Jordan University of Science and Technology
Faculty of Engineering
Biomedical Engineering Department

BME 462: Microcontrollers and Embedded Systems

Course Description

3 Credit hours (3 h lectures). Introduction to Microcontroller based systems; architecture, hardware fundamentals, basic programming using Arduino environment, sensor and output interface, specialized digital communication, with biomedical engineering applications

Text Book(s)

Title	Introduction to Embedded Systems: Using ANSI C and the Arduino Development Env.
Author(s)	David Russell
Publisher	Morgan and Claypool
Year	2010
Edition	1st Edition

References

- But How Do It Know? The Basic Principles of Computers for Everyone by: J. Clark Scott
- Exploring Arduino Tools and Techniques for Engineering Wizardry by: Jeremy Blum
- Arduino Microcontroller Processing for Everyone! Part I&II by: Steven F. Barrett
- Arduino Cookbook 2nd edition, by Michael Margolis

Prerequisites

Prerequisites by topic	Digital Signal Processing
Prerequisites by course	BME421
Co-requisites by course	BME 464
Prerequisite for	None

Evaluation

Assessment Tool	**Expected Due Date**	**Weight**
Midterm Exam	See Dept. Schedule	30 %
Term Project	Last Week of classes	30 %
Final Exam	According to the University final examination schedule	40 %

Topics Covered		
Week	**Topics**	**References**
1	- Discuss Syllabus and Course Structure - Introduction - Basic Concepts of embedded systems	Hand Out Lec Notes (Scott)
2	- Introduction to computer architecture - Digital Numbering systems - Digital Logic Gates	Lec. Notes (Scott)
3	- Digital Logic Gates	Lec. Notes (Scott)
4	- Digital control, ALU & RAM	Lec. Notes (Scott)
5	- System-level Instructions	Lec. Notes (Scott)
Midterm Exam		
6	- Introduction to Arduino compatible boards - Working with digital Inputs/Outputs	Lec. Notes (Blum)
7	- Analog Inputs and A/D basics - LCD & user-defined functions	Lec. Notes (Blum)
8	- Driving high-current devices - System calibration and distance measurements	Lec. Notes (Blum)
9	- Working with biopotentials	Lec. Notes
10	- Sampling frequency and processing optimization for RT systems	Lec. Notes
11	- Real-time signal processing and FIR system implementation	Lec. Notes
12	- Digital Communication Protocols: I2C and SPI - Datalogging and Wireless connectivity	Lec. Notes
13	- Biomedical Engineering applications	Lec. Notes
14	- Projects Week	
Final Exam		

Objectives and Outcomes[1]	
Objectives	**Outcomes**
1. Introduce fundamental concepts of computer architecture [1,7]	• Examine and understand a basic microprocessor system and its main components. • Understand and use the programmer's model of a CPU.
2. Introduce hardware and software integration and instruction controls [1,2,6,7]	• Understand and use the various addressing modes of a CPU. • Understand and use the Instruction Set of a CPU
3. Identify the various aspects of Arduino compatible boards [1,4,7]	• Understand and use various programming techniques including subroutines, structured programming, traps. • Develop, analyze, and debug Arduino compatible programs.
4. Link between the hardware and software optimization [1,2,7]	• Evaluate speed and performance of Microprocessors • Understand the CPU hardware model, interface, and timing.
5. Apply programming skills to develop customized software [1,2]	• Programming with ANSI C and the Arduino Development Environment
6. Apply different microcontrollers communication approaches [1,2,6,7]	• Understand serial and parallel interfaces in a microprocessor system.

Contribution of Course to Meeting the Professional Component

The course contributes to building the fundamental basic concepts of computer hardware elements, and integrating it with software elements to build embedded systems and their implementation using Arduino compatible boards and IDE.

Relationship to Program Outcome (%)

1	2	3	4	5	6	7	8	9
34	22		8		10	23		3

[1] Lower-case letters in brackets refer to the Program outcomes

Relationship to Biomedical Engineering Program Objectives

PEO1	PEO2	PEO3	PEO 4
√	√	√	√

Policy	
Attendance	Attendance will be checked at each class. University regulations will be strictly followed for students exceeding the maximum number of absences. In addition, points will be deducted from the participation grade for excessive absence.
Student Conduct	It is the responsibility of each student to adhere to the principles of academic integrity. Academic integrity means that a student is honest with him/herself, fellow students, instructors, and the University in matters concerning his or her educational endeavors. Cheating will not be tolerated in this course. University regulations will be pursued and enforced against any cheating student.