SREENIVASA INSTITUTE of TECHNOLOGY and MANAGEMENT STUDIES
(AUTONOMOUS)

(ENGINEERING METROLOGY AND MEASUREMENTS)

18MEC315

QUESTION BANK

III - B.TECH / I - SEMESTER REGULATION: R18

COMPILED BY
FACULTY INCHARGE:

Ms.K.SANTHOSH PRIYA
DEPARTMENT : MECHANICAL ENGINEERING

II B.Tech I Semester	**L**	**T**	**P**	**C**
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18MEC315 ENGINEERING METROLOGY AND MEASUREMENTS

Course Educational Objectives:

1. To understand the basic need for metrology and standards of measurements
2. To study the principle and applications of various linear, angular and measuring instruments.
3. To apply the principles and methods of form measurements and surface metrology.
4. To develop the advanced measurements for quality control in manufacturing industries.
5. To discuss various measuring techniques of mechanical properties in industrial applications.

UNIT – 1: NEED FOR METROLOGY AND STANDARDS OF MEASUREMENTS

Introduction: Need for inspection and quality control – Factors affecting measurement– Methods of measurements – characteristics of measuring instruments – Errors in measurements – Precision, accuracy, calibration and uncertainty. **Standards:** Line, end and wave length standards – Limits, fits and tolerances – Unilateral and bilateral tolerance system, hole and shaft basis systems – Interchangeability and selective assembly – Indian Standard Institution (ISI) system – International Standard (IS) system. **Gauges**: Plug, ring, snap, taper and position gauges – Taylors's principle – Design of GO and NOGO gauges.

UNIT – 2: LINEAR, ANGULAR MEASUREMENTS AND COMPARATORS

Linear Measuring Instruments: Graduated Scales – Scaled instruments - Vernier caliper – Vernier height gauge – Micrometer – Types of micrometer – Slip gauges – Dial Indicators. **Angular measurements:** Bevel protector, sine bar, sine centre, angle dekkor, clinometer, angle gauges, Autocollimator and alignment telescope. **Comparator:** Mechanical, pneumatic, optical and electrical comparators and applications.

UNIT – 3: FORM MEASUREMENTS AND SURFACE FINISH MEASUREMENT

Form measurements: Principles and methods of straightness – Flatness Measurement – Measurement of roundness – Measurement of screw thread elements – Measurement of gear elements. **Surface Finish Measurement:** Surface texture – Surface roughness – Codes – Analysis of surface traces – Methods of measuring surface roughness – Introduction to 3D surface metrology.

UNIT – 4: ADVANCES IN METROLOGY

Laser Metrology: Michelson, single frequency, NPL and DC interferometer – Laser interferometer – Optical flats – Toolmaker's microscope – Profile projector – Ball bar tests. CMM: Constructional features, types, probes, accessories, software and applications. Machine Vision: Basic concepts – Elements – Applications – On-line and in-process monitoring – Computed tomography – White light Scanners.

UNIT – 5: MEASUREMENT OF DISPLACEMENT,FORCE,TORQUE AND TEMPERATURE

Displacement, Speed, Force, Torque, and Strain: LVDT – Piezo electric, inductive, capacitance, resistance, ionization and photo electric transducers – Tachometers – Stroboscope – Measurement of force by direct methods, load cells and proving rings – Measurement of torque by torsion-bar, servo-

controlled and absorption dynamometer – Measurement of strain by mechanical and electrical strain gauges.

Temperature and Pressure: Measurement of temperature by bimetallic strip, thermocouples, pyrometry, thermistors and electrical resistance thermometer – Measurement of pressure by dead weight gauges and manometers, elastic and resonant transducers, vibrating cylinder, high and low pressure measurement – Measurement of vacuum by McLeod and Pirani gauge.

