COURSE UNIT (MODULE) DESCRIPTION

Course unit (module) title	Code
Solar energy and photovoltaics	

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

Study cycle	Type of the course unit (module)
First (bachelor studies)	Compulsory

Mode of delivery	Period when the course unit (module) is delivered	Language(s) of instruction
Lectures, seminars, laboratory works	V (autumn) semester	Lithuanian/English

Requirements for students	
Prerequisites: "Electricity and Magnetism", "Applied Electronics I" or similar general physics and electronics courses.	**Additional requirements (if any):**

Course (module) volume in credits	Total student's workload	Contact hours	Self-study hours
5	133	64	69

Purpose of the course unit (module): programme competences to be developed		
To provide knowledge of Solar energy, photovoltaics and ability to: apply theoretical knowledge in practice for scientific investigations or/and planning and implementation of solar power installations; efficiently analyse information in literature sources about solar energy and related devices, by applying semiconductor physics, general physics and optics knowledge.		
Learning outcomes of the course unit (module)	**Teaching and learning methods**	**Assessment methods**
Ability of the student to apply theoretical knowledge for the investigation of properties of devices used for solar energy harvesting; ability to understand the causes of the problems and solution possibilities (1.1, 5.1)	Laboratory works	Control questions, evaluation of ability to perform measurements self-sufficiently, 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 (1.3, 2.3, 3.1, 3.2)	Seminars	Evaluation of presentation quality, abilities to answer related questions and to summarize information in a short written paper.
Acquisition of theory knowledge required for solution of practical problems in solar energy field; ability to understand the literature about solar energy, to exchange information and to present results; ability to understand, interpret and apply knowledge related to solar energy; acquisition of knowledge required for understanding the operating principles of devices	Lectures	Multiple choice test, exam in written form.

and systems for solar energy harvesting (2.1, 2.2, 3.2)		

Content: breakdown of the topics	Contact hours							Self-study work: time and assignments	
	Lectures	Tutorials	Seminars	Exercises	Laboratory work	Internship/work placement	**Contact hours**	**Self-study hours**	**Assignments**
1. **Introduction.** Sun as energy source. Solar energy use in Lithuanian and the World.	2						**2**	**2**	Repetition for exam.
2. **Passive solar applications.** Principles, solutions, Solar and Trombe walls, solar spaces.	2						**2**	**2**	Repetition for exam.
3. **Solar thermal applications.** Operation principles, types and construction of solar collectors. System components. Solar thermal power plants and energy accumulation solutions.	4						**4**	**4**	Repetition for exam.
4. **Photovoltaics.** Principles of solar cell operation, main properties of crystalline silicon and thin film solar cells. Research and market trends.	6						**6**	**6**	Repetition for exam.
5. **Modules and arrays.** Production sequence, materials, circuits, mismatch effects. Typical warranties, testing and safety.	4						**4**	**4**	Repetition for exam.
6. **Inverters and other BOS components.** Basic circuits for DC to AC conversion and their elements. PWM applications. Cost share of BOS components. Autonomous and grid-connected installations.	6						**6**	**6**	Repetition for exam.
7. **Solar energy in smart grids.** 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 fuel cells.	4						**4**	**4**	Repetition for exam.
8. **Value and cost of solar energy.** Correlation between production and use, investment delay possibilities. Feed-in tariff and other means of support. Long term trends of module prices. Material supply issues in meeting the "Terawatt challenge".	4						**4**	**4**	Repetition for exam.
Seminars: • analysis of review articles about solar energy; • solar concentrators; • tracking systems; • building integrated photovoltaics; • 3-rd generation solar cells; • characterization methods for solar cells; • HVDC networks for long distance solar energy transmission.			16				**16**	**13**	Analysis of the literature on the given topic, preparation of the presentation and short report.
Laboratory works (4 from the listed ones): • Current-voltage curves of solar cells and influence of their mismatch. • Investigation of the inverter circuit. • Investigation of the DC-DC converter.					16		**16**	**24**	Preparation for laboratory works, writing of reports.

• Application of PWM modulation for high efficiency inverter (PC-based simulation). • Energy storage in hydrogen: investigation of electrolysis and PEC fuel cell efficiency.									
Total	**32**		**16**		**16**		**64**	**69**	

Assessment strategy	**Weigh t,%**	**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 the tasks during the seminars
Test	20	In the end of course	10 questions with multiple answer choices. Correct choice adds 1 point, incorrect choice subtracts 1 point. It is possible not to answer the question. Final score is multiplied by the weight coefficient.
Exam (written form)	40	During the exam session	4 open questions. Assessment of answer particularity, consistency and mistakes.

Author	**Year of public ation**	**Title**	**Issue of a periodical or volume of a publication**	**Publishing place and house or web link**
Compulsary reading				
B. K. Hodge	2010	Alternative Energy Systems and Applications		John Wiley & Sons (Copy available at VU library).
M .Kaltschmitt, W. Streicher, A. Wiese	2007	Renewable Energy - Technology, Economics and Environment		Springer (e-book available from VU network).
S. Bowden, C. Honsberg	-	Photovoltaic Education Network - PVCDROM		www.pveducation.org/pvcdrom
Optional reading				
A. Luque, S. Hegedus (Editors)	2010	Handbook of Photovoltaic Science and Engineering, 2nd Edition		John Wiley and sons