Engineering Metrology

S.No.	Board of Study	Course Code	Course Title	Scheme of Examination					
				Theory			Practical		Total Marks
				ESE	CT	TA	ESE	TA	
1.	Mechanical Engineering	2037475(037)	Engineering Metrology	70	20	30	-	-	120
2.	Mechanical Engineering	2037465(037)	Engineering Metrology(Lab)	-	-	-	30	50	80

Unit Number	Unit Titles	Total Marks
I	Introduction	10
II	Linear Measurements	12
III	Angular Measurements	12
IV	Measurement of Geometric Tolerances and Surface Roughness	12
V	Screw Thread Measurements and Gear Measurements	12
VI	Comparators & Limit Gauges	12
	Total	**70**

Unit-1.0 Introduction

1.1 Inspection, its objective and purpose, types of inspection – raw material inspection, in process inspection, final inspection, Methods of Inspection - centralized and decentralized inspection, their advantages, disadvantages and applications, Inspection report.

1.2 Metrology: Correlation ofinspection and metrology, definition of metrology and its importance in industrial inspection, meaning of specification, Interchangeability and selective assembly,

1.3 Accuracy and Precision, their need in industrial measurement, relationship between cost and accuracy, Errors – systematic and random

1.4 Elements of measuring systems – standard, workpiece, instruments, person and environment,Standard, its importance material standard and wavelength standard, classification of standards – primary, secondary, tertiary and working standards.

Unit-2.0 LinearMeasurement

2.1 Standards of length – Line and End standards,their characteristics and applications, Datum planes in dimension measurement – Surfaceplate, V-block.

2.2 Classification of linear measurement instruments – direct andindirect with examples, Direct measuring instruments:

i Vernier caliper,ii Micrometer – outside, inside anddepth

iii Vernier height gaugeiv Depth gauge construction working,handling, specifications, applications, precautions and errors of each

2.3 Indirect measuring instruments: Telescopicgauges, small hole gauges –their construction, working, specifications, applications, precautions and errors.

2.4 Dial Gauge: classification as per IS: 2092-1962, schematic diagram, function of parts, working principle, accuracy, applications and precautions.

2.5 Slip gauge – Classification as per IS: 2984-1966, their accuracy, applications, selection of gauge blocks, wringing, handling and precautions.

Unit-3.0 Angular measurements

3.1 Need for angle measurement, Direct angle measurement:

i Optical Bevel Protractor

ii Universal Bevel

Protractor their construction, working, handling, specifications, applications, precautions.

3.2 Indirect angle measurement:

i Angle gauges – sets, ,handling, method of combining, selection of angle gauge blocks for a given angle.

ii Sine bar – working principle, types as per IS:5979-1970, specifications, handling, measuring known and unknown angles.

iii Spirit level – working principle, sensitivity and factors affecting it, handling, applications, .

iv Autocollimator – working principle, construction, handling, applications.

v Angle Dekkor – working principle, construction, handling, applications.

Unit 4.0 Measurement of Geometric Tolerances and Surface Roughness

4.1 Concept of straightness, flatness, squareness and roundness, importance of their measurement.

4.2 Measurement of Straightness: Straight edge method (Light gap and feeler gauge method), Wedge method, Precision level method and Autocollimator method

Their principle, instruments required for each method, precautions, limitations, applicability i.e., type of job/situation where each of methods is suitable and accuracy of each method.

4.3 Measurement of flatness: High spot method, Precision level method, Autocollimator method Their principle, instruments required for each method, precautions, limitations, applicability i.e., type of job/situation where each of methods is suitable and accuracy of each method.

4.4 Measurement of Squareness: Indicator method, Engineer's square tester, Autocollimator method Their principle, instruments required for each, method, precautions, limitations, applicability *i.e.,* type of job/situation where each of methods is suitable and accuracy of each method.

4.5 Measurement of Roundness: V block and Dial indicator method, principle, instruments required, precautions, and limitations.

4.6 Assessment of surface roughness:

i Terminology associated with assessment of surface roughness (as per IS: 3073 – 1967) –

Surface roughness, primary texture (roughness), secondary texture (waviness), real surface, geometrical surface, effective surface, real profile, geometrical profile, effective profile, reference line, lay, traversing length, sampling length, spacing of irregularities, mean line of profile, centre line of

profile.

ii 'M' and 'E' system of assessment of surface roughness, their merits and demerits, reasons for adoption of 'M' system,

iii Basic units of indicating surface roughness – C.L.A. value, R.M.S. value, ten point height of irregularity, their graphical and mathematical interpretation

iv Measurement of surface roughness

(a) Comparison method - touch inspection, visual inspection, scratch inspection, microscopic inspection, their applications ,limitations

(b) Direct measurement – Stylus based instrument: Tomlinson surface meter, Taylor-Hobson Talysurf, Profilometer

4.4 Relationship of Machining processes and surface texture and their representation.

Unit 5.0 Screw Thread Measurements and Gear Measurements

5.1 Thread nomenclature, Various types of threads, Errors in screw threads: Error in Pitch (Progressive and periodic), effective diameter, major diameter, minor diameter and angle or form.

5.2 Methods of measuring external screw thread elements:

i Pitch – Thread pitch gauge, microscope method, Pitch measuring machine

ii Effective diameter – Thread micrometer, two and three wire method

iii Minor diameter – Micrometer with two V – shaped hard steel pieces

iv Major diameter – Micrometer

v Angle or Form – Tool room projection

Procedure of each method, precautions to be taken, advantages and limitations.

