COURSE TITLE	**FUNDAMENTALS OF SENSORS & ACTUATORS**
COURSE CODE	**01EC0311**
COURSE CREDITS	**1**

Objective:

1 The objective of this course is to provide fundamental and practical knowledge of sensors and actuators along with their interfacing, signal conditioning, and applications in embedded, industrial, and smart electronic systems.

Course Outcomes: After completion of this course, student will be able to:

1 Understand the working principles and classifications of sensors and actuators.
2 Analyze characteristics and performance of various sensors.
3 Apply sensors for measurement of physical parameters.
4 Interface sensors and actuators with electronic and embedded systems.
5 Design and implement basic sensor-actuator based smart systems.

Pre-requisite of course: Basic knowledge of Physics (measurement concepts), Fundamentals of Electrical Circuits (Ohm's Law, KCL, KVL), Basic understanding of electronics and instrumentation (preferred)

Teaching and Examination Scheme

Theory Hours	Tutorial Hours	Practical Hours	ESE	IA	CSE	Viva	Term Work
0	0	2	0	0	0	50	50

Contents : Unit	Topics	Contact Hours
Total Hours		

Suggested List of Experiments:

Contents : Unit	Topics	Contact Hours
1	**Experiment No. 1** To measure light intensity using a Light Dependent Resistor (LDR) and interface with microcontroller to implement automatic street light.	2
2	**Experiment No. 2** To measure temperature using LM35 temperature sensor and interface with microcontroller to display real-time temperature.	2
3	**Experiment No. 3** To measure humidity using DHT11/DHT22 sensor and interface with microcontroller for environmental monitoring.	2

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Suggested List of Experiments:

Contents : Unit	Topics	Contact Hours
4	**Experiment No. 4** To detect motion using PIR motion sensor (HC-SR501) and interface with microcontroller to implement automatic security lighting system.	2
5	**Experiment No. 5** To measure distance using Ultrasonic sensor (HC-SR04) and interface with microcontroller for obstacle detection system.	2
6	**Experiment No. 6** To measure acceleration and tilt using Accelerometer (ADXL335/MPU6050) and interface with microcontroller for motion sensing application.	2
7	**Experiment No. 7** To measure angular velocity using Gyroscope (MPU6050) and interface with microcontroller for orientation tracking.	2
8	**Experiment No. 8** To measure atmospheric pressure and altitude using BMP280/BME280 sensor and interface with microcontroller for weather monitoring.	2
9	**Experiment No. 9** To interface Hall Effect based sensor (like A3144, SS49E, etc.) for contactless position and proximity detection based on Hall Effect.	2
10	**Experiment No. 10** To measure CO2 concentration using MH-Z19B (or equivalent) sensor and interface with microcontroller for air quality monitoring.	2
11	**Experiment No. 11** To measure air quality using MQ-135 (or equivalent) sensor and analyze environmental pollution levels.	2
12	**Experiment No. 12** To measure pH value of liquid using pH sensorPH-4502C (or equivalen) module and interface with microcontroller for water quality monitoring.	2
13	**Experiment No. 13** To control an electromagnetic relay module using microcontroller to switch AC/DC loads.	2
14	**Experiment No. 14** To control speed of a DC motor using PWM technique through microcontroller for variable speed applications.	2
15	**Experiment No. 15** To control rotation of a Stepper motor (with ULN2003 or other driver) using microcontroller	2
16	**Experiment No. 16** To control position of a Servo motor (SG90 or other) using PWM signals from microcontroller for angular positioning.	2

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Suggested List of Experiments:

Contents : Unit	Topics	Contact Hours
17	**Experiment No. 17** To interface BMP280/MPU6050 sensor using SPI/I2C protocol and display pressure and altitude readings.	2
18	**Experiment No. 18** To develop a sensor–actuator closed loop system (e.g., temperature-based fan control using LM35 and DC motor).	2
Total Hours		**36**

Textbook :

1 Handbook of Modern Sensors: Physics, Designs, and Applications, J. Fraden, Springer, 2016

2 Practical Electronics for Inventors, P. Scherz and S. Monk, McGraw-Hill Education, 2016

3 Mechatronics: Electronic Control Systems in Mechanical and Electrical Engineering, W. Bolton, Pearson Education, 2015

4 Sensors and Transducers, D. Patranabis, Prentice Hall of India (PHI),, 2013

References:

1 Sensors and Actuators, Sensors and Actuators, D. Patranabis, Prentice Hall of India (PHI),, 2013

2 Learning the Art of Electronics: A Hands-On Lab Course, Learning the Art of Electronics: A Hands-On Lab Course, T. C. Hayes and P. Horowitz, Cambridge University Press, 2016

3 Measurement Systems: Application and Design, Measurement Systems: Application and Design, Ernest O. Doebelin and Dhanesh N. Manik, McGraw Hill Education, 2019

Suggested Theory Distribution:

The suggested theory distribution as per Bloom's taxonomy is as follows. This distribution serves as guidelines for teachers and students to achieve effective teaching-learning process

Distribution of Theory for course delivery					
Remember / Knowledge	**Understand**	**Apply**	**Analyze**	**Evaluate**	**Higher order Thinking / Creative**
0.00	10.00	35.00	20.00	20.00	15.00

Instructional Method:

1 The internal evaluation will be carried out based on continuous assessment of students during laboratory sessions and performance.

2 A practical examination will be conducted at the end of the semester to evaluate the hands-on skills and understanding of the experiments.

3 Students are encouraged to use supplementary learning resources such as online lectures, NPTEL courses, e-learning platforms, and virtual laboratories.

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Instructional Method:

4 The course delivery will be based on the requirements of the subject and student needs. In addition to conventional teaching methods (chalk and talk), the instructor may use modern pedagogical tools such as demonstrations, quizzes, brainstorming sessions, flipped classroom, project-based learning, collaborative learning, and MOOCs for effective understanding.

Supplementary Resources:

1 https://onlinecourses.nptel.ac.in/noc21_ee32/preview
2 https://onlinecourses.nptel.ac.in/noc24_ee68/preview?
3 https://www.vlab.co.in
4 https://www.arduino.cc/en/Guide
5 https://www.coursera.org/specializations/iot
6 https://www.udemy.com/course/arduino-sbs-17gs/
7 https://lastminuteengineers.com/
8 https://simulide.com/p/
9 http://www.youtube.com/@LastMinuteEngineeringedtech

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