KING FAHD UNIVERSITY OF PETROLEUM & MINERALS
COLLEGE OF COMPUTER SCIENCES & ENGINEERING

COE 306 Introduction to Embedded Systems

Syllabus - Term 171

Catalog Description

Introduction to Embedded Systems. Microcontroller Hardware. ARM Processor. CPU Programming. Memory and I/O. Interfacing: Parallel and Serial Communication. A/D and D/A conversion. Embedded system design methodologies. Specifications. Designing robust software for embedded systems. RTOS features.

Prerequisite: COE 301 and COE 203

Instructor   Dr. Aiman H. El-Maleh.   Room: 22/407-5   Phone: 2811
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Office Hours   UTW 11:00-11:50 AM and by appointment

Text Books

Marilyn Wolf, "Computers as Components: Principles of Embedded Computing System Design", Third Edition, Morgan Kaufmann, 2012

Course Learning Outcomes

- Understand the design process and some of the related UML models.
- Understand the interrupt mechanism, and develop interrupt-driven C programs.
- Understand memory systems: cache mapping, virtual memory, and address translation.
- Understand various system buses, protocols, and peripheral interaction.
- Implement and use various common software components of embedded systems.
- Understand the software compilation process and various basic compiler optimizations.
- Understand context switching and scheduling of periodic processes in real-time operating systems.
- Ability to analyze performance at the CPU, platform, and program levels.
- Ability to develop ARM-based bare-metal embedded software in C.

Grading Policy

Discussions	4%	
Programming Assignments	8%	
Quizzes	8%	
Major Exam I	15%	**(Sat, Oct. 28, 10:00 AM)**
Major Exam II	20%	**(Sat, Dec. 2, 10:00 AM)**

Laboratory & Project	25%
Final	20%

- Attendance will be taken regularly. The tenth unexcused absence results in a DN grade
- Excuses for officially authorized absences must be presented no later than one week following resumption of class attendance.
- Late assignments will be accepted (up to 3 days) but you will be penalized 10% per each late day.
- A student caught cheating in any of the assignments will get 0 out of 8%.
- No makeup will be made for missing Quizzes or Exams.

Course Topics

1. *Introduction to Embedded Systems*
Introduction to embedded systems; requirements analysis; specifications; design methodologies overview.

2. *Microcontroller Organization*
Computer architectures, ARM organization, ARM instruction set, data operations, control flow, PIC, TI DSPs.

3. *CPUs*
I/O and memory mapping, addressing modes, interrupts and traps, caches, co-processors, memory management unit, virtual memory, address translation, CPU performance, pipelining.

4. *Embedded Platforms*
Hardware and software components of embedded platforms, bus protocols, DMA, system bus configurations, the AMBA and AHB buses, memory devices, example embedded platforms, bandwidth, bus and memory performance, performance bottleneck.

5. *Program Design and Analysis*
State machines, circular buffers, queues, models of programs, the compilation process, program performance and optimization.

6. *Processes and Operating Systems*
Tasks and processes, process timing requirements, real-time operating systems, preemptive execution, context switching, scheduling processes, priority scheduling, inter-process communication, shared-memory systems, message passing.

7. *Networks and Multiprocessors*
Multiprocessor systems, distributed embedded systems, CANbus, I2C bus, multiprocessor system-on-chip (MPSoC), accelerators.

Lab Topics
- **Getting familiar with the development platform**
- **General-purpose input/output (GPIO)**
- **Interrupts**
- **Hardware timers**
- **Analog input and output**
- **Pulse-width modulation**
- **Serial communication**
- **Building a microcontroller system on an FPGA**