AGH UNIVERSITY OF SCIENCE AND TECHNOLOGY

Module name: Physics

Academic year: 2013/2014 Code: RMS-1-201-s ECTS credits: 12

Faculty of: Mechanical Engineering and Robotics

Field of study: Mechatronics with English as instruction languagege Specialty: —

Study level: First-cycle studies Form and type of study: Full-time studies

Lecture language: English Profile of education: Academic (A) Semester: 2

Course homepage: http://fatcat.ftj.agh.edu.pl/~woloszyn/phys/

Responsible teacher: dr hab. inż. Wołoszyn Maciej (woloszyn@newton.fis.agh.edu.pl)

Academic teachers: dr hab. inż. Wołoszyn Maciej (woloszyn@newton.fis.agh.edu.pl)
dr hab. inż. Spisak Bartłomiej (spisak@novell.ftj.agh.edu.pl)
mgr inż. Dwużnik Michał (michal.dwuznik@fis.agh.edu.pl)

Description of learning outcomes for module

MLO code	Student after module completion has the knowledge/ knows how to/is able to	Connections with FLO	Method of learning outcomes verification (form of completion)
Social competence			
M_K001	Student is able to accomplish projects and team tasks, and to collaborate in the group carrying out her/his part of the job.	MS1A_K04, MS1A_K05	Report, Execution of laboratory classes, Involvement in teamwork
M_K002	Student understands the need for continuous updating and expanding the knowledge of modern physics.	MS1A_K01, MS1A_K07	Participation in a discussion
Skills			
M_U001	Student is able to use known principles and methods of physics and the appropriate mathematical tools to solve typical problems concerning mechanics, oscillations, waves, thermodynamics, electricity and magnetism, optics and the basics of quantum mechanics.	MS1A_U01, MS1A_U06	Activity during classes, Examination, Test

M_U002	Student is able to perform basic physical measurements, analyse and present their results. In particular, student can build a simple system based on standard measuring devices, in accordance with the specification, can determine the uncertainty of measurement results (direct and indirect), is able to assess the credibility of measurement results and interpret them in the context of physics knowledge.	MS1A_U01, MS1A_U02, MS1A_U09, MS1A_U03	Report, Execution of laboratory classes
Knowledge			
M_W001	Student has a basic knowledge about the principles of classical and modern physics, physical quantities, fundamental interactions in nature, solid state physics, and applications of new materials in technology.	MS1A_W02	Activity during classes, Examination, Test, Report, Participation in a discussion, Execution of laboratory classes
M_W002	Student has a well-ordered knowledge about the mechanics of particles and rigid bodies, oscillations and waves, the basics of thermodynamics, electromagnetism, optics, wave and photon theory of electromagnetic radiation, and foundations of quantum mechanics.	MS1A_W02	Activity during classes, Examination, Test, Report, Execution of laboratory classes
M_W003	Student has a knowledge about performing measurements of physical quantities and analysing the results, possible measurement uncertainties and how to determine them.	MS1A_W07	Report, Execution of laboratory classes

FLO matrix in relation to forms of classes

MLO code	Student after module completion has the knowledge/ knows how to/is able to	Form of classes										
		Lectures	Auditorium classes	Laboratory classes	Project classes	Conversation seminar	Seminar classes	Practical classes	Others	Fieldwork classes	Workshops	E-learning
Social competence												
M_K001	Student is able to accomplish projects and team tasks, and to collaborate in the group carrying out her/his part of the job.	-	-	+	-	-	-	-	-	-	-	-
M_K002	Student understands the need for continuous updating and expanding the knowledge of modern physics.	+	+	+	-	-	-	-	-	-	-	-

Skills												
M_U001	Student is able to use known principles and methods of physics and the appropriate mathematical tools to solve typical problems concerning mechanics, oscillations, waves, thermodynamics, electricity and magnetism, optics and the basics of quantum mechanics.	+	+	-	-	-	-	-	-	-	-	-
M_U002	Student is able to perform basic physical measurements, analyse and present their results. In particular, student can build a simple system based on standard measuring devices, in accordance with the specification, can determine the uncertainty of measurement results (direct and indirect), is able to assess the credibility of measurement results and interpret them in the context of physics knowledge.	+	+	+	-	-	-	-	-	-	-	-
Knowledge												
M_W001	Student has a basic knowledge about the principles of classical and modern physics, physical quantities, fundamental interactions in nature, solid state physics, and applications of new materials in technology.	+	+	+	-	-	-	-	-	-	-	-
M_W002	Student has a well-ordered knowledge about the mechanics of particles and rigid bodies, oscillations and waves, the basics of thermodynamics, electromagnetism, optics, wave and photon theory of electromagnetic radiation, and foundations of quantum mechanics.	+	+	+	-	-	-	-	-	-	-	-
M_W003	Student has a knowledge about performing measurements of physical quantities and analysing the results, possible measurement uncertainties and how to determine them.	-	-	+	-	-	-	-	-	-	-	-

