

Embedded Systems

1. **Course number and name:** 020SEMES3 Embedded Systems
2. **Credits and contact hours:** 4 ECTS credits, 2x1:15 contact hours
3. **Instructor's or course coordinator's name:** Georges Zakka El Nashef
4. **Text book:**
 - a. **Other supplemental materials:**
Professor textbook and course material
5. **Specific course information**
 - a. **Catalog description:**
Embedded systems: Introduction, History, Motivation and applications – Definitions of real-time embedded systems – Technology integration and the implementation levels – Recap on logic gates: AND, OR, NOR, XOR, NAND, NOT, NXOR – Recap on combinatorial logic circuits: Multiplexer, Decoder, Encoder, 7-segment display – Recap on sequential logic circuits: D flip-flop, RS flip-flop, JK flip-flop, T Flip-flop, registers – Introduction to co-design: link between the hardware and the software – Alternatives to microcontroller (in particular the FPGA) – FGPA: Introduction, Basic Logic Element (BLE) architecture, Programmable Input/Output – Introduction to Lab, Quartus and Altera DE2 – VHDL: Introduction, Basics, Combinatorial and sequential behavior, Process and clocks, Advanced concepts.
 - b. **Prerequisites or co-requisites:** 020TEDNI4 Digital Systems Design or 020TEDCI4 Digital Systems Design, 020IF1NI2 Programming 1 or 020IF1CI2 Programming 1
 - c. **Required:** Elective for CCE and EE students
6. **Specific goals for the course**
 - a. **Specific outcomes of instruction:**
 - Analyze the basic concepts of an embedded system.
 - Describe the architecture of an FPGA and understand the software/hardware co-design.
 - Compare the advantages and limitations of an FPGA circuit and a microcontroller.
 - Recognize recent developments in the field of co-design and verification of digital embedded systems.
 - Develop a VHDL code for embedded system applications.

b. KPI addressed by the course:

KPI	a2	c2	c3	e1	e2	e3	k2	k3
Covered		x	x		x	x	x	x
Assessed	x		x	x	x	x	x	x
Give Feedback								

7. Topics and approximate lecture hours:

- Introduction to embedded systems, history, motivation and applications (2 lectures)
- Real time embedded systems, technology integration and implementation (1 lecture)
- Recap on logic gates, combinatorial and sequential circuits (2 lectures)
- Link between hardware and software: Co-design – Alternatives to microcontrollers (1 lecture)
- Introduction to lab: learning Altera DE2 and acquiring Quartus (2 lectures)
- FPGA: Introduction, architecture of BLE, Programmable I/O and clocks (2 lectures)
- VHDL: Introduction, basics, concurrent and sequential instructions, combinatorial, structural and sequential behaviors, clocked process, advanced concepts (13 lectures)
- Lab sessions on logic circuits, 7-segment decoder, Switches, lights, multiplexers, adders, subtractors, binary counter (up/down), clock divider and shift registers, Asynchronous and synchronous counter, Blinking LEDs and knight rider display, react timer and clock watch (8 lab lectures of 2:30 hours each).