Course Outcomes:

Successful completion of the course the student will be able to,

Course Outcomes		POs related to COs
CO1	Understand the importance of measurements in engineering and the factors affecting measurements and to estimate measurement uncertainty and its knowledge using lifelong	PO1, PO2 ,PO12
CO2	Apply the working principle and applications of various linear and angular measuring instruments and basic concepts of comparators uncertainty and its knowledge using life long	PO1, PO5, PO12
CO3	Apply the principles and methods of form measurements and surface Metrology	PO1, PO5
CO4	Apply the advances in measurements for quality control in manufacturing industries.	PO1, PO2,PO5
CO5	Understand various measuring techniques of mechanical parameters in industrial applications.	PO1,PO2,PO5

Text Books:

1.Engineering Metrology, R.K. Jain, 3/e, 2012, Khanna Publishers, New Delhi.

2.Engineering Metrology and Measurements, N.V. Raghavendra and L. Krishnamurthy, 2013, Oxford University Press.

Reference Books:

1. Fundamentals of Dimensional Metrology, Connie L. Dotson, 6/e, 2016, Cengage Learning, India.
2. Metrology & Measurement, Anand K Bewoor and Vinay A. Kulkarni, 1/e, 2009, Tata McGraw-Hill Education Pvt. Ltd., Noida.
3. Handbook of Dimensional Measurement, Mark Curtis and Francis T. Farago, 5/e, 2013, Industrial Press.
4. Mechanical Measurements, S. P. Venkateshan, 2/e, 2015, John Wiley &Sons.
5. Mechanical Measurements, Thomas G. Beckwith, Roy D. Marangoni and John H. Lienhard V, 6/e, 2009, Pearson Educations, New Delhi.
6. The Metrology Handbook, Jay L. Bucher, 2/e, 2012, The Measurement Quality Division, ASQ.

QUESTION BANK

Question No.	Questions	PO Attainment	Bloom's Taxonomy
	UNIT – 1: NEED FOR METROLOGY AND STANDARDS OF MEASUREMENTS **Introduction:** Need for inspection and quality control – Factors affecting measurement– Methods of measurements – characteristics of measuring instruments – Errors in measurements – Precision, accuracy, calibration and uncertainty. **Standards:** Line, end and wave length standards – Limits, fits and tolerances – Unilateral and bilateral tolerance system, hole and shaft basis systems – Interchangeability and selective assembly – Indian Standard Institution (ISI) system – International Standard (IS) system. **Gauges**: Plug, ring, snap, taper and position gauges – Taylors's principle – Design of GO and NOGO gauges.		
	UNIT 1 – NEED FOR METROLOGY AND STANDARDS OF MEASUREMENTS		
	PART –B		
1	**Explain the different types of fits used in engineering practice with neat sketch.**	**PO1**	**BT1**
2	**Explain clearly what is meant by Selective assembly, when it is used and how does it differ from Interchangeability.**	**PO1**	**BT2**
3	**Why is it necessary to give a tolerance on engineering dimension? Give an example of both unilateral and bilateral tolerances**	**PO1**	**BT1**
4	**Explain the terms: Hole based system, shaft-based system. Enumerate the differences between them.**	**PO1**	**BT1**
5	Explain the need for measurement? Differentiate between precision and accuracy with suitable example?	**PO1**	**BT2**
6	Classify in detail various types of errors that may arise in engineering measurements.	**PO1**	**BT2**
7	Differentiate between Line Standard and End Standard of measurement. Bring out suitable examples under each category.	**PO1**	**BT1**
8	State and explain the Taylor's principle of gauge design with neat sketch of Plug gauge and Snap gauges.	**PO1**	**BT2**
9	Briefly explain the features of Indian Standard limit system and compare it with the I.S.O system.	**PO1**	**BT1**
10	Find the values of allowance, and tolerance for hole and shaft assembly for the following dimensions of mating parts : ΦHole:$25^{+0.05+0.00}$ ΦShaft:$25^{-0.02-0.05}$	**PO1, PO2**	**BT4**

