ECTS catalog with learning outcomes
University of Montenegro

Faculty of Electrical Engineering / /

Course:				
Course ID	**Course status**	**Semester**	**ECTS credits**	**Lessons** (Lessons+Exercises+Laboratory)
13285	Mandatory	3	6	3+1+0

Programs	
Prerequisites	It is desirable for the student to pass the exam Basics of Electronics.
Aims	Students are introduced to methods for approximating commonly used functions in digital systems and their hardware implementations (matrix multiplication, matrix inversion, random number generation, square root calculation) on programmable chips. Additionally, students learn VHDL and ABEL programming languages for describing and analyzing the operation of digital circuits through this course.
Learning outcomes	Upon completion of the course on Selected topics in digital systems, a student who passes the subject will be able to: 1. Utilize VHDL and ABEL programming environments for hardware specification and verification. 2. Design hardware for sorting arrays in digital systems and verify functionality in the VHDL programming language. 3. Design hardware for generating sequences of random numbers. 4. Design hardware for matrix multiplication and transposition. 5. Design hardware for QR decomposition and matrix inversion. Functional implementation verification. 6. Design hardware for circuits performing logarithmic and power functions computation.
Lecturer / Teaching assistant	Prof. dr Srdjan Stanković - Teacher, Dr. Andjela Draganić - Teaching Assistant
Methodology	Lectures, exercises, seminars, consultations.
Plan and program of work	
Preparing week	Preparation and registration of the semester
I week lectures	Introduction to the programming languages VHDL and ABEL.
I week exercises	Introduction to the programming languages VHDL and ABEL.
II week lectures	Sorting methods in digital systems - Bitonic sorting, VHDL implementation.
II week exercises	Sorting methods in digital systems - Bitonic sorting, VHDL implementation.
III week lectures	Sorting methods in digital systems - Bitonic sorting, VHDL implementation.
III week exercises	Sorting methods in digital systems - Bitonic sorting, VHDL implementation.
IV week lectures	Hardware implementations of techniques for generating random number sequences.
IV week exercises	Hardware implementations of techniques for generating random number sequences.
V week lectures	First midterm exam.
V week exercises	First midterm exam.
VI week lectures	Techniques for approximating square root calculation; Hardware implementations of square root calculation techniques (restoring and non-restoring methods).
VI week exercises	Techniques for approximating square root calculation; Hardware implementations of square root calculation techniques (restoring and non-restoring methods).
VII week lectures	Techniques for approximating square root calculation; Hardware implementations of square root calculation techniques (Newton-Raphson method, Babylonian method).
VII week exercises	Techniques for approximating square root calculation; Hardware implementations of square root calculation techniques (Newton-Raphson method, Babylonian method).
VIII week lectures	Matrix multiplication; Hardware implementation of matrix multiplication and transposition.
VIII week exercises	Matrix multiplication; Hardware implementation of matrix multiplication and transposition.
IX week lectures	Techniques for calculating matrix inversion and their hardware implementations (QR matrix decomposition using Givens rotations).
IX week exercises	Techniques for calculating matrix inversion and their hardware implementations (QR matrix decomposition using Givens rotations).
X week lectures	Techniques for calculating matrix inversion and their hardware implementations (QR matrix decomposition using Gram-Schmidt orthogonalization).
X week exercises	Techniques for calculating matrix inversion and their hardware implementations (QR matrix

	decomposition using Gram-Schmidt orthogonalization).
XI week lectures	Methods for computing exponential and logarithmic functions and their hardware implementations.
XI week exercises	Methods for computing exponential and logarithmic functions and their hardware implementations.
XII week lectures	Second midterm exam.
XII week exercises	Second midterm exam.
XIII week lectures	Methods for computing exponential and logarithmic functions and their hardware implementations.
XIII week exercises	Methods for computing exponential and logarithmic functions and their hardware implementations.
XIV week lectures	Methods for computing power function and hardware implementations.
XIV week exercises	Methods for computing power function and hardware implementations.
XV week lectures	Final exam.
XV week exercises	Final exam.
Student workload	Weekly workload calculation for a 5-credit course: 5 credits x 40/30 = 6 hours and 40 minutes Structure: - 3 hours of lectures - 1 hour of computational exercises - 2 hours and 40 minutes of independent work, including consultations during the semester Teaching and final exam: (6 hours 40 minutes) x 16 = 106 hours 40 minutes Necessary preparations before the semester (administration, registration, verification): 2 x (6 hours and 40 minutes) = 13 hours and 20 minutes Total workload for the course: 5.0 x 30 = 150 hours Additional work for exam preparation in the retake exam period, including taking the retake exam: 0 to 30 hours (remaining time from the first two items to the total workload for the course) Workload breakdown: - 106 hours and 40 minutes (Teaching) - 13 hours and 20 minutes (Preparation) - 30 hours (Additional work)

Per week	**Per semester**
6 credits x 40/30=8 hours and 0 minuts 3 sat(a) theoretical classes 0 sat(a) practical classes 1 excercises **4 hour(s) i 0 minuts** of independent work, including consultations	Classes and final exam: **8 hour(s) i 0 minuts x 16 =128 hour(s) i 0 minuts** Necessary preparation before the beginning of the semester (administration, registration, certification): **8 hour(s) i 0 minuts x 2 =16 hour(s) i 0 minuts** Total workload for the subject: **6 x 30=180 hour(s)** Additional work for exam preparation in the preparing exam period, including taking the remedial exam from 0 to 30 hours (remaining time from the first two items to the total load for the item) **36 hour(s) i 0 minuts** Workload structure: **128 hour(s) i 0 minuts (cources), 16 hour(s) i 0 minuts (preparation), 36 hour(s) i 0 minuts (additional work)**
Student obligations	Students are required to attend lectures and exercises, complete and submit all homework assignments, and participate in both midterm exams.
Consultations	After the lectures, and as needed by arrangement.
Literature	Miloš Ercegovac, Tomas Lang: Digital Arithmetic, 1st Edition, Morgan Kaufmann, Print Book ISBN : 9781558607989, 2003 Israel Koren: Computer Arithmetic Algorithms, 2nd Edition, Published by A. K. Peters, Natick, MA, 2002 (ISBN 9781568811604) Mark Zwolinski: Digital System Design with VHDL, Prentice Hall, 2004
Examination methods	Two midterm exams are worth 25 points each, and the final exam is worth 50 points. A cumulative total of 50 points is required to pass the exam.
Special remarks	
Comment	

Grade:	F	E	D	C	B	A
Number of points	less than 50 points	greater than or equal to 50 points and less than 60 points	greater than or equal to 60 points and less than 70 points	greater than or equal to 70 points and less than 80 points	greater than or equal to 80 points and less than 90 points	greater than or equal to 90 points