

Course Code	Course Name	Credits
MEC501	Mechanical Measurements and Controls	03

Objectives:

1. To study the principles of precision measuring instruments & their significance.
2. To familiarize with the handling & use of precision measuring instruments/ equipment's.
3. To impart knowledge of architecture of the measurement system.
4. To deliver working principle of mechanical measurement system.
5. To study concept of mathematical modelling of the control system.
6. To acquaint with control system under different time domain.

Outcomes: Learner will be able to...

1. Handle, operate and apply the precision measuring instruments / equipment's.
2. Analyze simple machined components for dimensional stability & functionality.
3. Classify various types of static characteristics and types of errors occurring in the system.
4. Classify and select proper measuring instrument for displacement, pressure, flow and temperature measurements.
5. Design mathematical model of system/process for standard input responses and analyse error and differentiate various types of control systems and time domain specifications
6. Analyse the problems associated with stability.

Module	Details	Hrs.
1	<p>1.1 Introduction to Metrology, Need for inspection, Fundamental principles and definition, Standards of measurement, Errors in measurements, International standardization.</p> <p>1.2 Limits, fits and tolerances of interchangeable manufacture, Elements of interchangeable system, Hole based and shaft based systems, Tolerance grades, Types of fits, General requirements of Go & No go gauging, Taylor's principle, Design of Go & No go gauges.</p>	06
2	<p>2.1 Principles of interference, Concept of flatness, Flatness testing, Optical flats, Optical Interferometer and Laser interferometer.</p> <p>2.2 Surface texture measurement: importance of surface conditions, roughness and waviness, surface roughness standards specifying surface roughness parameters - Ra, Ry, Rz, RMS value etc., Surface roughness measuring instruments.</p> <p>2.3 Screw Thread measurement: Two wire and three wire methods, Floating carriage micrometer.</p> <p>2.4 Gear measurement: Gear tooth comparator, Master gears, Measurement using rollers and Parkinson's Tester.</p>	08
3	<p>3.1 Significance of Mechanical Measurements, Classification of measuring instruments, generalized measurement system, types of inputs: Desired, interfering and modifying inputs.</p> <p>3.2 Static characteristics: Static calibration, Linearity, Static Sensitivity, Accuracy, Static error, Precision, Reproducibility, Threshold, Resolution, Hysteresis, Drift, Span & Range etc.</p>	06
4	<p>4.1 Displacement Measurement: Transducers for displacement, displacement measurement, potentiometer, LVDT, Capacitance Types, Digital Transducers (optical encoder), Nozzle Flapper</p>	08

	<p>Transducer</p> <p>4.2 Strain Measurement: Theory of Strain Gauges, gauge factor, temperature Compensation, Bridge circuit, orientation of strain gauges for force and torque, Strain gauge based load cells and torque sensors</p> <p>4.3 Pressure Measurement: Elastic pressure transducers viz. Bourdon tubes, diaphragm, bellows and piezoelectric pressure sensors, High Pressure Measurements, Bridge man gauge. Vacuum measurement: Vacuum gauges viz. McLeod gauge, Ionization and Thermal Conductivity gauges</p> <p>4.4 Flow Measurement: Bernoulli flowmeters, Ultrasonic Flowmeter, Magnetic flow meter, rotameter</p> <p>4.5 Temperature Measurement: Electrical methods of temperature measurement Resistance thermometers, Thermistors and thermocouples, Pyrometers</p>	
5	<p>5.1 Introduction to control systems, Classification of control system. Open loop and closed loop systems.</p> <p>5.2 Mathematical modelling of control systems, concept of transfer function, Block diagram algebra</p> <p>5.3 Transient and steady state analysis of first and second order system. Time Domain specifications. Step response of second order system. Steady-state error, error coefficients, steady state analysis of different type of systems using step, ramp and parabolic inputs</p>	06
6	<p>6.1 Stability analysis: Introduction to concepts of stability, The Routh criteria for stability</p> <p>6.2 Experimental determination of frequency response, Stability analysis using Root locus, Bode plot</p>	06

Assessment:

Internal Assessment for 20 marks:

Consisting **Two Compulsory Class Tests**

First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I)

End Semester Examination:

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of total **six questions, each carrying 20 marks**
2. **Question 1** will be **compulsory** and should **cover maximum contents of the curriculum**
3. **Remaining questions will be mixed in nature** (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only **Four questions need to be solved**

Text/Reference Books:

1. Engineering. Metrology, I.C. GUPTA, Dhanpat Rai Publications.
2. Engineering. Metrology, R. K. Jain, Khanna Publisher.
3. Measurement Systems: Applications and Design, by EO Doebelin, 5th Edition, McGraw Hill
4. Mechanical Engineering Measurements, A. K. Sawhney, Dhanpat Rai & Sons, New Delhi
5. Instrumentation & Mechanical Measurements, A. K. Thayal
6. Control System Engineering by Nagrath I.J. and Gopal M, Wiley Eastern Ltd.
7. Modern Control engineering: by K. Ogata, Prentice Hall
8. Control systems by Dhanesh Manik, Cengage Learning
9. Engineering Metrology and Measurements by N V Raghavendra and L Krishnamurthy, Oxford University Press.
10. Instrumentation and Control System, W. Bolton, Elsevier
11. Experimental Methods for Engineers by J P Holman, McGraw Hills Int. Edition
12. Engineering Experimentation by EO Doebelin, McGraw Hills Int. Edition
13. Mechanical Measurements by S P Venkateshan, John Wiley & Sons

Links for online NPTEL/SWAYAM courses:

- <https://nptel.ac.in/courses/112/103/112103261/> - Principles of Mechanical Measurement, IIT Guwahati
- <https://nptel.ac.in/courses/112/107/112107242/> - Mechanical Measurement System, IIT Roorkee
- <https://nptel.ac.in/courses/112/106/112106138/> - Mechanical Measurements and Metrology, IIT Madras