GUJARAT TECHNOLOGICAL UNIVERSITY

Minor Degree: Control Systems and Sensors Technology
Subject Code: 114AM01
Semester – IV
Subject Name: Advance Sensors and Actuators in Control System

Prerequisite: Physics, Basics of Electronics

Rationale: This course includes the basics of measurement techniques along with operational principles of transducers used in the industries. It also focuses on microtechnology and its use to fabricate microsensors and systems. The course also includes the basics of sensors, actuators and their operating principle along with Microsensors and Micro actuators. It has also included different types of microfabrication techniques for designing and developing sensors in addition to fundamental principles of various types of biosensors.

Teaching and Examination Scheme:

Teaching Scheme			Credits	Examination Marks				Total Marks
				Theory Marks		Practical Marks		
L	T	P	C	ESE (E)	PA (M)	ESE (V)	PA (I)	
3	0	2	4	70	0	30	0	100

Course Content:

Unit No	Course Content	No of Hours
1	**Classification of transducers:** Input and output characteristics of various transducers. Sensor and signal conditioning circuits. Sensor selection, installation and calibration.	**4**
2	**Introduction to Measurement Techniques:** Pressure measurement, Strain Measurement, Humidity and Moisture measurement, Force-Torque measurement.	**4**
3	**Actuators:** Introduction of Actuators, Principle of Electronic, Pneumatic and Hydraulic Actuators & its operation with applications.	**8**
4	**MEMS fabrication & Microsystems:** Overview of MEMS and Micro Systems, Working Principles of Microsystems, Types of micro sensors, Materials for MEMS and Microsystems, Microsystem fabrication process, Micromachining	**10**
5	**Micro sensors and Micro actuators:** MEMS Sensors: Design of Acoustic wave sensors, resonant sensor, Capacitive and Piezo Resistive sensors. Micro actuation: using thermal forces, piezoelectric crystals and electrostatics forces. MEMS with micro actuators: microgrippers, micromotors, microvalves, micropumps, micro accelerometer	**10**
6	**Bio sensors**: Basics of Biosensor, Types of biosensors & its applications.	**5**
7	**Case Studies**: Application of Sensors & Actuators in different industries. i.e automotive, process, manufacturing etc.	**4**
	Total Hrs.	**45**

Suggested Specification table (Theory):

Distribution of Theory Marks (%)					
R Level	**U Level**	**A Level**	**N Level**	**E Level**	**C Level**
10	35	35	10	5	**5**

Legends: R: Remembrance; U: Understanding; A: Application, N: Analyze and E: Evaluate C: Create and above Levels (Revised Bloom's Taxonomy)

Reference books:

1. Introduction to Instrumentation and Control by A. K. Ghosh, 4th edition, PHI publications
2. MEMS and Microsystems: Design and Manufacture, Tai Ran Hsu, Tata McGraw Hill, 2002
3. Micro sensors, MEMS and smart Devices, Julian W. Gardner & Vijay K. Varadan, John Wiley & Sons, 2001
4. Transducers and Instrumentation by D. V. S. Murty, 2nd edition, PHI publications.
5. Industrial Instrumentation by K. Krishnaswamy and S. Vijayachitra, New Age International Publication.
6. Measurement Systems: Application and Design by E. D. Doebelin, McGraw – Hill Publication.
7. Handbook of Applied Instrumentation by D. M. Considine and Sidney David Ross, McGraw – Hill Publication.
8. Instrument Engineers' Handbook: Process Measurement and Analysis by B. G. Liptak.

Course Outcome:

No	Course Outcomes	% weightage
01	Comprehensive fundamental and technical knowledge of advanced sensor and actuator systems.	30
02	Understand the problem and select a sensor and its design.	15
03	Describe the working principles of biosensors in terms of their bio recognition elements and signal transduction schemes.	15
04	To learn the principles, design, working and applications of microsensors.	20
05	To learn the principles, design, working and applications of micro-actuators.	20

List of Practical:

1) Study detailed classification of sensors
2) Study various characteristics of transducers
3) Calibration of pressure gauge using dead weight pressure tester
4) Measurement of strain on a beam using strain gauge
5) Determine the moisture content of given sample
6) Study various types of actuators
7) Study different Fabrication processes of MEMS.
8) Study various types of MEMS based Sensors and Actuators
9) Study various types of Biosensors.
10) Design and simulation of thin film based Piezoelectric sensor (using simulator like COMSOL, etc.)
11) Design and simulation of Electrostatic parallel plate actuator for normal motion (using simulator like COMSOL, etc.)
12) Application of MEMS based sensor in automobile sector and in pharmaceutical field.
13) Application of MEMS based technology in biomedical field and in various process industries.