

## **Metrology & Measurement**

**ME-504**

**Contracts: 3L**

**Credit: 3**

### **Module 1**

Introduction: Definition and importance of Metrology Measurement; Methods of measurements – direct, indirect, comparison, substitution, transposition, deflection and null measurement; Errors in measurement – absolute, relative, parallax, alignment, loading, dynamic and calibration error; Units of measurements – SI base and derived units, SI prefixes of units. [3]

### **Module 2A**

Linear Metrology: Vernier scale; construction and use of Vernier calliper, Vernier height and depth gauge, micrometer; slip gauge. [3]

### **Module 2B**

Angular Metrology: Constructional features and use of protractor, Vernier bevel protractor, angle gauges, sine bar and slip gauges. [2]

### **Module 2C**

Measurements of : (i) Level using spirit-level; (ii) Flatness using straight edge, interferometry (Newton's rings) and surface plate; Parallelism, cylindricity and concentricity using dial indicator. [3]

### **Module 3**

Interchangeability of components; concept of limits, tolerances and fits; Hole basis and shaft basis system of fits; Go and No Go limit gauges; plug, ring, snap, thread, radius and filler gauges. [5]

### **Module 4**

Definition, use and essential features of Comparators; working principle and application of (i) dial gauge, (ii) Cook optical comparator, (iii) back pressure Bourdon gauge pneumatic comparator, (iv) optical comparator-profile projector. [4]

### **Module 5**

Measuring Instruments: Functional elements of an instrument –sensing, conversion & manipulation, data transmission and presentation element; Characteristics –accuracy, precision, repeatability, sensitivity, reproducibility, linearity, threshold, calibration, response, dynamic or measurement error; Transducers – definition, primary and secondary, active and passive. [5]

### **Module 6**

Measurement of Surface Finish: Definition; Terminologies –geometrical surface, effective surface, surface roughness, roughness (primary texture), waviness (secondary texture), form, lay, sampling length; Numerical evaluation of surface roughness: peak-to-valley height ( $R_{max}$ ), centre line average (CLA,  $R_a$ ), average depth ( $R_m$ ), smoothness value (G); Principle of operation of a Talysurf. [4]

### **Module 7**

Principle of operation of a few measuring instruments: displacement by LVDT; force by strain – gauge load cell and piezoelectric load cell; pressure by Bourdon – tube gauge; temperature by liquid-in-glass thermometer, thermocouples, optical pyrometer; liquid velocity by pitot tube; water flow by orifice meter. [7]

#### **Note for Teachers:**

1. Different concepts involved should be explained.
2. Operating principle of different instruments should be explained, and whenever possible the working of the instruments/equipment should be demonstrated in class and/or corresponding lab (ME 594).

#### **Note for Examination Paper Setter:**

At least one question should be set from each module.

#### **Books Recommended:**

1. Measurement systems – Application and Design by E.O. Doebelin and D.N. Manik, 5<sup>th</sup> ed., Tata McGraw Hill.
2. Principles of Engineering Metrology by R. Rajendra, Jaico Pub. House.
3. Mechanical Measurements by Beckwith, Lienhard and Marangoni, 6<sup>th</sup> ed. Pearson.
4. Metrology & Measurement by Bewoor and Kulkarni, TMH.
5. Metrology by R.K. Jain.