWN W-wa 1997</td></tr>
<tr><td>Supplementary literature</td><td>1. Szczeniowski Sz., Fizyka doświadczalna, cz. I i IV, PWN W-wa 1983</td></tr>
<tr><td>eResources addresses</td><td>Adresy na platformie eNauczanie:</td></tr>
</table>
</td></tr>
<tr><td>Example issues/ example questions/ tasks being completed</td><td>1. Simple gravity pendulum

2. Harmonic oscylator

3. Fermat’s principle</td></tr>
<tr><td>Work placement</td><td>Not applicable</td></tr>
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