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Question No.	Questions	PO Attainment	Bloom's Taxonomy
	UNIT 2 –LINEAR AND ANGULAR MEASUREMENTS AND COMPARATORS **Linear Measuring Instruments:** Graduated Scales – Scaled instruments - Vernier caliper – Vernier height gauge – Micrometer – Types of micrometer – Slip gauges – Dial Indicators. **Angular measurements:** Bevel protector, sine bar, sine centre, angle dekkor, clinometer, angle gauges, Autocollimator and alignment telescope. **Comparator:** Mechanical, pneumatic, optical and electrical comparators and applications		
	PART-A (Two Marks Questions)		
	PART-B (Ten Marks Questions)		
1	Describe with a neat sketch the principle of working of an auto-collimator. Explain how flatness of the surface is determined with help of an auto-collimator?	**PO1**	**BT2**
2	Explain with the help of a diagram the principle of working of a sine bar for angular measurement. List the advantages and limitations of sine bar.	**PO1**	**BT2**
3	(a)List the functional requirements of a comparator. (b)With a neat sketch explain the electrical comparator.	**PO1, PO5**	**BT2**
4	Explain the construction and working of a Vernier Caliper and vernier height gauge.	**PO1**	**BT2**
5	Explain the construction and working of Sigma mechanical comparator with a neat sketch.	**PO1**	**BT1,BT2**
6	Explain with a neat sketch construction and working of the solex pneumatic comparator.	**PO1**	**BT1,BT2**
7	Explain the construction and use of (i) Vernier bevel protractor, (ii) Angle dekkor and (iii) Sine bar with suitable sketches.	**PO1**	**BT2**
8	Describe in brief the classifications of comparator? Explain the construction and working principle of a reed type mechanical comparator .	**PO1**	**BT1**
9	(a)Define comparator. What is the need of a comparator. (b)With a neat sketch explain Dial indicator and state its advantages.	**PO1**	**BT2**
10	**Explain the differences between a comparator and a measuring instrument. State the fields of application of comparator.**	**PO1**	**BT2**

Question No.	Questions	PO Attainment	Bloom's Taxonomy
***UNIT 3 – METROLOGY OF* FORM MEASUREMENTS AND SURFACE FINISH MEASUREMENT**			
Form measurements: Principles and methods of straightness – Flatness Measurement – Measurement of roundness – Measurement of screw thread elements – Measurement of gear elements. **Surface Finish Measurement:** Surface texture – Surface roughness – Codes – Analysis of surface traces – Methods of measuring surface roughness – Introduction to 3D surface metrology.			
PART-B (Ten Marks Questions)			
1	**Describe the following methods of checking straightness of a surface (a)Auto collimator method.(b)Straight edge method**	**PO1**	**BT1,BT2**
2	**Define roundness. State the causes of out of roundness. Name the commonly used methods of measurement of roundness.**	**PO1**	**BT2**
3	What is 'best size of wire' for effective diameter measurement? Derive a relationship for the best size wire in terms of its effective diameter	**PO1**	**BT1**
4	With a neat sketch explain how the simple effective diameter of a screw thread may be checked using the two wire method.	**PO1**	**BT2**
5	Explain with a neat sketch, the principle and working of Taylor Hobson Talysurf surface roughness tester for the measurement of surface finish	**PO1**	**BT2**
6	Describe a gear tooth vernier caliper and show how it is used for gears?	**PO1**	**BT1**
7	What are the various errors in screw threads? Discuss sources of these errors and precautions need to minimize or completely eliminate these errors.	**PO1**	**BT2**
8	**In the measurement of Surface roughness, heights of 20 successive peaks and valleys were measure from a datum as follows: 35,25,40,22,35,18,42,25,35,22,36,18,42,22,32,21,37,18,35,20 microns. If these measurements were obtained over length of 20mm, Determine the C.L.A and R.M.S values of the surface.**	**PO1, PO4**	**BT4**
9	with a neat sketch, the principle and working of Tomlinson surface Meter roughness tester for the measurement of surface finish	**PO1**	**BT2**
10	**Explain the Evaluation of Surface finish using (a)Peak to Valley method(b)Average Roughness and (iii)Form Factor.**	**PO1**	**BT1**

