

## Specification for the book of courses

<b>Study program</b>		Electrical Engineering and Computer Science		
<b>Module</b>		Electron Devices and Microsystems		
<b>Type and level of studies</b>		Undergraduate Academic Studies		
<b>The name of the course</b>		Characterization of Electronic Devices		
<b>Lecturer (for lectures)</b>		Manić Đ. Ivica, Davidović S. Vojkan		
<b>Lecturer/associate (for exercises)</b>		Davidović S. Vojkan		
<b>Lecturer/associate (for OFE)</b>		Davidović S. Vojkan		
<b>Number of ECTS</b>		6	<b>Course status (obligatory/elective)</b>	Obligatory
<b>Prerequisites</b>				
<b>Course objectives</b>		To understand the most important techniques of characterization of electronic devices and microsystems, as well as to master the practical application of specific characterization techniques and methods for data processing and analysis.		
<b>Course outcomes</b>		Students understand the test chip concept and structure, and are capable to perform measurements accessing the devices on the wafers by means of optical microscope and probes. Students are skillful enough to use standard laboratory equipment and sockets, understand GPIB and RS232 protocols, can measure I-V characteristics and static and dynamic parameters of various electronic devices and microsystems, and are familiar with interface characterization techniques. Students have knowledge to process the data, draw the required diagrams and make the necessary calculations and parameter extraction. Students can read technical documentation and are well aware of precaution measures during measurements at high voltages.		
<b>Course outline</b>				
<b>Theoretical teaching</b>		Wafer level device characterization: the roles of probe and optical microscope; test chip concept. Electrical characterization techniques based on transfer and output I-V characteristics. Data processing and parameter extraction. Application of curve tracer and electrical parameter analyzer. Characterization of the encapsulated devices: application of test sockets. Characterization of power devices and sensors. Techniques for characterization of interfaces and electro-physical parameters: CV technique, Charge Pumping based technique, I-V techniques. Analytical characterization techniques. Detailed analysis of various device datasheets: device parameters and their meanings. GPIB and RS232 protocols. Precaution measures at measurements requiring application of high voltages.		
<b>Practical teaching (exercises, OFE, study and research work)</b>		Auditory exercises cover the areas of device electrical characterization, data analysis and parameter extraction, characterization of electrical and physical parameters, analytical techniques, and chip topography and surface analyses. Laboratory exercises include: electrical measurements on wafer level devices, manual and automatic (computer software controlled) measurements of electrical characteristics and breakdown voltages of encapsulated devices, as well as determination of static and dynamic parameters (resistance, threshold voltage, gain, transconductance) in different types of diodes, bipolar transistors, MOS transistors, thyristors, JFETs, CMOS inverters and sensor devices by means of curve tracer, parameter analyzer, C-V meter, specific source-measure units, oscilloscopes, signal generators and other source and measure units.		
<b>Textbooks/references</b>				
1	Badih El-Kareh, Richard J. Bombard, INTRODUCTION TO VLSI SILICON DEVICES - Physics, Technology and Characterization, Kluwer Academic Publishers, 2001, ISBN 978-1-4612-9404-7			
2	The Parametric Measurement Handbook, Third Ed., March 2012, Agilent Technologies.			
3	D.K. Schroder, Semiconductor material and device characterization (2nd ed.), John Willey & Sons, New York, 1998, ISBN 0-471-24139-3			
4	Sony Tektronix 370 Programmable Curve Tracer, Operations manual			
5	Printed matter – lecture texts and PowerPoint slides, problems with solutions and measurement manuals			
<b>Number of classes of active education per week during semester/trimester/year</b>				
<b>Lectures</b>	<b>Exercises</b>	<b>OFE</b>	<b>Study and research work</b>	<b>Other classes</b>
2	2	1	0	0
<b>Teaching methods</b>		Lectures, exercises, laboratory exercises, consultations		
<b>Grade (maximum number of points 100)</b>				
<b>Pre-exam duties</b>		<b>Points</b>	<b>Final exam</b>	<b>Points</b>
<b>Activity during lectures</b>		5	<b>Written exam</b>	20

<b>Exercises</b>	25	<b>Oral exam</b>	20
<b>Colloquia</b>	20		
<b>Projects</b>	10		