COURSE UNIT DESCRIPTION

Course unit title	Code
Renewable energy solutions	

Lecturer(s)	Department where the course unit is delivered
Coordinator: prof. Vincas Tamošiūnas **Other(s): dr. Linas Minkevičius,** **dr. Algirdas Novičkovas**	Faculty of Physics

Study cycle	Type of the course unit (module)
Master studies	Mandatory

Mode of delivery	Period when the course unit (module) is delivered	Language(s) of instruction
Lectures, seminars, laboratory works	Autumn Semester	English

Requirements for students	
Prerequisites: Mechanics, Thermodynamics, Electricity and Magnetism, or similar general physics courses.	**Additional requirements (if any):** -

Course (module) volume in credits	Total student's workload	Contact hours	Self-study hours
5	140	64	76

Purpose of the course unit (module): program competences to be developed
To provide knowledge about renewable energy sources, related technologies and ability to: apply theoretical knowledge for the critical evaluation of applicability of various renewable energy technologies and devices; efficiently analyze information in literature sources; explain the operation principles and efficiency limits of machinery for renewable power generation.

Learning outcomes of the course unit (module)	Teaching and learning methods	Assessment methods
Ability of the student to apply theoretical knowledge to understand the causes of the problems and solution possibilities.	Laboratory works	Control questions, evaluation of results, reports, and conclusions.
Ability to find, understand, and apply modern knowledge presented in literature sources; ability to exchange information and present results.	Seminars	Evaluation of presentation quality, ability to answer related questions and to summarize information in a short written paper.
Acquisition of theory knowledge required for solution of practical problems; ability to understand the literature sources, to exchange information and to present results; ability to understand, interpret and apply knowledge in renewable energy field; acquisition of knowledge required for understanding the operating principles of devices.	Lectures	Multiple choice test, exam in written form.

Content: breakdown of the topics	Contact hours							Self-study work: time and assignments	
	Lectures	Tutorials	Seminars	Exercises	Laboratory work	Internship/work [illegible]	**Contact hours**	**Self-study hours**	**Assignments**
1. **Introduction.** Trends in global energy production, share of renewable energy sources, estimates of total renewable energy resources available.	2						**2**	**2**	Repetition for the exam.
2. **Photovoltaics.** Principles of solar cell operation, main properties of crystalline silicon and thin film solar cells. Production of solar cells. Research and market trends.	6						**6**	**6**	Repetition for the exam.
3. **Modules and arrays.** Production sequence, materials, circuits, mismatch effects. Typical warranties, testing, and safety.	2						**2**	**2**	Repetition for the exam.
4. **Power conversion.** Basic circuits for AC/DC and DC/AC conversion and their elements. PWM applications. Cost share of BOS components. Autonomous and grid-connected installations.	2						**2**	**2**	Repetition for the exam.
5. **Wind energy.** Model of an ideal wind energy converter. Power dependence on wind velocity. Types of turbines. Rotation speed management.	4						**4**	**4**	Repetition for the exam.
6. **Hydro energy.** Types of power stations; equipment; types of turbines and their application limits; energy conversion chain and losses.	3						**3**	**3**	Repetition for the exam.
7. **Geothermal energy.** Near-surface geothermal energy and energy from ambient air. Heat pumps and system components, heating capacity requirements. Deep geothermal energy for electricity production and heating, geothermal resources.	4						**4**	**4**	Repetition for the exam.
8. **Bioenergy.** Biomass conversion technologies. Use of wood, plants, waste, and landfill gases.	3						**3**	**3**	Repetition for the exam.
9. **Smart grids and energy storage.** Energy and data transfer in smart grids. Requirements for monitoring and control. Sensors and other electronics components in smart grids. Hydrogen production for energy storage and operation of fuel cells. Batteries technologies.	4						**4**	**4**	Repetition for the exam.
10. **Value and cost of renewable energy.** Correlation between production and use, investment delay possibilities. Feed-in tariff and other means of support. Long-term trends in renewable energy costs. Material supply issues in meeting the “Terawatt challenge”.	2						**2**	**2**	Repetition for the exam.
Seminars: Analysis of review articles on renewable energy applications.			16				**16**	**20**	Analysis of the literature on the given topic, preparation of presentation and short report.
Laboratory works: • Current-voltage curves of solar cells and influence of their mismatch.					16		**16**	**24**	Preparation for laboratory work, writing of reports.

• Investigation of the inverter circuit. • Investigation of the DC-DC converter. • Investigation of water electrolysis; investigation of the fuel cell. • Application of PWM modulation for high-efficiency inverter (PC-based simulation).									
Total	**32**		**16**		**16**		**64**	**76**	

Assessment strategy	**Weight,%**	**Deadline**	**Assessment criteria**
Laboratory work rating	20*	All course	Preparation to answer theoretical questions, quantity of errors in circuit connection, the quality of the work description, ability to describe the results. Evaluation in 10 scores system, the final score is multiplied by the weight coefficient. * It is obligatory to finish and defend all laboratory works.
Seminars rating	20	All course	Ability to understand and accomplish tasks during seminars
Test	20	At the end of the course	10 questions with multiple answer choices. Correct choice adds 1 point, incorrect choice subtracts 1 point. It is possible to skip the question. The final score is multiplied by the weight coefficient.
Exam (written form)	40	During the exam session	4 open-ended questions. Assessment of answer particularity, consistency, and mistakes.

Author	**Year of publication**	**Title**	**Issue of a periodical or volume of a publication**	**Publishing place and house or web link**
Compulsory reading				
B. K. Hodge	2017	Alternative Energy Systems and Applications, 2nd edition		Hoboken [N.J]: John Wiley & Sons (e-book is available within VU network, 1st paper edition available in the VU library: 620.9/Ho37).
M. Kaltschmitt, W. Streicher, A. Wiese	2007	Renewable Energy - Technology, Economics, and Environment		Berlin; Heidelberg : Springer (available in the VU library: 620.9/Ka235).
Optional reading				
S. Bowden, C. Honsberg	-	Photovoltaic Education Network - PVCDROM		www.pveducation.org