Philadelphia University
Faculty of Engineering & Technology
Department of Mechatronics Engineering
First Semester 2019/2020

Course Details:

Title: Advanced Measurement Systems and Sensors (0640732)

Prerequisite: BS Degree in Mechatronics or related field

Credit Hours: 3 credit hours (16 weeks per semester, 3 hours/week)

Textbook: Jacob Fraden, "Handbook of Modern Sensors: Physics, Designs, and Applications" Springer, 2010, ISBN 978-1-4419-6465-6.
http://link.springer.com/book/10.1007%2F978-1-4419-6466-3

Description: The course is based on mechatronic philosophy, regarding mechanic, electronic and informatics as a whole. After finishing the course the student should be able to design, analyze and/or select the best suited sensors for a specified problem, regarding range, accuracy, dynamic behavior, environment requirements etc.

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Materials: *http://www.philadelphia.edu.jo/academics/kaubaidy/*

Course Outlines:

Week	Topic
1	**Introduction:** Mechatronics systems and Measurement systems, Sensors, Signals, and Systems; Sensor Classification; Units of Measurements.
2	**Sensor Characteristics:** Transfer Function; Calibration; Accuracy; Hysteresis; Nonlinearity; Saturation; Repeatability; Dead Band; Resolution;
3	**Sensor Characteristics:** Dynamic Characteristics; Environmental Factors; Reliability; Application Characteristics; Uncertainty
4	**Physical Principles of Sensing:** Electric Charges, Fields, Capacitance, Magnetism, Induction, Resistance, Piezoelectric Effect, Hall Effect, Thermoelectric Effects, Temperature and Thermal Properties of Materials, Heat Transfer, Light, Dynamic Models of Sensor Elements.
5, 6	**Interface Electronic Circuits:** Input Characteristics of Interface Circuits, Amplifiers, Light-to-Voltage Converters, Excitation Circuits, Analog-to-Digital Converters, Bridge Circuits, Data Transmission, Noise in Sensors and Circuits.
7	**Motion Detectors:** Ultrasonic Detectors, Microwave Motion Detectors, Capacitive Occupancy Detectors, Triboelectric Detectors, Optoelectronic Motion Detectors, Optical Presence Sensors, Pressure-Gradient Sensors.
8	**Position, Displacement, and Level:** Potentiometric Sensors, Capacitive Sensors, Inductive and Magnetic Sensors, Optical Sensors, Ultrasonic Sensors, Radar Sensors, Thickness and Level Sensors, Pointing Devices.
9	**Velocity and Acceleration:** Accelerometer Characteristics, Capacitive Accelerometers, Piezoresistive, Piezoelectric Accelerometers, Gyroscopes, Gravitational Sensors.
10	**Force, Strain, Tactile Sensors and Pressure Sensors: Pressure Sensors:** Concepts of Pressure, Mercury Pressure Sensor, Bellows, Membranes, and Thin plates, Piezoresistive Sensors, Capacitive Sensors, VRP Sensors, Optoelectronic Pressure Sensors, Indirect Pressure Sensor, Vacuum Sensors.
11	**Flow Sensors:** Basics of Flow Dynamics, Pressure Gradient Technique, Thermal Transport Sensors, Ultrasonic Sensors, Electromagnetic Sensors, Breeze Sensor, Coriolis Mass Flow Sensors, Drag Force Sensors, Dust and Smoke Detectors,
12	**Acoustic Sensors**: Resistive Microphones, Condenser Microphones, Fiber-Optic Microphone, Piezoelectric Microphones, Dynamic Microphones, Solid-State Acoustic Detectors,
13	**Humidity and Moisture Sensors:** Concept of Humidity, Capacitive Sensors, Electrical Conductivity Sensors, Optical Hygrometer, Oscillating Hygrometer.

	Light Detectors: Photodiodes, Phototransistor, Photoresistors, Cooled Detectors, Image Sensors, Thermal Detectors, Gas Flame Detectors.
14	**Temperature Sensors:** Coupling with Object, Temperature Reference Points, Thermoresistive Sensors, Thermoelectric Contact Sensors, Optical Temperature Sensors, Acoustic Temperature Sensor, Piezoelectric Temperature Sensors.
15	**Chemical Sensors:** Chemical Sensor Characteristics, Biochemical Sensors, Multisensor Array.
16	**Smart sensors:** Smart sensor systems (Definition – Different types- new trends)

Course Learning Outcomes with reference to ABET Student Outcomes:

Upon successful completion of this course, student should:

1.	Describe the concepts of different measurement & Mechatronics systems used in industry	[a, d, e]
2.	Describe the function, suitability of different sensors and Transducers.	[a , c]
3.	Analyze, Design and/or select the suitable sensors for a given system.	[a, c, d]
4.	Analyze & design the signal conditioning circuits.	[a , c]
5.	Conduct research in measurement system and sensor field to generate novel techniques.	[a, c]
6.	Carry out calibration and error estimation of measuring devices	[a, c]
7	Improve system performance	[e, k]

Assessment Guidance:

Evaluation of the student performance during the semester (total final mark) will be conducted according to the following activities:

Mid-Exam (30%):	The students will be subjected to scheduled written exam during the semester to cover materials given in lectures.
Assignments (10%):	Assignments and technical notes will be prepared by students and submitted before or on a set agreed date.
Projects (20%):	Students will be assigned to present project(s).
Final Exam (40%):	The students will undergo a scheduled final exam at the end of the semester covering the whole materials taught in the course.

Note: Cheating by copying homework from others is strictly forbidden and punishable by awarding the work with zero mark.

Attendance Regulation:

The semester has in total 45 credit hours. Total absence hours from classes must not exceed 15% of the total credit hours. Exceeding this limit without a medical or emergency excuse approved by the deanship will prohibit the student from sitting the final exam and a zero mark will be recorded for the course. If the excuse is approved by the deanship the student will be considered withdrawn from the course.

References:

1. Pavel Ripka & Alois Tipek, “Modern Sensors Handbook”, ISTE Ltd UK, 2007, ISBN 978-1-905209-66-8, www.iste.co.uk.
2. Ernest O. Doebelin, " Instrumentation Design Studies", CRC Press, Taylor & Francis Group, 2010.
3. Robert Bishop , “The Mechatronics Handbook”, Second Edition, CRC Press 2002.
4. Pavel Ripka and Alois Tipek (editors), “Modern Sensors Handbook”, ISTE Ltd, 2007.
5. Devdas Shetty & Richard Kolk, “Mechatronics System Design”, 1997.
6. David G. Aldatore & Michael B. Histand, "Introduction to Mechatronics and Measurement Systems", McGraw Hill, 2004.