Institute of Cyber-Physical Systems						
Name of the subject:	Code of the subject:	Credits:	Weekly hours:			
				lec	sem	lab
Int. to Computer Architectures	NKXSA1EBNF	4	full-time	3	0	0
Responsible person for the subject: Dr. Mehdi Taassori			Classification:			
Subject lecturer(s):						
Prerequisites:	NIXDR0EBNE	Digital Systems				
Way of the assessment:	Exam					

Course description	
Goal:	The course aims to equip students with the knowledge to design computer systems by exploring computer architecture, machine language, and hardware components. It provides a comprehensive understanding of how computer hardware interacts.
Course description:	The course focuses on the fundamental principles of computer architecture. It covers the design and functionality of modern computer systems, including topics such as data representation, assembly language programming, processor design, memory hierarchy, and input/output mechanisms.

Lecture schedule	
Education week	Topic
1.	Computer Abstractions and Technology: Introduction, Abstractions, Instruction set architecture, Technology Trends, Performance, Measuring Performance, CPU Clocking, CPU Time, Improving Performance
2.	Computer Abstractions and Technology: CPI, Power Trends, The Power Wall, Uniprocessors to Multiprocessors, SPEC CPU Benchmark, SPEC Power Benchmark, Amdahl's Law, MIPS as a Performance Metric
3.	Instructions: Language of the Computer: Instruction Set, MIPS Instruction Format, Operations of the Computer Hardware, Register operands, Memory operand, Immediate operand, Signed and Unsigned Number
4.	Instructions: Language of the Computer: Representing Instructions in the Computer, MIPS R-format Instructionsm, MIPS I-format Instructions, Logical Operations, Shift Operations, Instructions for Making Decisions, Conditional Operations, Loop Statement, MIPS Addressing for 32-bit Immediates and Addresses, Instruction formats, ARM and MIPS
5.	Arithmetic for Computers: Addition, Subtraction, Multiplication, Multiplication Hardware, Optimized Multiplier, MIPS Multiplication, Division, Division Hardware, Optimized Divider, MIPS Division
6.	Arithmetic for Computers: Floating Point, Floating Point Arithmetic
7.	The Processor: CPU Overview, Logic Design Conventions, Building a Datapath, Creating a Single Datapath,
8.	The Processor: Simple Implementation Scheme, Designing the Main Control Unit, Operation of the Datapath, Multicycle Implementation, Full Datapath
9.	The Processor: ALU Control, Datapath with Control Unit, Overview of Pipelining, Designing Instruction Sets for Pipelining, Pipeline Hazards
10.	The Processor: MIPS Pipeline, Pipelined Datapath and Control, Pipelined Control, Data Hazards: Forwarding versus Stalling
11.	The Processor: Data Hazards and Stalls ,Control Hazards, Dynamic Branch Prediction, Exception
12.	Large and Fast: Exploiting Memory Hierarchy: Principle of Locality, Memory Hierarchy, Memory Technologies, The Basics of Caches
13.	Large and Fast: Exploiting Memory Hierarchy:, Measuring and Improving Cache Performance, Associative Caches, Multilevel Caches

14.	Large and Fast: Exploiting Memory Hierarchy: Virtual Memory, Finite-State Machine to Control a Simple Cache

Mid-term requirements	
Conditions for obtaining a mid-term grade/signature	Homeworks, Quizzes, Project A minimum of 51% must be achieved in each part to receive a signature.

Assessment schedule	
Education week	Topic

Method used to calculate the *mid-term grade* (to be filled out only for subjects with mid-term grades)

Type of the replacement

Type of the replacement of written test/mid-term grade/signature	The signature retake exam is exclusively available to students whose average quiz grade is less than 51%.

Type of the exam (to be filled out only for subjects with exams)

Written and multiple-choice exam

Calculation of the exam mark (to be filled only for subjects with exams)

- Homework 10%
- Quiz 0 - 10%
- Project 0 - 10%
- Exam 70% - 90%
- The submission of homework and project by the designated deadline is mandatory for all students.
- Attendance for quizzes, and the exam is mandatory.
- Conducting the quiz and delivering the project depends on the class schedule.
- A minimum of 51% must be achieved in each exam to pass.

Final grade calculation methods:

0-59 points - Fail
60-69 points - Pass
70-79 points – Satisfactory
80-89 points - Good
90-100 points – Excellent

References

Obligatory:	D. A. Patterson and J. L. Hennessy, Computer Organization and Design: The Hardware/Software Interface, Morgan kaufmann.
Recommended:	
Other references:	