COURSE UNIT DESCRIPTION

Course unit title	Code
Electricity and magnetism	

Annotation
Electricity and magnetism is third course on classical physics. The course is dedicated for understand electrical and magnetic phenomena. Electric and magnetic forces and fields are introduced. The electromagnetic laws are described using calculus, and are summarized by Maxwell equations in the end of the course. The strong focus during the course is on performing laboratory works and problems solving.

Lecturer(s)	Department, Faculty
Coordinating: dr. Tadas Malinauskas	Faculty of Physics

Study cycle	Type of the course unit
Bachelor	Mandatory

Mode of delivery	Semester or period when it is delivered	Language of instruction
Auditory and remote teaching	Spring semester	English

Requisites	
Prerequisites: Classical mechanics; Classical Thermodynamics.	**Co-requisites (if relevant):** None

Number of ECTS credits allocated	Student's workload (total)	Contact hours	Individual work
10	260	128	132

Purpose of the course unit: programme competences to be developed		
The aim of course is to enable students deeply and accurately understand the concepts and laws of electricity and magnetism as a connected whole and part of general physics, to develop the ability to analyze and describe physical phenomena, to solve physical problems. To improve computer literacy by solving physical problems.		
Learning outcomes of the course unit	**Teaching and learning methods**	**Assessment methods**
Deep and precise understanding and knowledge of the concepts and laws of electricity and magnetism.	Lectures, seminars, homework, problem solving, laboratory works	Homework, midterm and finals exams
Ability to apply analytical and numerical methods to solve problems of electromagnetism.	Seminars, homework, problem solving	Homework, exams, and laboratory works.
Ability to address phisical problems critically, identifying the laws and concepts that apply in a specific situation,	Seminars, homework, problem solving.	Homework, midterm and finals exams.
Ability to use various sources of information for studing electromagnetism phenomena.	Lectures, seminars, homework, problem solving, laboratory works	Lectures, seminars, homework, problem solving, laboratory works
Ability to work with electronic devices, choose measurement methods, interpret experimental results	Laboratory works	Laboratory works

Course content: breakdown of the topics	Contact hours							Individual work: time and assignments	
	Lectures	Tutorials	Seminars	Workshops	Laboratory work	Internship/work placement	**Contact hours, total**	**Individual work**	**Assignments**
1. **Electric charge**. Coulomb's law. Electrostatic induction. Quantization and conservation of a charge.	2		1	2	3		**8**	**8**	Halliday 21 ch.
2. **Electric field**. Electric field lines. Electric field due to point, line and surface charge. Electric dipole.	2			2	3		**8**	**8**	Halliday 22 ch.
3. **Gauss' law**. Application of Gauss' law for various symmetries. Charged conductor.	2		1	2	3		**8**	**8**	Halliday 23 ch.
4. **Electric potential**. Electrostatic potential energy. Work done in electric field. Link between electric potential and electric field. Linear particle accelerators.	2		1	2	3		**8**	**8**	Halliday 24 ch.
5. **Capacitance.** Capacitors. Energy of electric field. Dielectrics. Microscopic view of dielectrics. Bound and free charges. Polar and nonpolar dielectrics. Feroelectrics. Piezoelectrics.	2		1	2	3		**8**	**8**	Halliday 25 ch. Matvejevas 26 ch.
6. **Electric current and resistance**. Specific conductivity and resistivity. Microscopic view of Ohm's law. Drude's model. Current in metals.	2		1	2	3		**8**	**8**	Halliday 26 ch. Matvejevas 185-204 p. Rinkevičius 81-96, 103-124 p.
7. **Electric current in different materials**. Energy band structure. Electric current in semiconductors. Electric current in liquids. Various discharges in gasses. Superconductors.	2		1	2	3		**8**	**10**	Halliday 26 ch. Halliday 41 ch.
8. **Circuits of direct current**. Electromotive force. Li–ion batteries. Kirchhof's rules. Energy and power of electric current. RC circuits.	2		2	2	3		**8**	**8**	Halliday 27 ch.
9. **Magnetic field**. Gauss' law for magnetic field. Lorentz force. Magnetic Force on a Current-Carrying Wire Current loop in a magnetic field. Magnetic dipole.	2		1	2	3		**8**	**8**	Halliday 28 ch.
10. **A point charge in magnetic and electric field**. Cyclotrons and synchrotrons. Bubbler chamber. Mass spectrometer. Hall's effect.	2		1	2	3		**8**	**8**	Halliday 28 ch.
11. **Magnetic field due to currents.** The law of Biot and Savart. Ampere's force. Ampere's law. Magnetic field due to straight wire, current loop, solenoid.	2		1	2	3		**8**	**8**	Halliday 29 ch.
12. **Electromagnetic induction**. Faradays's law. Lenz's law. Circular electric field and induced emf.	2		2	4	3		**8**	**8**	Halliday 30 ch.
13. **Applications of Faraday's law.** Electricity generator. Eddy currents. Displacement current. Maxwell's equations.	2				3		**8**	**8**	Halliday 30 ch.
14. **Magnetic field in materials.** Diamagnetics. Paramagnetics. Feromagnetics. Maxwell's equations in material. **Inductors and inductance**. RL circuits. Energy of magnetic field.	2		1	2	3		**8**	**8**	Halliday 32 ch. Matvejevas 239-254 p.

15. **Alternating current**. LC oscillations. Dramped and forced oscillations. LRC circuits. Transformers. Current and voltage resonances.	2		1	2	3		**8**	**8**	Halliday 31 ch. Rinkevičius 196-222 p.
16. **Electromagnetic oscillations and waves**. Wave equation. Energy transport. Applications of different electromagnetic waves.	2		1	2	3		**8**	**10**	Halliday 33 ch.
Total	**32**		**16**	**32**	**48**		**128**	**132**	

Assessment strategy	Weight %	Deadline	Assessment criteria
Midterm exam	13	After Electricity part of the course is finished (8 Lectures)	Theoretical knowledge and ability to apply the laws of **electricity** is assessed. During midterm exam around 20 short questions and problems are given. Maximum score – 13 points.
Midterm exam	13	Midterm after 14 lectures is finished.	Theoretical knowledge and ability to apply the laws of **magnetism** is assessed. During midterm exam around 20 short questions and problems are given. Maximum score – 13 points.
Final exam	20	Final exam during exam session	Theoretical knowledge and ability to apply the laws of **electromagnetism** is assessed. During final exam around 20 short questions and problems are given. Maximum score – 20 points.
Homeworks (problem solving).	24	All semester	About 30 problems have to be solved at home during the semester. One problems is worth about 1 point. It is possibility to collect 27 points (up to 3 extra points).
Laboratory works.	30	All semester	It is obligatory to finish all appointed laboratory works. Maximum score – 30 points.

Author	Publishing year	Title	Issue of a periodical or volume of a publication; pages	Publishing house or internet site
Required reading				
Main book. *D. Halliday, R. Resnick, J. Walker* (*Halliday*).	2007	*Fundamentals of Physics. Extended version.* 9th edition.	*Chapters* 21-33	*John Willey & Sons.*
A.Matvejevas (*Matvejevas*).	1991	Elektra ir magnetizmas.		Vilnius, Mokslas
V. Rinkevičius (Rinkevičius)	2004	Elektra ir magnetizmas		Vilniaus universiteto leidykla
Recommended reading				
R.P. Feynman, R.B. Leighton, M. Sounds	2011	*The Feynman Lectures on Physics*		*Basic Books*
D. C. Giancoli	2000	*Physics for Scientists & Engineers. Third Edition.*		*Prentice Hall*