# Advanced Microcontroller Systems

1. **Course number and name:** 020SAMES4 - Advanced microcontroller systems

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

3. **Instructor's or course coordinator's name:** Jean Sawma – Vahe Seferian

4. **Instructional materials:** Professor textbook and course material

5. **Specific course information**
   a. **Catalog description:**
      Introduction to embedded systems – Introduction to STM32 family of MCUs and STM32CubeIDE –Principles of schematic interpretation for embedded applications – Overview and practical exploration of MCU Peripherals: ADC, DAC, Advanced Timers, PWM, UART, I2C, SPI, DMA, SDIO, USB – Introduction to Real Time Operating System (RTOS) – Introduction to machine learning on MCUs and TinyML.

   b. **Prerequisites:** 020SMPES3 Microprocessor Systems

   c. **Selected Elective** for CCE and EE students

6. **Specific goals for the course**
   a. **Specific outcomes of instruction:**
      - Introduce STM32 family of MCUs and STM32 development environment.
      - Analyze and understand schematic for embedded applications.
      - Comprehend functionality of advanced MCU peripherals.
      - Design embedded software based on advanced MCU peripherals.
      - Introduce RTOS and its advantages.
      - Introduce machine learning on embedded devices.

   b. **PI addressed by the course:**

| **PI** | 1.1 | 1.2 | 1.3 | 6.1 | 6.2 | 6.3 | 6.4 | 7.1 |
|---|---|---|---|---|---|---|---|---|
| **Covered** | x | x | x | x | x | x | x | x |
| **Assessed** | | | | x | x | x | x | |

7. **Topics and approximate lecture hours**
   - Introduction to embedded systems (2 lectures)
   - Introduction to STM32 family of MCUs and STM32CubeIDE (2 lectures)
   - Principles of schematic interpretation for embedded applications (1 lecture)
   - Overview of MCU Peripherals: ADC, DAC, Advanced Timers, PWM, UART, I2C, SPI, DMA, SDIO, USB (6 lectures)
   - Introduction to Real Time Operating System (5 lectures)
   - Introduction to machine learning on MCUs and TinyML. (3 lectures)
   - Lab Sessions on practical exploration of MCU Peripherals (5 labs of 2.5 hours each):
     Labs 1 and 2: Capturing and digitally filtering analog signals and outputting the processed signals in real time using ADC, DAC, timers, and DMA peripherals.
     Lab 3: Implementing master-slave communication between MCUs utilizing SPI and I2C peripherals for controlling the PWM duty cycle on the slave microcontroller.
     Lab 4: Reading and writing files on a microSD card using the SDIO peripheral.
     Lab 5: Execution of two synchronized threads, employing queues for inter-task communication within FreeRTOS.