جامعة الملك عبدالله
للعلوم والتقنية
King Abdullah University of
Science and Technology

Course Syllabus: Mechatronics and Intelligent Systems - ME 222B

Division	Physical Science and Engineering Division
Course Number	ME 222B
Course Title	Mechatronics and Intelligent Systems
Academic Semester	Spring
Academic Year	2018/2019
Semester Start Date	01/27/2019
Semester End Date	05/23/2019
Class Schedule (Days & Time)	02:30 PM - 04:00 PM | Mon Wed

Instructor(s)

Name	Email	Phone	Office Location	Office Hours
Shehab Ahmed Elsayed	Shehab.Ahmed@kaust.edu.sa	+966128087823	0235, 5, Al-Kindi (bldg. 5)	30 mins after each lecture or by appointment

Teaching Assistant(s)

Name	Email
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Course Information

Comprehensive Course Description	This course will introduce students to the application of different sensors and motors typically used in mechatronic systems. Methods to integrate them into embedded systems used in consumer and industrial products will be addressed. Students will build systems that take sensor inputs, and develop filters and evaluate the resulting data. They will create basic schematics, wire sensors and motors into working circuits, and write firmware to operate these systems. They will learn how industrial companies design, calibrate, test, manufacture, and market sensor/actuator embedded devices, and be trained to specify and purchase them for specific applications. Students will also acquire a decent understanding of embedded system architectures for the purpose of creating mechatronic system prototypes or products. Tradeoffs between hardware and software implementations as well as processor and operating system selection will be addressed. A discussion of contemporary topics in mechatronic system development will be addressed. There will be homework, quizzes given during lecture time, as well as a midterm and final to measure a student's knowledge of the class material.
Course Description from Program Guide	Principles, modeling, interfacing and signal conditioning of motion sensors and actuators; acquire and analyze data and interact with operators. Basic electronic devices, embedded microprocessor systems and control, power transfer components and mechanism design. hardware-in-the-loop simulation and rapid prototyping of real-time closed-loop computer control of electromechanical systems; modeling, analysis and identification of discrete-time or samples-data dynamic systems; commonly used digital controller design methods; introduction to nonlinear effects and their compensation in mechatronic systems; robotic manipulation and sensing; obstacle avoidance and motion planning algorithms; mobile robots, use of vision in navigation systems. The lectures will be divided between a review of the appropriate analytical techniques and a survey of the current research literature. Course work will focus on an independent research project chosen by the student.

Goals and Objectives	-Study a lab experiment or production process and understand how to specify the proper sensor for taking real-time process data and the proper motor/actuator for applying torque and/or speed to a physical process. -Implement the sensor or motor into an embedded system in both hardware and software. -Modify existing hardware schematics to add the sensor and all support circuitry needed to implement the signal chain into the existing microprocessor-based system. -Create hardware and firmware to process the sensor signal and feed data to a microprocessor for further evaluation. -Study sensor signal noise and apply proper hardware and firmware techniques to reduce it to levels well below the measurement uncertainty of the system -Develop an understanding of embedded systems architectures for the purpose of creating prototypes or products for a variety of applications. -Examine the salient issues in the decision making process, including tradeoffs between hardware and software implementations, processor and operating system selection, and IP creation or acquisition -Have an understanding of contemporary topics related to the development of embedded processor based mechatronic systems
Required Knowledge	-Basic knowledge of assembly and C programming, digital logic design, and basic computer architecture. Ideally, students should have a first course in each of these subjects. Alternatively, students should have completed a laboraroty based undergraduate mechatronics class. -Has used simulation and circuit analysis tools such as LTspice, OrCAD Capture, OrCAD Pspice, Matlab or Simulink.
Reference Texts	Suggested references: -Handbook of Modern Sensors by Jacob Fraden, Fifth Edition. Springer Science+Business Media, LLC ISBN 978-3-319-19302-1 for hardcover book. ISBN 978-3-319-19303-8 for ebook. Avaialble as e-book free of charge from KAUST libarary. › https://link.springer.com/book/10.1007%2F978-3-319-19303-8 -Weekly online reading and online videos will be assigned and shared with students. -Industry 4.0 by Alasdair Gilchrist, ISBN:978-1-4842-2046-7. Avaialble as e-book free of charge from KAUST libarary. › https://link.springer.com/book/10.1007%2F978-1-4842-2047-4 -Computers as Components – Principles of Embedded Computing System Design, 4th Edition, by Marilyn Wolf -What Every Engineer Should Know about Developing Real-Time Embedded Products by Kim R. Fowler. Avaialble as e-book free of charge from KAUST libarary. › https://www.taylorfrancis.com/books/9780849379635
Method of evaluation	**10.00**% - Quiz(zes) **45.00**% - Others - Please specify **20.00**% - Midterm exam **5.00**% - Homework /Assignments **20.00**% - Final exam

