

<b>Study program:</b> Mechanical engineering				
<b>Type and level of studies:</b> Bachelor studies				
<b>Course unit:</b> Alternative Energy Sources				
<b>Teacher in charge:</b> Prof. Dr Rade Karamarković				
<b>Assistant:</b> Đorđe Novčić				
<b>Language of instruction:</b> English				
<b>ECTS:</b> 6				
<b>Prerequisites:</b> basic knowledge of physics and/or thermodynamics				
<b>Semester:</b> Summer semester				
<b>Course unit objective:</b> To teach students the basic characteristics of renewable energy sources and the ways to use them, and to train them to design systems that use solar thermal energy and low-temperature, shallow-depth geothermal heat.				
<b>Learning outcomes of the course unit</b> Students will gain the skills to assess the feasibility of renewable energy technologies and to design, test, and implement systems for solar thermal and shallow-depth geothermal energy applications in heating and cooling.				
<b>Course unit contents</b> <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.				
<b>Literature</b> 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.				
<b>Number of active teaching hours</b>				<b>Other classes</b>
Lectures: 30	Practice: 30	Other forms of classes:	Independent work:	Laboratory exercises 5 Field visits 10
<b>Teaching methods</b> 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.				
<b>Examination methods ( maximum 100 points)</b>				
<b>Exam prerequisites</b>	<b>No. of points:</b>	<b>Final exam</b>	<b>No. of points:</b>	
Student's activity during lectures	5	oral examination	30	
practical classes/tests	10	written examination		
Seminars/Homework		Laboratory exercises	5	
Projects	50			
Other				

<b>Grading system</b>		
<b>Grade</b>	<b>No. of points</b>	<b>Description</b>
<b>10</b>	<b>91-100</b>	Excellent
<b>9</b>	<b>81-90</b>	Exceptionally good
<b>8</b>	<b>71-80</b>	Very good
<b>7</b>	<b>61-70</b>	Good
<b>6</b>	<b>51-60</b>	Passing
<b>5</b>	<b>Less than 51</b>	Failing