

Study program: Mechanical engineering				
Type and level of studies: Bachelor studies				
Course unit: Renewable Energy Sources				
Teacher in charge: Rade Karamarković				
Assistant: Đorđe Novčić				
Language of instruction: English				
ECTS: 6				
Prerequisites: basic knowledge of physics and/or thermodynamics				
Semester: Summer semester				
Course unit objective: To teach students about the basic characteristics of renewable energy sources and the ways to use them. In addition, to train them to design systems that use solar thermal energy and low-temperature shallow depth geothermal heat.				
Learning outcomes of the course unit Students acquainted with the potentials and possibilities of using renewable energy sources, and technologies for their use and trained to design and test systems for the use of solar thermal energy for space and process heating as well as to use low-temperature shallow-depth geothermal energy directly or by the use of heat pumps for heating and cooling purposes.				
Course unit contents <i>Theoretical classes</i> Potentials for the use of renewable energy sources: energetic, economic, and environmental impacts. The concept of sustainable development. Geothermal energy: high, medium, and low enthalpies. Heat and cold storage. Geothermal heat pumps: thermodynamic basics of refrigeration cycles, types of heat pumps (compressor, absorption, adsorption, and sound), types of working fluids, and design of systems with heat pumps for space heating and cooling. Solar energy: characteristics and geometry of solar radiation. Types of solar collectors for air and water heating. Testing of solar receivers. Solar energy systems. Design of solar systems for heating domestic hot water. PV systems. Biomass energy: the usage for the production of heat and/or electricity and other biofuels. Biogas. The basics of small hydropower plants. Wind energy: advances and drawbacks. Other renewable sources. <i>Practical classes</i> Numerical examples for all areas covered in the theoretical classes. The accent is on designing solar thermal systems and the system for the usage of low-temperature shallow-depth geothermal heat. Laboratory testing of simple air heating receivers made by students. Preparation and presentation of seminar papers. Developing two project tasks.				
Literature 1. Karamarković R. Novčić Đ. Internal lectures in the form of video presentations on the subject of Renewable Energy. 2. Karamarković R. Solved problems in renewable energy. Faculty of Mechanical and Civil Engineering in Kraljevo, Kraljevo 2016. 3. Scientific journals: Renewable energy, Renewable and sustainable energy reviews.				
Number of active teaching hours				Other classes
Lectures: 30	Practice: 30	Other forms of classes:	Independent work:	Laboratory exercises 5 Field visits 10
Teaching methods Practical teaching in the form of theoretical lectures and auditory exercises with computational examples, review of project assignments, presentations of seminar papers, and testing of solar thermal collectors.				
Examination methods (maximum 100 points)				
Exam prerequisites	No. of points:	Final exam	No. of points:	
Student's activity during lectures	5	oral examination	30	
practical classes/tests	10	written examination		
Seminars/Homework		Laboratory exercises	5	

Projects	50		
Other			
Grading system			
Grade	No. of points	Description	
10	95-100	Excellent	
9	85-94	Exceptionally good	
8	75-84	Very good	
7	65-74	Good	
6	55-64	Passing	
5	Less than 55	Failing	