Computer Architecture

1. **Course number and name:** 020AROES3 Computer Architecture

2. **Credits and contact hours:** 4 ECTS credits, 2x1:15 contact hours

3. **Name(s) of instructor(s) or course coordinator(s):** Tina Yaacoub

4. **Instructional materials:** PowerPoint slides; course handouts

   References:
   - book (David A. Patterson and John L. Hennessy, *Computer Organization and Design: the hardware/Software Interface,* 6th edition, Maurgan Kaufmann, 2020.)

5. **Specific course information**
   a. **Catalog description:**
      Computer evolution and performance - Von Neumann model – interconnection structures – memory systems - inputs / outputs - instruction sets – processor structure and function - pipelines - RISC and CISC – ILP and superscalar processors - parallel architectures and organizations

   b. **Prerequisites:** 020TEDNI4 Digital Systems Design or 020TEDCI4 Digital Systems Design

   c. **Required** for CCE Software Engineering option students; **Selected Elective** for CCE Telecommunication Networks option students

6. **Educational objectives for the course**
   a. **Specific outcomes of instruction:**
      - Explain and describe the principles of computer architecture and organization.
      - Understand, describe and evaluate the evolution of and advances in computer systems.
      - Understand the various components of computer systems and their interaction
      - Demonstrate understanding of interrupt mechanisms, bus interconnections, and various bus interfaces.
      - Describe different I/O mechanisms and peripherals.
      - Understand and implement the memory hierarchy of a computer system (including registers, cache, internal memory, external storage).
      - Understand and compare various instruction set architectures of microprocessors, as well as instruction formats and addressing modes.
      - Understand and apply pipelining concepts and control implementations in scalar and superscalar microprocessors.
      - Describe and compare the parallel architectures and their implementations available on the market and understand the organization of these architectures.

b. PI addressed by the course:

PI	1.1	1.2	1.3	2.1	2.2	2.4	7.2
Covered	x	x	x	x	x	x	x
Assessed			x	x	x	x	x

7. Brief list of topics to be covered

- Introduction, seven great ideas in Computer Architecture, Computer Structure and Function, Computer History (1 lecture)
- Computer Evolution, Performance, and power wall (1 lecture)
- Technologies for building processors and memory (1 lecture)
- Exercises and problems (1 lecture)
- Operations of the computer hardware, operands of the computer hardware, signed and unsigned numbers, representing instructions in the computer, logical operations, instructions for making decisions, MIPS Addressing for 32-bit immediates and addresses (2 lectures)
- Exercises and problems (2 lectures)
- Logic design conventions, building a datapah, a simple implementation scheme (2 lectures)
- Exercises and problems (2 lecture)
- An overview of pipelining, pipelined datapah and control, data hazards: forwarding vs stalling, control hazards (3 lectures)
- Exercises and problems (2 lectures)
- Memory technologies, the basics of caches (3 lectures)
- Measuring and improving cache performance (3 lectures)
- Exercises and problems (2 lectures)
- Introduction to parallel processors, parallelism via intructions, IPC and CPI, static and dynamic multiple issue, superscalar and VLIW, speculation, Loop unrolling, register renaming, out-of-order and in-order commit (2 lectures)
- Exercises and problems (1 lecture)