Philadelphia University
Mechatronics Engineering Department
Faculty of Engineering
First Semester 2015/2016

Course Syllabus	
Course Title	Advanced Measurement Systems and Sensors
Course Number	0640732
Course Level	1st year Graduate Level
Class Time	15:00 - 18:00 Monday
Instructor	Prof. Kasim Al-Aubidy
email	*kma@philadelphia.edu.jo and alaubidy@gmail.com*
website	*http://www.philadelphia.edu.jo/academics/kaubaidy/*
Prerequisites	BS Degree in Mechatronics or related field
Office Hours	09:00-10:00 Sun/Tues/Thurs Office: 6700
Text Book	Lectures will be based on several resources (See References)

Course 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:-

- Analyze measurement- and control problems,
- Design and/or select the best suited sensors for a specified problem, regarding range, accuracy, dynamic behavior, environment requirements etc.
- Perform all necessary calculations regarding the sensor implementation and the analog and digital signal processing required.

Course Objectives:
On completing the course, students will be able to have to following skills:

- **Knowledge and understanding**
  A1- Describe the concepts of different measurement & Mechatronics systems used in industry.
  A2 - Describe the function, suitability of different sensors and Transducers.
  A3- Know and understand in depth the concepts of Input/ Output Signal conditioning
- **Intellectual skills**
  B1- Analyze, Design and/or select the suitable sensors for a given system.
  B2- Analyze & design the signal conditioning circuits.
  B3– Conduct research in measurement system and sensor field to generate novel techniques.
- **Professional and practical skills:**
  C1- Carry out calibration and error estimation of measuring devices
  C2- Design and assessment of the sensors used in industrial systems.
  C3– Improve system performance
- **General and transferrable skills**
  D1- Critical thinking.
  D2- Team work
  D3- Self learning.

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Course Academic Calendar		
lecture	**Subject**	**Notes**
1	**Introduction:** Mechatronics systems and Measurement systems, Sensors, Signals, and Systems; Sensor Classification; Units of Measurements.	Ref 1: Chap 1 Ref 2: Chap 16
2	**Sensor Characteristics:** Transfer Function; Calibration; Accuracy; Hysteresis; Nonlinearity; Saturation; Repeatability; Dead Band; Resolution;	Ref 1: Chap3
3	**Sensor Characteristics:** Dynamic Characteristics; Environmental Factors; Reliability; Application Characteristics; Uncertainty	Ref 1: Chap3
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.	Ref 1: Chap4
5	**Interface Electronic Circuits:** Input Characteristics of Interface Circuits, Amplifiers, Light-to-Voltage Converters, Excitation Circuits	Ref 1: Chap5
6	**Interface Electronic Circuits:** Analog-to-Digital Converters, Bridge Circuits, Data Transmission, Noise in Sensors and Circuits.	Ref 1: Chap5
7	**Motion Detectors:** Ultrasonic Detectors, Microwave Motion Detectors, Capacitive Occupancy Detectors, Triboelectric Detectors, Optoelectronic Motion Detectors, Optical Presence Sensors, Pressure-Gradient Sensors.	Ref 1: Chap6
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.	Ref 1: Chap7
9	**Velocity and Acceleration:** Accelerometer Characteristics, Capacitive Accelerometers, Piezoresistive, Piezoelectric Accelerometers, Thermal Accelerometers, Gyroscopes, Gravitational Sensors.	Ref 1: Chap8
10	**Force, Strain, and Tactile Sensors:** Strain Gauges, Tactile Sensors, Piezoelectric Force 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,	Ref 1: Chap9,10
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,	Ref 1: Chap11

12	**Acoustic Sensors**: Resistive Microphones, Condenser Microphones, Fiber-Optic Microphone, Piezoelectric Microphones, Electret Microphones, Dynamic Microphones, Solid-State Acoustic Detectors,	Ref 1: Chap12
13	**Humidity and Moisture Sensors:** Concept of Humidity, Capacitive Sensors, Electrical Conductivity Sensors, Optical Hygrometer, Oscillating Hygrometer. **Light Detectors:** Introduction, Photodiodes, Phototransistor, Photoresistors, Cooled Detectors, Image Sensors, Thermal Detectors, Gas Flame Detectors.	Ref 1: Chap13, 14
14	**Temperature Sensors:** Coupling with Object, Temperature Reference Points, Thermoresistive Sensors, Thermoelectric Contact Sensors, Optical Temperature Sensors, Acoustic Temperature Sensor, Piezoelectric Temperature Sensors.	Ref 1: Chap16
15	**Chemical Sensors:** Chemical Sensor Characteristics, Biochemical Sensors, Multisensor Array.	Ref 1: Chap17
16	**Smart sensors:** Smart sensor systems (Definition – Different types- new trends)	Ref 3: Chap 4
FINAL EXAMS		

Assessment Instruments

Allocation of Marks	
Midterm Exam	**30%**
Assignments	**10%**
Project	**20%**
Final Exam	**40%**

References:

1. Jacob Fraden, “Handbook of Modern Sensors; Physics, Design, and Applications”, Fourth Edition, Springer Press 2010.
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.