EE443 - Embedded Systems
Course Outline

Objectives:

- Manage development environments, compilers, and assemblers.
- Become familiar with embedded system hardware.
- Take full advantage of real-time programming techniques.

Course Schedule

There will be lectures during the laboratory hours in the first three weeks of the semester.

Week-1: Embedded systems introduction
System characteristics, evolution, applications.
Basic microprocessor structure and operation

Week-2: Assembly language, assembly process, generation of machine code

Week-3: Microcontroller hardware introduction, widely used processor architectures, memory organization
Quiz-1, Laboratory introduction

Week-4: Microcontroller hardware: reset and clock generators, I/O ports
Laboratory experiment-1

Week-5: Microcontroller hardware: timers, PWM units, analog signal interfaces
Laboratory experiment-2

Week-6: Microcontroller hardware: design examples, Review of C data types
Laboratory experiment-3

Week-7: Review of C data types, **Quiz-2**
Laboratory experiment-4

Week-8: Real-time programming data structures: Stacks, queues
Laboratory experiment-5

Week-9: Real-time programming data structures: Circular buffers, link lists
Laboratory recovery for past experiments

Week-10: Data flow control and interrupts
Midterm exam

Week-11: Data flow control and interrupts
Laboratory experiment-6

Week-12: Applications: Lookup tables
Laboratory experiment-7, **Quiz-3**

Week-13: Applications: Handling noise, arithmetic overflow, buffer overrun and other exceptions
Laboratory experiment-8

Week-14: Real-time operating systems, in-system programming
No laboratory meeting.

Grading

Quiz exams:	**25 %**. (Three quiz exams will be given. Exact dates and covered topics will be announced.)
Midterm exam:	**20 %** (date to be determined)
Final exam:	**30 %** (date to be determined)
Laboratory Performance:	**25 %**

Course Material

No text book is specified for the course. Lecture notes will be uploaded to IYTE Course Management System (CMS) as they become available. You need a valid CMS account to access the course materials at:

`https://cms.iyte.edu.tr/`

Reference book: Introduction to Embedded Systems
by Edward A. Lee and Sanjit A. Seshia

Electronic book available at
`http://leeseshia.org/`

A comprehensive book organized in three sections: 1) Modeling, 2) Design, 3) Analysis. This course will focus on embedded systems design.

Laboratory Work

Necessary laboratory documents will be posted on CMS.

ATmega328 Atmel AVR processor will be used for the laboratory experiments.

Code::Blocks open-source Integrated Development Environment (**IDE**) and **GNU WinAVR C** compiler will be used for code generation.

Proteus simulation program will be used for code verification.

Arduino processor boards will be available for those who want to have some experience on real hardware.

Experiment-1: Code Compilation and Simulation
Become familiar with the development tools.

Experiment-2: Input Port Pins and Execution Timing
Read MCU port inputs, adjust timing of output signals.

Experiment-3: Edge Detection and Delay Generation
Detect input signal transitions, use delay functions for periodic operations.

Experiment-4: LCD Module and Time Markers
Display variables on an LCD (liquid crystal display) module. Monitor execution time of operations using pins of a microcontroller as time markers.

Experiment-5: Analog Input Output
Sample an analog signal using built-in ADC, display results on an LCD, use an external DAC to obtain analog output

Experiment-6: Timers and Interrupts
Use timers to generate a PWM waveform and to activate an Interrupt Service Routine (**ISR**) with precise timing.

Experiment-7: Interrupts and Data Flow
Eliminate the CPU time wasted in LCD operations using circular queue buffers.

Experiment-8: Serial Data Transmission
Establish serial communication between the MCU and a personal computer, optimize I/O functions by using serial I/O interrupts and a circular queue buffer.