Course Code	Course Title	L	T	P	C
BECE409E	Sensors Technology	2	0	2	3
Pre-requisite	NIL	Syllabus version			
		1.0			

Course Objectives

1. To attain a broad familiarity with the principle of sensing and different sensors for real world applications
2. Study the various sensor technologies for the measurement of physical quantities and develop suitable signal conditioning circuits.
3. Identify most suitable sensors for each measurement application and get acquainted with fabrication and interfacing process

Course Outcomes

At the end of the course, students will be able to

1. Understand the sensors, sensor materials and sensor technologies.
2. Utilize various RLC and self-generating sensors for measuring physical quantities
3. Design appropriate signal conditioning and compensating circuits for RLC sensors
4. Fabricate various sensors using different fabrication techniques
5. Explore advanced sensing mechanisms.
6. Explore smart sensors and IOT for various sensor applications
7. Integrate the various sensors, work with them and interpret the data obtained from various applications.

Module:1	Sensing Mechanism	4 hours

Principles of Sensing: Resistive, Capacitive, Magnetic, Inductive, Piezoelectric, Piezo-resistance, Pyro-electric, Hall effect, RF sensing. Sensor materials and material properties. Sensor Technologies: Micro Technology, Micro-Electro-Mechanical Systems Technology, Nanotechnology. Example of Smart Sensors in Nature (Vision, Hearing, Touch, and Smell).

Module:2	RLC and Self Generating Sensors	4 hours

Resistive Sensors – Strain Gauges, Resistance Temperature Detectors, Thermistors, Light dependent resistors, Self and Mutual Inductive Transducers, LVDT, Capacitive Transducers, Variable Distance, Variable Area, Variable Dielectric Type Capacitive Sensors. Self-Generating Sensors – Thermoelectric Sensors, Piezoelectric Sensors, Pyroelectric sensors, Photovoltaic sensors, Electrochemical Sensors.

Module:3	Sensor Signal Conditioning	4 hours

DC Bridges for Resistance Measurements-Wheatstone Bridge, Kelvin Bridge. AC Bridges for Capacitance and Inductance Measurements-AC Bridge, Schering Bridge. Sensor Compensation Circuits-Temperature, Non-linearity and Offset Compensation.

Module:4	Sensor Fabrication	4 hours

Thick and Thin Film Sensor Fabrication – Screen Printing Technology, PVD, CVD, Fabrication of MEMS and NEMS Sensors – Lithography, Micromachining Techniques

Module:5	Advanced Sensors	4 hours

Position Encoders, Resonant Sensors, Sensors Based on Semiconductor Junctions, Fiber-Optic Sensors, Ultrasonic-Based Sensors, Biosensors, Superconducting Quantum Interference Devices (SQUIDs).		
Module:6	**Smart Sensors**	**4 hours**
Smart Transducers: Smart Sensors, Components of Smart Sensors, General Architecture of Smart Sensors, Evolution of Smart Sensors, Advantages, Application area of Smart Sensors.		
Module:7	**Sensors for IoT**	**4 hours**
Sensor-Cloud; Fog Computing, Smart Cities and Smart Homes, Connected Vehicles, Smart Grid, Industrial IoT, Case Study: Agriculture, Healthcare, Activity Monitoring		
Module:8	**Contemporary Issues**	**2 hours**
	Total Lecture hours:	**30 hours**

Text Book(s)	
1.	Winncy Y. Du, "Resistive, Capacitive, Inductive, and Magnetic Sensor Technologies", 2019, 1st Edition, CRC press, London.
2.	B. C. Nakra and K. K. Chaudhary, "Instrumentation, Measurement and Analysis", 2016, 4th Edition, McGraw Hill Education India Private Limited.
Reference Books	
1.	A.K. Sawhney, "A Course in Electronic Measurements and Instrumentation", 2015, Dhanpat Rai & Co. (P) Limited.
2.	Ramón Pallás-Areny and John G. Webster, "Sensors and Signal Conditioning" 2012, 2nd Edition, John Wiley and Sons, Inc.
3.	Pethuru Raj and Anupama C. Raman, "The Internet of Things: Enabling Technologies, Platforms, and Use Cases", CRC Press, 2017.
4.	Nihtianov, Stoyan, and Antonio Luque, eds. Smart sensors and MEMS: Intelligent sensing devices and microsystems for industrial applications. Woodhead Publishing, 2018.

Mode of Evaluation: Continuous Assessment Test, Digital Assignment, Quiz and Final Assessment Test

List of Experiments		
1	Characteristics of Thermistor	**2 hours**
2	Characteristics of Strain Gauge	**2 hours**
3	Characteristics of Light Dependent Resistor	**2 hours**
4	Characteristics of Resistance Temperature Detector	**2 hours**
5	Characteristics of Angular potentiometer transducer model.	**2 hours**
6	Characteristics of LVDT	**2 hours**
7	Characteristics of Capacitive Level Sensor	**2 hours**
8	Characteristics of Thermocouples	**2 hours**
9	Characteristics of Photoelectric Tachometer	**2 hours**
10	Calibration of RTD and signal conditioning of RTD	**2 hours**
11	Calibration of Thermistor and signal conditioning of thermistor	**2 hours**
12	Characteristics of piezoelectric and Hall effect sensors	**2 hours**

13	Simulation of Biosensors/Chemical Sensors	**2 hours**
14	Simulation and design of sensors using MATLAB/LABVIEW/ COMSOL	**2 hours**
15	PC based Data acquisition system.	**2 hours**
	Total Laboratory Hours	**30 hours**
Mode of assessment: Continuous assessment &Final Assessment Test (FAT)		
Recommended by Board of Studies	28-02-2023	
Approved by Academic Council	No. 69	Date 16-03-2023