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	Design of Photovoltaic Systems		
Lecturer (for lectures)	Pantić S. Dragan, Mančić D. Dragan		
Lecturer/associate (for exercises)	Jovanović D. Igor		
Lecturer/associate (for OFE)	Jovanović D. Igor		
Number of ECTS	5	**Course status (obligatory/elective)**	Elective
Prerequisites	Basic of Photovoltaic, Solar Technologies and Devices		
Course objectives	The objectives of this course are reflected in: acquiring basic knowledge about photovoltaic (PV) systems; methods of designing and realization of electric power converters used in PV systems; methods of designing and realization of PV systems; getting acquainted with the standards of PV systems and electric power converters for PV systems; meeting the relevant economic aspects, both for autonomous (off-grid) PV systems and for grid connected PV systems.		
Course outcomes	After completion of the course, students will, based on the acquired theoretical and practical knowledge, be able to: identify different types of solar modules and components used in PV systems; determine the optimum orientation (optimum tilting angles) of PV panels in relation to the geographic position of the system; calculate the expected production of electricity PV systems; analyze different methods of monitoring maximum power; compare the different topology of the PV system; design PV systems and evaluate the costs of system implementation; follow the trends of further development of the PV system.		
Course outline			
Theoretical teaching	Types and characteristics of solar panels. Basic characteristics of topology of electric power converters and criteria for selecting the optimal topology of converters in the design of PV systems: selection of electric power converters depending on the power of the photovoltaic system, single-mode converters and inverters. Control and protection functions of the PV system: methods for monitoring the maximum power point (MPP tracker) and overall system efficiency; control of electric power converters; synchronization with network voltage and network voltage monitoring; detection of network failure, protection against overheating. Types of PV system (fixed and rotating, standalone and network connected). Estimation of the expected energy using software packages for analyzing, estimating and simulating the operation of the PV system. Calculation of the power losses of the PV system due to shading, dust accumulation and increase of the temperature of the module. Principles of design of PV system and accompanying control, protective, measuring and monitoring equipment. Connecting the PV system to the distribution network and monitoring the performance of the PV system.		
Practical teaching (exercises, OFE, study and research work)	Introduction to the Matlab / Simulink software package. Modeling the electrical characteristics of the solar cell under standard test conditions. Measurement of open circuit voltage VOC and short-circuit current ISC of regular, parallel and combined solar cells. Modeling of the MPPT algorithm: direct methods and indirect methods. Configuration of a stand-alone photovoltaic system and measurement of its characteristics I / V photovoltaic PVCHECK tester. Introduction to PVGIS and RETScreen software packages. Measuring the effect of shading on the electrical characteristics of photovoltaic modules. Viziting the realized modular rotating photovoltaic system of 5kW power. Measurement of characteristics of network-connected (grid-on) photovoltaic system 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	Applied Photovoltaic 2nd ed., S. Wenham, M. Green, et. al., ARC Centre for Advance Silicon Photovoltaics and Photons, 2007.		
4	Lectures and Exercises (http://mikro.elfak.ni.ac.rs/predmeti/projektovanje-fotonaponskih-sistema/)		
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Number of classes of active education per week during semester/trimester/year				
Lectures	**Exercises**	**OFE**	**Study and research work**	**Other classes**
2	1	1		
Teaching methods	Lectures, independent studio research work, computational exercises, laboratory exercises, consultations. Through study research, a student is studying available literature through seminar work or team project. Practical examples of calculation and design of concrete PV systems are used in calculating and laboratory exercises.			
Grade (maximum number of points 100)				
Pre-exam duties		**Points**	**Final exam**	**Points**
Activity during lectures		10	**Written exam**	20
Exercises		10	**Oral exam**	30
Colloquia				
Projects		30		