5.3 Methods of internal thread measurement: i Core diameter – Using Wedge parallel and micrometer

ii Effective diameter - Using optical comparator

iii Thread Form – Using thread cast method, materials used for casting – plaster of Paris, Sulphur, Dental wax

Procedure of each method, precautions to be taken, advantages and limitations.

5.4 Gear Measurement: Terminology associated with gear measurements, recall types of gears with their sketches, Spur gear nomenclature, need of gear measurement, Gear elements requiring measurement – gear tooth form, gear tooth thickness, pitch, eccentricity.

5.5 Measurement of gear elements:

i Gear tooth form – Principle of measurement, Use of Tool room microscope, Use of David Brown gear tooth form testing machine.

ii Gear tooth thickness – Principle of measurement – Chordal thickness and Constant Chord, Use of Gear tooth vernier caliper.

iii Pitch – Principle of pitch measurement, Use of Parkson gear tester.

iv Eccentricity – Purpose and principle of measurement.

Unit 6.0 Comparators and Limit Gauges

6.1 Comparators: Definition, working principle, basic requirements of a good comparator, applications.

6.2 Types of Comparators –Mechanical, Electrical, Optical and Pneumatic Their working, application, advantages and limitations, selection for given specific work/component.

6.3 Limit Gauges:
Recall the terminology associated with limits, fits and tolerances, Define gauging, its need and difference with measuring, classification of gauges – according to use, according to form, according to construction, according to specific use.

6.4 Fixed size gauges – Plug, ring, snap and thread gauges, their sketches, applications, Go and Not Go ends of a limit gauge, their purpose and identification.

6.5 Taylor's principle, maximum and minimum metal conditions and their correlation with Go and Not Go gauge, working tolerance, gauge tolerance, wear allowance, calculation of gauge dimensions for a given set of data.

H) Suggested Specification Table (For ESE of Laboratory Instruction*):

Laboratory Instruction Number	Short Laboratory Experiment Titles	Assessment of Laboratory Work (Marks)		
		Performance		Viva-Voce
		PRA	PDA	
LE1.1	Given the industrial situations, suggest the type of inspection applicable to each situation.	15	10	5
LE1.2	Given the situations, state where accuracy is necessary and where precision is necessary.	15	10	5
LE2.1	Measure the linear dimensions (length, diameter – outside & inside) of a given job using vernier caliper.	15	10	5
LE2.2	Measure the diameter – outside & inside) of a given job using micrometer.	15	10	5
LE 2.3	Measure the height of a given object using vernier height gauge.	15	10	5
LE2.4	To measure the depth of a given object using Depth gauge.	15	10	5
LE2.5	Check the parallelism and perpendicularity of a machine tool using dial gauge.	15	10	5
LE2.6	Set a job on lathe using dial gauge.	15	10	5
Laboratory Instruction Number	**Short Laboratory Experiment Titles**	**Assessment of Laboratory Work (Marks)**		
		Performance		**Viva-Voce**
		PRA	**PDA**	
LE2.7	Set the adjustable snap gauge Go end and No-Go end for a give dimension using slip gauges combination.	15	10	5
LE3.1	Measure given angle of a component using Optical bevel protractor and Universal bevel protractor.	15	10	5
LE3.2	Set the Sine bar to a given known angle.	15	10	5
LE3.3	Measure the angle of taper of a given component using Sine bar.	15	10	5
LE3.4	Measure the angle of a given component with Angle Dekkar.	15	10	5
LE4.1	Check the straightness of a given job with straight edge method and Wedge method.	15	10	5
LE4.2	Check the straightness of a given job using precision level.	15	10	5

LE4.3	Check the straightness of a given job using autocollimator.	15	10	5
LE4.4	Check the flatness of a given job using precision level	15	10	5
LE4.5	Check the flatness of a given job using autocollimator.	15	10	5
LE4.6	Check the squareness of a given job using indicator method or Engineer's squareness tester.	15	10	5
LE4.7	Check the roundness of a given job using V block and dial indicator.	15	10	5
LE4.8	Using any one direct measuring instrument check the conformity or non-conformity of given three test specimen with values of roughness recommended by IS:3073.	15	10	5
LE5.1	Measure the effective diameter of a given screw thread using screw thread micrometer.	15	10	5
LE5.2	Measure the pitch of a given screw thread using screw pitch gauge.	15	10	5
LE5.3	Measure the major diameter, minor diameter, pitch and included angle using toolmaker's microscope.	15	10	5
LE5.4	Measure the gear tooth thickness using Gear tooth vernier caliper.	15	10	5
LE5.5	Check the gear tooth form using Toolmaker's microscope.	15	10	5
LE 6.1	Use dial indicator as mechanical comparator to inspect given components.	15	10	5
LE6.2	Select limit gauges for checking given dimensions.	15	10	5

I) Suggested Learning Resources:

(a) Books :

S. No.	Titles	Author	Publisher	Edition*
1	Engineering Metrology	R.K. Jain	Khanna Publishers	Latest edition 978-8174091536
2	Engineering Metrology	I.C. Gupta	Dhanpat Rai & Sons	Latest edition 978-8189928452
3	A Text Book of Engineering Metrology	M. Mahajan	Dhanpat Rai & Co.	Latest edition 1234567143086
4	Engineering metrology & measurements	N V Raghavendra and L krishnamurthy	Oxford	Latest edition ISBN-9780198085492
5	Principles of Engineering Metrology	Rega Rajendra	Jaico Publishing House	Latest edition 978-8179928370