

# MECHANICAL MEASUREMENT & CONTROL

## Module I

(14 hours)

Introduction to Instruments and their Representation:

Typical Applications of Instrument Systems, Functional Elements of a Measurement System, Brief Description of the Functional Elements of the Instruments, Classification of Instruments, Microprocessor -Based Instrumentation, Standards and Calibration.

Static and Dynamic Characteristics of Instruments:

Static Performance Parameters, Impedance Loading and Matching, Selection and Specifications of Instruments, Dynamic Response, Compensation.

Transducer Elements:

Analog Transducers, Digital Transducers,

Basic detector transducer elements : Electrical transducer, Sliding Contact devices, Variable-inductance transducer elements, the differential transformer, Variable-reluctance transducers, Capacitive transducers. The piezoelectric effect, photo-electric transducer, electronic transducer element.

Intermediate Elements:

Amplifier, Operational Amplifier, Differential and Integrating Elements, Filters, A-D and D-A Converters

The simple current sensitive circuit, the ballast circuit, The voltage-dividing potentiometer circuit, The voltage balancing potentiometer circuit, Resistance bridges.

Indicating, Recording and Display Elements:

Meter Indicators. The vacuum tube voltmeter, CRO, Electronic Switch, CRO recording techniques, Oscillographs. Digital Recorders

## Module II

(12 hours)

### Strain Measurement

The electrical resistance strain gauge. The metallic resistance strain gauge, Selection and Installation factors for metallic strain gauge, Circuitry, metallic strain gauge. The strain gauge ballast circuit, the starting gauge bridge circuit, Temperature compensation.

### Measurement of Pressure

Pressure measurement systems, Pressure measurement transducers, Elastic diaphragms, strain gauge pressure cells, measurement of high pressure, Measurement of low pressures, dynamic characteristics of pressure measuring systems.

### Measurement of Fluid Flow

Flow characteristics obstruction meters, Obstruction meter for compressible fluids- Orifice, Venturi meter and Pitot tube, The variable-area meter, Turbine Flow meters.

### Temperature Measurement

Use of bimetals pressure thermometers, Thermocouples, Pyrometry, Calibration of temperature measuring devices.

### Force, Power, Speed and Torque Measurement :

Load Cell, Dynamometers, Tachometer and Tacho-generator, Stroboscope, The seismic instrument.- Vibrometers and accelerometers

## Module III

(12 hours)

Description of open and closed loop control systems and their block diagrams. Use of block diagram and signal flow graph to find overall transfer function.

1<sup>st</sup> and 2<sup>nd</sup> order systems and their response to step and sinusoidal input, error analysis, static and dynamic error coefficients.

Routh's stability criterion. The Root-Locus method, Bode Plot and Nyquist plot, Gain margin and phase margin.

### Textbooks

1. Instrumentation Measurement and Analysis, B.C.Nakra and KK.Chaudhry, Tata Mc Graw Hill, Third Edition.

### Reference :

1. Mechanical Measurements, T.G. Beckwith and N. Lewis Buck, Oxford and IBH Publishing Co.
2. Modern Control Engineering, K.K. Ogata, prentice Hall India