EEE4021	Sensors and Signal Conditioning	L	T	P	J	C
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Pre-requisite	**PHY 1001, EEE3002**	**Syllabus version**				
Anti-requisite		v. 1.1				

Course Objectives:

1. To give an understanding of the general concepts and terminology of measurement systems and transducer classifications.
2. To introduce the basics of various sensors and transducers and their construction.
3. To describe the principle of operation and function of sensors.
4. To teach the design of signal conditioning circuits.

Expected Course Outcome:

On the completion of this course the student will be able to:

1. Promote the concepts of transducers, standards and calibration.
2. Analyse various types of resistive sensors.
3. Apply reactive variation sensors in real time industrial environments.
4. Interpret the concepts of signal conditioning circuits for resistive sensors.
5. Illustrate the working principle of signal conditioning for reactance variation sensors
6. Describe the Self-generating Sensors and its signal conditioning circuits
7. Discuss various types of Electromagnetic ,Optical and Digital Sensors
8. Design and Conduct experiments, as well as analyze and interpret data

Student Learning Outcomes (SLO):	**1,2,5,9**

1. Having an ability to apply mathematics and science in engineering applications
2. Having a clear understanding of the subject related concepts and of contemporary issues
5. Having design thinking capability
9. Having problem solving ability- solving social issues and engineering problems

Module:1		**7 Hours**

Introduction: General concepts and terminology of measurement systems, Transducers classification, General input-output configuration, Static and dynamic characteristics of a measurements system, Calibration and standards. Errors and statistical analysis in measurement systems, least square fit of experimental data in measurement systems.

Module:2	**Resistive Sensors**	**5 Hours**

Strain gages: Introduction - Beam, column and Ring type force, torque measurement, Piezo resistive effect, RTDs, Thermistor- models-types and applications-linearization, Magneto resistors, Light dependent resistors.

Module:3	**Reactance Variation Sensors**	**4 Hours**

Capacitive sensors-variable-differential, Inductive sensors- variable reluctance-eddy current-LVDT-Synchros-resolvers- inductosyn- magnetoelastic- magnetostrictive

Module:4	**Signal conditioning for resistive sensors**	**5 Hours**

Voltage dividers - amplifiers for voltage dividers, Wheatstone bridge- balance measurements-deflection measurements- sensitivity, linearity, and analog linearization of resistive sensor bridges, Differential and Instrumentation amplifiers. Grounding and Isolation

Module:5	**Signal conditioning for reactance variation sensors**	**5 Hours**
AC bridges, Operation Amplifier based inductance and capacitance measuring circuits, carrier amplifiers and coherent detection, signal conditioners for capacitive sensors.		
Module:6	**Self-generating Sensors and its signal conditioning**	**8 Hours**
Thermocouple, piezoelectric sensors-effect-materials-applications, pyroelectric sensors- effect-materials-applications, and electrochemical sensors. Signal conditioning circuits: Chopper and low drift amplifiers, electrometer and trans impedance amplifiers, charge amplifiers, noise in amplifiers		
Module:7	**Electromagnetic ,Optical and Digital Sensors**	**9 Hours**
Electromagnetic sensors- sensors based on Faraday's law-Hall effect sensor, Ultrasonic based sensors, Optical transducer, Photo emissive cells, Photoconductive cells, Photo diodes, Photo transistors, Photovoltaic cells – Measurement of physical quantities. Position encoders-absolute position encoder-incremental position encoder, Resonant sensors- sensors based on quartz resonators- digital quartz thermometer- quartz micro balance-quartz resonators for force and pressure sensing- quartz angular rate sensor, SAW sensors.		
Module:8	**Contemporary issues:**	**2 Hours**
	Total Lecture hours:	**45 Hours**

Text Book(s)	
1.	Ramon Pallas-Areny,John G.Webster, "Sensors and Signal Conditioning", Wiley India Pvt.Ltd.,NewDelhi, 2nd Edition 2013.
2.	D.V.S.Murthy, "Transducers and Instrumentation", Prentice Hall of India Learning Pvt. Ltd. 2nd edition 2012.

Reference Books	
1.	Doebelin E.O., "Measurement System Application and Design", McGraw Hill, 5th Edition 2004.
2.	Patranabis, "Sensors and Transducers", Prentice Hall of India, New Delhi, 2003.
3.	A.K.Shawney, "A course in Electrical and Electronic measurement and Instrumentation", Dhanpat Rai &Company, 18th Edition, 2010.
4.	John P. Bentley, "Principles of Measurement Systems", 3rd edition Addison Wesley Longman Ltd, UK 2000
5.	Jacob Fraden, "Handbook of Modern Sensors: Physics, Designs, and Application"', Springer Science + Business Media, Inc, 3rd Edition, 2004.

Mode of Evaluation: CAT / Assignment / Quiz / FAT / Project / Seminar

List of Challenging Experiments (Indicative)		**Hours**
1.	Strain gauge based torque measurement	
2.	Temperature Measurement using RTD	

3.	Temperature Measurement using Thermistor	
4.	Temperature Measurement using J and K type Thermocouples	
5.	Displacement Measurement using LVDT	
6.	Speed measurement using magnetic sensor	
7.	Displacement Measurement using Inductive Pickup	
8.	Pressure Measurement using Diaphragm pressure gauge	
9.	Velocity measurement using Piezo-electric Transducer	
10.	Acceleration measurement using Piezo-electric Transducer	
11.	Design a signal conditioning circuit for thermocouple cold junction compensation using K-type thermocouple and analyse its output.	
12.	Design the linearization circuit for the 5KΩ thermistor	
13.	Design the signal conditioning circuit using RTD PT100with a input range of 30 °C to 100 °C to get an output voltage of 0 to 4 V with $\alpha = 0.004$ and Power dissipation = 30 mW and test its performance.	
14.	Design signal conditioning circuit for strain gauge sensor to compensate temperature effects.	
15.	Design the signal conditioning circuit for the pressure cell using Piezo electric sensor having the sensitivity of 10mV/g.	
	Total Laboratory Hour	

Mode of Evaluation: Assignment /FAT			
Recommended by Board of Studies	**29/05/2015**		
Approved by Academic Council	**37th AC**	**Approved by Academic Council**	**37th AC**