Specification for the book of courses

Study program	Electrical Engineering and Computer Science		
Module	Electron Devices and Microsystems		
Type and level of studies	Undergraduate Academic Studies		
The name of the course	Reliability of Microelectronic Devices		
Lecturer (for lectures)	Davidović S. Vojkan, Pešić M. Biljana		
Lecturer/associate (for exercises)	Davidović S. Vojkan		
Lecturer/associate (for OFE)	Davidović S. Vojkan		
Number of ECTS	5	**Course status (obligatory/elective)**	Elective

Prerequisites	
Course objectives	The objective of the course is to enable students to master the basic issues in the field of reliability and failure diagnostics of microelectronic devices. This implies knowledge of the basic reliability theory (failure, reliability function, distribution function, time to failure), knowledge of the causes of failures related to the device structure (substrate, oxide, metallization, package), modeling of failure mechanisms, and knowledge of failure diagnostic techniques. Also, the objective of the course is familiarization with the laboratory methods for accelerated testing (HALT, HASS, BURN-IN, thermal cycling, vibration) with existing standards (MIL-STD, IEC), and training the student to define the necessary set of appropriate tests for reliability evaluation.
Course outcomes	The student acquires the necessary theoretical and practical knowledge about the importance of testing and predicting the reliability and failure diagnostics of microelectronic devices. He is able to define a sampling plan, he understands reliability tests, is able to analyze the cause of failure in the case of standard failures, knows how to calculate the mean time time to failure of the device. The student is familiar with models for testing at elevated temperature, humidity, vibrations, electric fields, thermal cycling. The student knows about MIL-STD and IEC standards and knows how to define a set of tests according to the application of the device.
Course outline	
Theoretical teaching	Degradation and failure of microelectronic components. The failre, mechanisms, and cause of failure. Elements of reliability theory. Graphical modeling of reliability (bathtub curve). Procedures for selecting reliable components. Accelerated Reliability Testing - High Temperature, Humidity, Voltage and Mechanical Stress Testing. Prediction of reliability and fault modeling (models of reliability of discrete devices and integrated circuits). Failure physics: failures due to mass transport (termination of contact and metallization), failures due to electric charge transport (breakdown dielectrics, hot carriers, electrical stress), failures due to external effects (moisture, ionizing radiation, electrostatic discharge). Failure diagnostics, non-destructive testing (radiography, SAM microscopy, PIND testing), electrical testing, structural characterization (optical microscopy, SEM, TEM, X-spectroscopy, Auger spectroscopy). MIL-STD and IEC and standards.
Practical teaching (exercises, OFE, study and research work)	Within the auditory part of the exercise students through tasks and examples master the necessary mathematical apparatus for processing the failure rate function, the time-to-failure calculation, the calculation of sample size from the bulk party, the calculations of the acceleration factors for testing, the calculations necessary for setting the test conditions. Within the practical part of the course, students are introduced to and mastered by techniques of electrical characterization and failure diagnostics at ships on wafer level (using curve tracers, probe and optical microscope), as well as simpler techniques for opening the packages (mechanical grinding on CNC machine and chemical etching of package) and failure analysis of a lower level complexity devices, including analyzes using an electronic microscope. Students also perform Burn-in experiments at elevated temperatures.
Textbooks/references	
1	E.A. Amerasekera and D.C. Campbell, Failure Mechanisms in Semiconductor Devices, John Wiley, 1987
2	F. Jensen, Electronic Component Reliability, John Wiley, 1995
3	J. W. MsPherson, Reliability Physics and Engineering (Time-To-Failure Modeling), Springer, 2010, ISBN 978-1-4419-6347-5
4	M. Ohring, Reliability and Failure of Electronic Materials and Devices, Academic Press, 1998
5	Microelectronics Reliability, Elsevier, selected papers from the field

Number of classes of active education per week during semester/trimester/year

Lectures	Exercises	OFE	Study and research work	Other classes
2	2	1	0	0

Teaching methods	Lectures (classical method and using PowerPoint presentations), consultations, computational exercises with examples from practice, laboratory exercises (experiment with specified devices and stress of DUT to failure, housing opening - decapsulation, electrical analysis of chips, microscopy), seminar team work, homework assignments.

Grade (maximum number of points 100)			
Pre-exam duties	**Points**	**Final exam**	**Points**
Activity during lectures	10	**Written exam**	20
Exercises	20	**Oral exam**	20
Colloquia	20		
Projects	10		