Module content

Lectures

1 Vectors: components of vectors, sum of vectors, scalar product, vector product.

2 One-dimensional motion: velocity, instantaneous velocity, average velocity, acceleration, instantaneous acceleration, motion with constant acceleration.
3 Motion in two dimensions: projectile motion, uniform circular motion, motion in a curved path.
4 Dynamics: mass, momentum, force, Newton’s laws of motion, contact force, friction, inertia.
5 Gravity: Newton’s law of gravitation, Kepler’s laws and the motion of planets, weight, inertial and gravitational mass, gravitational field, fields associated with forces.
6 Work and energy: work done by constant forces, work done varying forces, kinetic energy, power.
7 Conservation of energy, conservative and non-conservative forces, potential energy, potential energy and potential of the gravitational field.
8 Conservation of momentum, centre of mass, centre-of-mass motion, momentum of a system of particles.
9 Collisions: one-dimensional collisions, collision in a plane,
10 Rotation: angular kinematics and dynamics of particles, angular momentum, conservation of angular momentum, rigid body and moment of inertia, parallel-axis theorem, moment-of-inertia calculations, combined translation and rotation.
11 Oscillation: harmonic force, free oscillations, simple pendulum, physical pendulum, energy in simple harmonic motion, damped harmonic oscillator, driven harmonic oscillator, resonance, equation of damped harmonic motion, amplitude and phase of driven oscillations.
12 Mechanical waves: types of waves, propagation of waves in space, group velocity, wave equation, energy transfer by waves, wave interference, standing waves, beats, amplitude modulation, the Doppler effect.
13 Fluid mechanics: pressure and density, Pascal’s law, Archimedes’ principle, general description of fluid flow, Bernoulli’s equation, dynamic lift force.
14 Kinetic theory of gases: ideal gas pressure, temperature, ideal-gas equation of state, zeroth law of thermodynamics, kinetic interpretation of temperature, rotational and vibrational degrees of freedom of hydrogen molecules, Poisson’s equation for the adiabatic process, measuring temperature, temperature scales, equipartition of energy.
15 Thermodynamics: the first law of thermodynamics, specific heat, specific heat at constant volume, specific heat at constant pressure, isothermal and adiabatic expansion, the mean free path, the Maxwell-Boltzmann distribution, van der Waals equation, reversible and irreversible processes, Carnot cycle, efficiency of a Carnot engine, thermodynamic temperature scale, entropy, entropy and disorder, equilibrium state, transport phenomena.
16 Electric field: electric charge, charge quantization, Coulomb’s law, superposition principle.
17 Gauss’s Law: electric flux, applications of Gauss’s law (long thin wire, uniformly charged conducting sphere, uniformly charged insulating sphere, infinite plane sheet of charge).
18 Electric potential: potential energy in the electric field, electric potential, calculating electric potential.
19 Capacitors and dielectrics: capacitance, electric-field energy, capacitor with dielectric, calculating capacitance, capacitors in series and parallel.
20 Electric current: Ohm’s law, derivation of Ohm’s law, energy and power in circuits, heat dissipation, circuits and electromotive force, Ohm’s law for a complete circuit, Kirchhoff’s rules, R-C circuits.
21 Magnetic field: magnetic field lines, direction of the magnetic field, motion of

