Specification for the book of courses

Study program	Electronics and Microsystems		
Module	Electronics and Microsystems		
Type and level of studies	Master studies		
The name of the course	Solar Technologies and Devices		
Lecturer (for lectures)	Pantić S. Dragan, Mančić D. Dragan		
Lecturer/associate (for exercises)	Aleksić M. Sanja		
Lecturer/associate (for OFE)	Aleksić M. Sanja		
Number of ECTS	5	**Course status (obligatory/elective)**	Elective
Prerequisites	No		
Course objectives	The objective of the course is to give students detailed knowledge of the technologies used for the production of solar cells, types of solar cells, electrical characteristics, as well as methods of optimal design of solar cells in order to maximize their efficiency. Students also get acquainted with basic elements of photovoltaic systems and their basic characteristics.		
Course outcomes	After the course, student acquired knowledge about all the most commonly used technologies for the production of solar cells, as well as about the different types of solar cells and their electrical characteristics.		
Course outline			
Theoretical teaching	Introduction. Preparation of silicon used for the production of solar cells. MG silicon, SG polysilicon and the Czochral method for the production of monocrystalline (c-Si) silicon. The process of obtaining Si wafers from the ingot. Types of solar cells: s-Si, mc-Si, thin-layer solar cells, amorphous silicon (a-Si), cadmium telluride (Cd-Te) solar cells, Cu (inGa) Se2 solar cells, organic and polymer solar cells. Commercial technology of Si solar cell production. Solar cell production process. Structures and production of highly efficient solar cells. Commercial technologies for the production of thin layer solar cells. Advantages and disadvantages of thin-layer solar cells. Materials used in production of thin-layer solar cells, thin layer deposition techniques. Reliability of characteristics and production costs. CdTe solar cells and solar cells on amorphous silicon (a-Si). Heterojunction (HIT) and CIGS solar cells. Advanced technology of new generation solar cells. Electrical characteristics of solar cells, current-voltage characteristics. Electrical parameters (open circuit voltage, short circuit current, maximum power, fill factor, efficiency), characterization of the solar cell. Simulation of the technology flow for the production and electrical characteristics of solar cells. Solar cells with concentrators. Types of concentrators, overview of CSP and CPV systems, Frensel's lenses and reflectors. Operation of solar cells in conditions of large incident radiation. Production of photovoltaic modules. Connections of solar cells, processes of encapsulation and lamination. Electrical and optical properties of the PV module. The effects of local shading and the formation of hot spots. Characterization of photovoltaic module. Types and components of photovoltaic systems. Independent, hybrid and network-connected systems. Inverters (DC / DC, DC / AC), MPPT algorithms, energy storage, batteries. Cables, connectors, monitoring equipment. Design and optimization of photovoltaic systems.		
Practical teaching (exercises, OFE, study and research work)	Simulation of the technology flow for the production and electrical characteristics of the mc-Si solar cell. Simulation of the technology flow for the production and electrical characteristics of IBC-SHJ solar cells. Simulation of the technology flow for the production and electrical characteristics of the CIGS solar cell. Simulation of the technology flow for the production and electrical characteristics of thin-layer tandem solar cells. Simulation of the technology flow for the production and electrical characteristics of organic solar cells. Measurement of the current-voltage characteristics of the illuminated and unexposed solar cells. Measurement of open circuit voltage VOC and short-circuit ISC, regular, parallel and combined solar cells. Measurement of electrical characteristics of photovoltaic modules. Configuration of a stand-alone photovoltaic system and measurement of its characteristics with I / V photovoltaic PVCHECK tester.		
Textbooks/references			
1	Photovoltaic Devices, Systems and Applications CD-ROM, C. Honsberg and S. Bowden, (free online resource)		
2	Photovoltaic Science and Engineering Handbook, Second Edition, Antonio Luque and Steven Hegedus, John Wiley and Sons, 2012.		

3	Thin film Solar Cells, Jeff Poortmans and Vladimir Arkhipov (Ed.), John Wiley and Sons Ltd. 2006.			
4	Lectures and Exercises (http://mikro.elfak.ni.ac.rs/predmeti/solarne-tehnologije-i-komponente/)			
5				
Number of classes of active education per week during semester/trimester/year				
Lectures	**Exercises**	**OFE**	**Study and research work**	**Other classes**
2	1	2		
Teaching methods	Lectures, independent studio research work, computational exercises, laboratory exercises, consultations. The lectures present the theoretical part of the material, supported by characteristic examples for easier understanding of matter. Through student research work, a student studying available literature, doing a seminar work or a team project. Practical examples of calculation and design of concrete photovoltaic systems are used in calculation exercises. Practical knowledge is acquired in laboratory exercises.			
Grade (maximum number of points 100)				
Pre-exam duties		**Points**	**Final exam**	**Points**
Activity during lectures		5	**Written exam**	25
Exercises		15	**Oral exam**	25
Colloquia		30		
Projects				