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

BME 464: Microcontrollers and Embedded Systems Lab

Course Catalog
1 Credit hours (3 h lab) Experiments in microcontrollers and embedded system design using Arduino development boards. Design and implementation of several interfacing tasks; interfacing with simple I/O devices like switches, LED, analog sensors. Communicating with sensor modules with various communication protocols. Biopotential Signal acquisition and real-time signal processing. Virtual system design, cloud programming, simulation and debugging.

Course Information	
Course Material	Microcontrollers and Embedded Systems Lab Manual
Location	M2L1-Microcontrollers and Embedded Systems Lab
Instructor	Dr. Yazan Dweiri

References	
Books	• Lab handouts. • Exploring Arduino Tools and Techniques for Engineering Wizardry , J. Blum
Journals	• International Journal of Electronics • Microprocessors and Microsystems • Journal of Systems Architecture
Other References	• Introduction to Embedded Systems: Using ANSI C and the Arduino Development Env. • Arduino Microcontroller Processing for Everyone! Part I&II by: Steven F. Barrett

Prerequisites	
Co-requisites by course	BME-462

Objectives and Outcomes	
Objectives	Outcomes
Understand Arduino board basic features and architecture [1,2,4,7]	- Understand Arduino board pin description - Understand the difference between RAM and ROM - Recognize Arduino I/O connectors, on-board regulators, serial port. - Understand the operating of the Arduino IDE.
Development of Arduino language [1,2,4,7]	- Understand the procedure of building basic program. - Understand linking the IDE with the board type. - Understand the features of Arduino IDE. - Apply a examples programs to the board.
Understand how to control I/O port of microcontroller. [1,2,4,5,7]	- Evaluate the driving circuit for output ports using LEDs. - Using I/O of microcontroller to interface with the system.
Controlling of Liquid Crystal Display [1,2,4,5,7]	- Understand the connection of LCD. - Evaluate the basic Arduino statements to control the LCD - Use the LCD in basic Arduino program to display outputs in various formats
Understand the controlling procedure of distance sensors [1,2,4,5,7]	- Understand the connection of distance sensors. - Using IR and Ultrasonic distance sensors to measure distance of objects - Understand the Arduino statements to acquire distance data
System measurement Calibration [1,2,4,5,6,7]	- Understand the concept of system calibration. - Understand the relation between the encoded system output and true measurement to perform necessary corrections.
Recording Biopotentials [1,2,4,5,7,9]	- Evaluate the practical approach to record biopotentials
Demonstrate controlling output device using biopotentials [1,2,5,7]	- Learn the operation and the switching schemes of the servo motor - Learn the necessary processing stages to process EMG. - Understand the moving window processing of EMG.
Real-time signal processing and FIR system implementation [4,5,7]	- Understand coding fixed sampling frequency in signal acquisition and build implementing the data time shift - Learn to implement FIR system for peak detection of ECG
Bluetooth connectivity [1,2,4]	- Understand the serial connection of Bluetooth module. - Demonstrates the wireless connectivity to transmit system output to Bluetooth enabled portable device.

Contribution of Course to Meeting the Professional Component

The course contributes to building the fundamental basic concepts and applications of Arduino compatible boards and the IDE programing language to build embedded systems in the field of biomedical engineering

Relationship to Program Outcome (%)

1	2	3	4	5	6	7	8	9
20	15		10	20	20	10		5

Relationship to Biomedical Engineering Program Objectives

PEO1	PEO2	PEO3	PEO 4
√	√	√	√

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

Topics Covered		
Week	Topics	Lab handout
1	Introduction to Arduino Boards	1
2	PC Serial Interface & PWM	2
3	Reading Digital Signals: Input Switches	3
4	Reading Analog signals: Sensors Interface	4
5	Liquid Crystal Display (LCD) & Cloud Simulation	5
6	Mid-term Exam	----------
7	Distance Measurement & System Calibration	6
8	Biopotentials and Servo Motors	7
9	Real-Time Signal Processing	8
10	Bluetooth Connection	9
11	Final Exam	----------

Evaluation		
Assessment Tool	Expected Due Date	Weight
LAB Work	Progress and completeness of work during lab session	20%
Homework	Due at the beginning of the following lab.	10%
Med Term	According to the department schedule, Practical and Theoretical	30 %
Final Exam	On the Last week of Lectures	40 %

Teaching & Learning Methods
A typical lab session starts with a short review with discussions to measure the students' digestion of the previous material. Then, students have a lecture on materials for the new experiment. The lecture presentation will be paused when needed with brain storming sessions that will allow students to reflect and think in more depth about what they learned in the lecture. Example problems will be presented when necessary and discussed with the students to illustrate the appropriate problem solving skills that the students should learn. After that, each group conducts the experiment.

Policy	
Attendance	Attendance will be checked at the beginning of each lab session. University regulations will be strictly followed for students exceeding the maximum number of absences.
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 on any cheating student.