Question No.	Questions	PO Attainment	Bloom's Taxonomy
	UNIT 4 – ADVANCES IN METROLOGY		
	Laser in Metrology: Michelson, single frequency, NPL and DC interferometer – Laser interferometer – Optical flats – Toolmaker's microscope – Profile projector – Ball bar tests. CMM: Constructional features, types, probes, accessories, software and applications. Machine Vision: Basic concepts – Elements – Applications – On-line and in-process monitoring – Computed tomography – White light Scanners.		
	PART-B (Ten Marks Questions)		
1	**What is coordinate Measuring machine? What are its basic elements? With neat sketch explain the construction and working principle of CMM.**	**PO1**	**BT2**
2	**What is optical flat? Explain how interference fringes are formed when optical flat is placed on a surface to be tested?**	**PO1**	**BT2**
3	a) Describe the working of NPL flatness interferometer with a neat sketch. (b) Explain why monochromatic light is used for Interferometry work and not the white light.	**PO1**	**BT2**
4	Describe with a neat sketch working principle of a Michelson interferometer.	**PO1**	**BT2**
5	**With the help of neat sketch explain the construction, working and application of Tool makers microscope.**	**PO1**	**BT2**
6	**Explain the various stages involved in machine vision system. Also elaborate the uses of machine vision systems in manufacturing industry.**	**PO1**	**BT1**
7	**Sketch and describe the optical system of the following interferometers.(a)Laser interferometer.(b)N.P.L Flatness interferometer.**	**PO1**	**BT1**
8	**Sketch the optical path of a profile projector and discuss use of such projectors.**	**PO1**	**BT1,BT2**
9	**Elaborate in detail Computed tomography and white light scanners.**	**PO1**	**BT2**
10	**(a)What are interferometers? What are their advantages over optical flats? (b)Name the various types of interferometers.**	**PO1**	**BT2**

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Question No.	Questions	PO Attainment	Bloom's Taxonomy
	UNIT 5: MEASUREMENT OF DISPLACEMENT, FORCE, TORQUE AND TEMPERATURE		
	Displacement, Speed, Force, Torque, and Strain: LVDT – Piezo electric, inductive, capacitance, resistance, ionization and photo electric transducers – Tachometers – Stroboscope – Measurement of force by direct methods, load cells and proving rings – Measurement of torque by torsion-bar, servo-controlled and absorption dynamometer – Measurement of strain by mechanical and electrical strain gauges. Temperature and Pressure: Measurement of temperature by bimetallic strip, thermocouples, pyrometry, thermistors and electrical resistance thermometer – Measurement of pressure by dead weight gauges and manometers, elastic and resonant transducers, vibrating cylinder, high and low pressure measurement – Measurement of vacuum by McLeod and Pirani gauge.		
	PART-B		
1	**Describe the following with neat sketches(i)LVDT(II)Load cell (iii)Proving Rings.**	**PO1**	**BT1**
2	**With neat sketch describe the following in connection with temperature measurement (i)Thermo couple (ii)Bimetallic strip(iii)Pyrometer.**	**PO1**	**BT1**
3	**Write the classification of Transducers? Describe the following transducer with neat sketch (i) Piezo electric transducer (ii)Capacitance Transducer.**	**PO1**	**BT2**
4	**Describe the following with neat sketch in connection with pressure measurement(i)Dead weight pressure gauges(ii)Bourdon tube pressure gauge.**	**PO1**	**BT2**
5	**What are the methods of strain measurement. Illustrate the working of electrical strain gauge.**	**PO1**	**BT2**
6	**Explain With a neat sketch the construction and working of McLeod guage and pirani gauge.**	**PO1**	**BT1,BT2**
7	Explain the working principle of an electrical resistance thermometer.	**PO1**	**BT1**
8	**Describe with neat sketches in brief (i)Radiation Pyrometers.(ii)Optical pyrometers.**	**PO1**	**BT1**
9	**Classify dynamometers and explain absorption dynamometer in brief.**	**PO1**	**BT2**
10	**(a)Differentiate between primary and secondary transducers.** **(b)State the basic requirements of a transducer.**	**PO1**	**BT2**

*****ALL THE BEST*****