charges in magnetic field, cyclotron, magnetic force on a current-carrying conductor, magnetic force and torque on a current loop, magnetic dipole moment, the Hall effect.
22 Sources of magnetic field: magnetic field of a current-carrying conductor, Ampere's law, examples (straight conductor, solenoid), interaction of parallel current-carrying conductors, the law of Biot and Savart (with examples).
23 Electromagnetic induction: Faraday's law, Lenz's law, inductance, transformers, self-inductance, magnetic-field energy, R-L circuits.
24 Electromagnetic oscillations: oscillations in L-C circuits, R-L-C series circuits, impedance of R-L-C series, resonance, power in AC circuits.
25 Maxwell's equations: Gauss' law for magnetic field, induced electric and magnetic fields.
26 Electromagnetic waves: electromagnetic spectrum, wave equation, propagation of electromagnetic waves, Poynting vector.
27 Geometric optics: reflection and refraction, index of refraction, dispersion of light, Fermat's principle, law of reflection, law of refraction, optical devices (lenses, magnifier, microscope, telescope), the conditions of applicability of geometric optics.
28 Wave Optics: Huygens's principle, interference, Young's experiment, coherence of light waves, interference in thin films, interference of waves from many sources, polarization.
29 Diffraction: single-slit diffraction, light intensity in the diffraction pattern, interference and diffraction at two slits, diffraction grating, diffraction of X-rays, Bragg condition.
30 Light and quantum physics: thermal radiation, black body, classical theory of radiation, Planck radiation law, the photoelectric effect, Einstein's quantum theory of the photoelectric effect, Compton scattering.
31 Relativity: Galilean coordinate transformation, Lorentz transformations, special theory of relativity.
32 The Bohr model: atomic spectra, the Bohr model of hydrogen atom, energy levels, the hydrogen spectrum.
33 Waves and particles: de Broglie waves, structure of atoms and matter waves.
34 Elements of quantum mechanics: wave functions, uncertainty principle, Schrödinger equation, quantum-mechanical description of the hydrogen atom and energy levels.
35 Basic semiconductor devices: diode, transistor.

Auditorium classes

Solutions of problems corresponding to the lectures are discussed during the classes. Assessment on the basis of written tests, activity and preparation for the classes.

Laboratory classes

A set of about 5-7 exercises is realized during the laboratories. For each activity, a report analyzing the results of measurements is prepared.
Examples of exercises:
- Estimation of uncertainty in laboratory measurements
- Physical pendulum
- Free-fall
- Young's modulus
- Interference of acoustic waves
- Resistance thermometer and thermocouple
- Wheatstone bridge
- Capacitors (dielectric permittivity)
- Electrolysis

- Tangent galvanometer
- Refractive index for solids
- Semiconductor p-n junction

Method of calculating the final grade

[final grade] = 0.4 [exam] + 0.4 [classes] + 0.2 [labs]
where:
[exam] is the average result (in %) obtained during all exams taken,
[classes] is the number of points (in %) collected during the classes, not later than during the last classes in the semester,
[labs] is the number of points (in %) collected during the laboratories.
Positive final grade is awarded only when positive results of all the activities (classes, labs and exam) were obtained.

Prerequisites and additional requirements

Basic knowledge of undergraduate mathematical analysis is assumed.

Recommended literature and teaching resources

1 Young H D, Freedman R A, University Physics
2 Halliday D, Resnick R, Walker J, Fundamentals of Physics
3 Serway R A, Jewett J W, Physics for Scientists and Engineers
4 Feynman R P, Leighton R B, Sands M L, The Feynman Lectures on Physics
5 Orear J, Physics
6 HyperPhysics, http://hyperphysics.phy-astr.gsu.edu/hbase/hframe.html, Georgia State University

Scientific publications of module course instructors related to the topic of the module

Additional scientific publications not specified

Additional information

• Absences :
Classes: All students are required to attend tutorial classes (attendance will be noted). It is impossible to pass the classes if attendance is below 80% (without excuse). In case of absences not exceeding the allowed 20%, it is required to independently study on the missed parts of material. If the absences were excused, there will be a possibility to collect points lost during the missed tests or midterm exams, but not later than during the last week of the classes.
Labs: At the end of the semester, an additional possibility of making measurements that were not done due to excused absences, will be announced (at least 2 weeks earlier). Details on http://www.fis.agh.edu.pl/~pracownia_fizyczna/
• Pass / Fail Policy :
Classes: Based on the points collected during the classes. If below 50%, two more possibilities of passing the classes will be provided at the end of semester. Please note, that it is impossible to pass the classes if attendance is below 80% (without excuse).
Labs: Details on http://www.fis.agh.edu.pl/~pracownia_fizyczna/
• Exams:
To attend the exam it is necessary to pass both the classes and the laboratories.
• For detailed information see http://fatcat.ftj.agh.edu.pl/~woloszyn/phys/

Student workload (ECTS credits balance)

Student activity form	Student workload
Examination or Final test	2 h
Participation in lectures	60 h
Participation in auditorium classes	45 h
Participation in laboratory classes	15 h
Preparation for classes	105 h
Realization of independently performed tasks	120 h
Summary student workload	347 h
Module ECTS credits	12 ECTS