

# Transducers – I

S.E. Sem. III [INST]

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## EVALUATION SYSTEM

	Time	Marks
<b>Theory Exam</b>	3 Hrs.	100
<b>Practical Exam</b>	2 Hrs.	50
<b>Oral Exam</b>	–	25*
<b>Term Work</b>	–	25

\* - Oral examination will be based on object-oriented industrial visit.

## SYLLABUS

### 1. Instrumentation System

Units and standards of measurement. Introduction, block diagram, functional elements of measurement system, static and dynamic characteristics or performance characteristics of transducer. Error: definition, classification, statistical analysis of errors.

### 2. Transducer

Definition, classification (active, passive, primary, secondary, mechanical, electrical, analog, digital), selection criteria, sources of error for parameter under measurement, transducer specifications, test condition and operating conditions.

### 3. Displacement

(a) **Resistance potentiometer** : (linear and logarithmic), piezoresistive effect, ultrasonic transducer. LVDT, RVDT (transfer function, linearity, sensitivity, source frequency dependence, phase null, and signal conditioning). Selection and properties of materials for LVDT and general electromagnetic sensors.

(b) **Capacitance type transducers** : with applications, materials for capacitive, ultrasonic and elastic transducers.

(c) **Digital transducer** : translational and rotary encoders (absolute position and incremental position encoders), Optical and magnetic pickups.

(d) **Pneumatic transducer** : flapper – nozzle transducer.

### 4. Temperature transducers

Modes of heat transfer, laws of conduction convection and radiation, engineering materials for Temperature and conductive, resistive sensors, properties of materials for RTD, thermistor, thermocouple. Temperature scales (standard scale), glass thermometers, liquid expansion thermometer, gas thermometer (filled system thermometer), bimetallic thermometer, solid state temperature sensor.

(a) **Resistance temperature detector (RTD)** : types, construction, errors associated with RTD and its solutions (3 wire and 4 wire method, null balance, power supply stability), self heating effect, sensitivity, response time, dissipation constant, range advantages, disadvantages and limitations.

(b) **Thermistors** : Principle, types (NTC, PTC), characteristics, construction, sensitivity, range, response time, signal conditioning measuring circuit, calibration and applications.

(c) **Thermocouple** : Principle, thermoelectric effect, seebeck effect, Peltier effect, laws of thermocouple, types of thermocouple with characteristic curve, thermocouple table, sensitivity, construction, range, signal conditioning, electrical noise and noise reduction techniques, cold junction compensation method, thermowell, thermopile, thermocouple emf measurement method.

(d) **Pyrometers** : Radiation and optical

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## 5. Level Transducers

Dipsticks, displacers, float system, bubbler, diaphragm bore type, capacitive devices for level measurement, ultrasonic level gauge, DP cell, load cell, vibrating type, microwave, radar, radioactive type level gauges, LASER type transducers, fiber optic level sensors, solid level detectors. Intelligent level measuring instruments.

## 6. Metrology

Elements of Engineering measurement: Abbas and Taylor's principle, theory of limits and fits and their selection, screw thread measurement, gear profile measurement, absolute and comparative measurement and measuring principle, alignment testing, use of auto collimators and design and use of limit gauges, screw and slip gauges.

### Reference :

1. Instrumentation Measurement and Analysis (*B.C. Nakra, K.K. Cahudhary*) Tata McGraw Hill.
2. Electrical and Electronic Measurement and Instrumentation (*Sawney A.K.*) Dhanpatrai & Co.
3. Measurement System (*Doebelin E.D.*) 4<sup>th</sup> Edition.
4. Process Measurement and Analysis (*Liptak B.G.*).
5. Instrument Transducer (*Neubert Hermann K.P.*) Oxford University Press – New Delhi, 2003 (2<sup>nd</sup> Edition).
6. Process Control Instrumentation Technology (*Johnson Curtis D.*) 5<sup>th</sup> Edition.
7. Engineering Metrology (*Jain R.K.*) Khanna Publishers.
8. Instrumentation Systems and Devices (*Rangan, Mani, Sarma*) Tata McGraw Hill (2<sup>nd</sup> Edition).
9. Heat Transfer (*S.P. Sukhatme*) University Press (3<sup>rd</sup> Edition).
10. Fundamentals of Test Measurement Instrument Instrumentation (*Cheatle Keith R.*) IS Publication.