Nature of the assignments	-Homework 5% -Labs/Project 45% (This is indicated as 'Others - Please speficy' in the Method of Evaluation section 15% Labs, and 30% Project) -Quizzes 10% -Mid-term exam 20% -Final exam 20% Homework will be submitted in class. No late homework will be accepted. Homework will not be graded, but solutions will be posted after the submission deadline. Consultation with other students on the problems is permitted but each student must submit his own and personal solution. Two identical solutions will not be considered. -You will get full credit for the homework if it complete, and legible. -You will get half credit if its not well done. -You will get no credit if you haven't submitted your homework. Lab experiments and a project will be also assigned. Labs will aim to get you comfortable in prototyping of embedded systems interfaced to sensors and actuators. Planned labs include: Thermistors, Motor Voltage and Current Measurement, Rotary Sensors, Strain Gauges, Closed Loop Motor Control, and PID Control. All labs will be conducted using an embedded platform. You will need to demo your lab and prepare a report.
Course Policies	Class attendance is expected. All assignments (homework, lab, project) and exams are required. If you dispute your grade on any graded work, you may request a regrade from the instructor only within 48 hours of receiving the grade. Incomplete (I) grade for the course will only be given under extraordinary circumstances such as sickness, and these extraordinary circumstances must be verifiable. The assignment of an (I) requires first an approval of the dean and then a written agreement between the instructor and student specifying the time and manner in which the student will complete the course requirements. Syllabus adjustments and all possible modifications in the schedule and deadlines will be given in the class. It is your responsibility to make up the material and keep informed of any announcements.
Additional Information	

Tentative Course Schedule *(Time, topic/emphasis & resources)*		
Week	**Lectures**	**Topic**
1	Mon 01/28/2019 Wed 01/30/2019	Course Introduction and Thermal Sensors
2	Mon 02/04/2019 Wed 02/06/2019	Prototyping of Sensor/Actuator based systems
3	Mon 02/11/2019 Wed 02/13/2019	Flow and Rotary Sensors
4	Mon 02/18/2019 Wed 02/20/2019	Amplifiers and Sensor Noise
5	Mon 02/25/2019 Wed 02/27/2019	AC Motor Designs
6	Mon 03/04/2019 Wed 03/06/2019	AC Motor Controls
7	Mon 03/11/2019 Wed 03/13/2019	DC and Stepper Motors
8	Mon 03/18/2019 Wed 03/20/2019	Pressure Sensors
9	Mon 03/25/2019 Wed 03/27/2019	Spring Break
10	Mon 04/01/2019 Wed 04/03/2019	Force and Strain Sensors
11	Mon 04/08/2019 Wed 04/10/2019	Position Sensors
12	Mon 04/15/2019 Wed 04/17/2019	Motion Sensors
13	Mon 04/22/2019 Wed 04/24/2019	Systems Development: Embedded Architecture Tradeoffs, Standards, Engineering Best Practices, CPU Architectures
14	Mon 04/29/2019 Wed 05/01/2019	ARM Architecture and Demo, Appliance Case Study, Processor Selectrion and Benchmarking
15	Mon 05/06/2019 Wed 05/08/2019	Embedded Operating Systems and Tools
16	Mon 05/13/2019 Wed 05/15/2019	Interfacing/Debugging and Contemporary Issues
17	Mon 05/20/2019 Wed 05/22/2019	Final Exam Week

Note

The instructor reserves the right to make changes to this syllabus as necessary.