

**4EE54: INDUSTRIAL INSTRUMENTATION**  
**CREDITS – 4 (LTP: 3, 0, 1)**

**Course Objective:**

This subject provides the knowledge of various transducers, sensors and measurement of various physical parameters like force, velocity, displacement, viscosity, temperature using various types of sensors and measurement techniques.

**Teaching and Assessment Scheme:**

Teaching Scheme (Hours per Week)			Credits	Assessment Scheme				Total Marks
L	T	P		Theory Marks		Practical Marks		
			ESE	CE	ESE	CE	150	
3	0	2	4	60	40	20		30

**Details of Assessment Instruments under CE Practical Component:**

Hands-on and experiments related to the course contents.

Term work [15]	Allied Evaluation [15]
Attendance/report/Assignment	Performance/Attitude-Aptitude/Quiz/ Questions & Answers/ Discussion

**Course Contents:**

Unit No.	Topics	Teaching Hours
1	<b>Transducers:</b> Introduction to instrumentation system, static and dynamic characteristics of an instrumentation system, Principles and classification of transducers, electrical transducers, basic requirements of transducers	06
2	<b>Strain Gauge and Strain Measurement:</b> Factors affecting strain measurements, Types of strain gauges, theory of operation of resistive strain gauge, gauge factor, types of electrical strain gauges, strain gauge materials, gauging techniques and other factors, strain gauge circuits and temperature compensation, applications of strain gauges.	06
3	<b>Displacement Measurement:</b> Resistive potentiometer (Linear, circular and helical), L.V.D.T., R.V.D.T. and their characteristics, variable inductance and capacitance transducers, Piezo electrical transducers-output equations and equivalent circuit, Hall effect devices and Proximity sensors, Large displacement measurement using synchro's and resolvers, Shaft encoders.	06
4	<b>Force and Torque Measurement:</b> Load cells and their applications, various methods for torque measurement, use of torque wrenches.	06

Unit No.	Topics	Teaching Hours
5	<b>Pressure, Flow &amp; Level Measurement:</b> Mechanical devices like Diaphragm, bellows, and bourdon tube for pressure measurement, variable inductance and capacitance transducers, Piezo electric transducers, Orifice plate, Venturi tube, flow nozzle, pitot tube, rotameter, turbine flow meter, electromagnetic flow meter, ultrasonic flow meter. resistive, inductive and capacitive techniques for level measurement, ultrasonic and radiation methods	08
6	<b>Temperature Measurement:</b> Resistance type temperature sensors–RTD & thermistor, thermocouples & thermopiles, laws of thermocouple –fabrication of industrial thermocouples signal conditioning of thermocouples output-radiation methods of temperature measurement–radiation fundamentals –total radiation & selective radiation pyrometers –optical pyrometer –two colour radiation pyrometers	06
7	<b>Smart and Advanced Sensors :</b> Measurement of Magnetic field, pH and viscosity, dissolved oxygen sensors, pollution measurement, infrared camera and thermal image sensors, field survey and problems.	07
<b>Total</b>		<b>45</b>

**List of References:**

1. S. K. Singh, “Industrial Instrumentation & Control”, 9<sup>th</sup> Reprint, TMH Publication, 2007.
2. A K Sawhney, “Electrical and Electronics Measurement and Instrumentation”, Dhanpatrai & sons publications, 2013.
3. E. O. Doebelin, “Measurement Systems –Application and Design”, 7<sup>th</sup> Edition, TMH Publication, 2013.
4. D Patranabis “Principles of Industrial Instrumentation”, 3rd edition, McGraw hill, 2013.

**Web resources:**

1. NPTEL video course on “Industrial Instrumentation” By Prof Alok Barua,IIT Kharagpur  
<https://nptel.ac.in/courses/108/105/108105064/>

**Course Outcome:**

After learning this course the students will be able to:

1. Select a transducer based on its operating characteristics for the required application.
2. Select appropriate sensors to obtain satisfactory task for the parameters like strain, stress force and torque to be measured
3. Acquainted with advantages and limitations of pressure flow and level measurement techniques used in process industries.
4. Actual use of routine as well as advance sensors and interpret the measurement results and cause of any possible error.

**List of experiments:**

Experiment No.	Suggested List of Experiment
1	Instrument and Process Equipment line diagram and various Symbols used in Industries.

- 2 Measurement of linear displacement using Linear Variable Differential Transformer LVDT).
- 3 The Performance Of Strain Gauge Amplifier And Strain Gauge Transducer
- 4 Measurement and control of temperature using Resistance Temperature Detector (RTD).
- 5 Measurement of flow using Electromagnetic flow-meter.
- 6 Measurement of flow using Ultrasonic Flow meter.
- 7 Measurement of speed using Opto transducer.
- 8 Measurement of torque. And force.
- 9 To Perform The Characteristic Of Various Optical Transducers
- 10 Characteristics Of Photoconductive Cell
- 11 Characteristics Of Photovoltaic Cell
- 12 Hands on training of Solar PV Transducers.
- 13 Mini Project based on sensors