Lok Jagruti Kendra University
University with a Difference

Diploma in Automation & Robotics

LJ Polytechnic

Course Code: 025120404

Metrology and Measurements

Programme / Branch Name			Diploma in Automation & Robotics			
Course Name	Metrology and Measurements				**Course Code**	025120404
Course Type	HSSC	BSC	ESC	PCC	OEC	PEC

Legends: HSSC: Humanities and Social Sciences Courses BSC: Basic Science Courses
ESC: Engineering Science Courses PCC: Program Core Courses
OEC: Open Elective Courses PEC: Program Elective Courses

1. Teaching and Evaluation Scheme

Teaching Hours / Week				**Evaluation Scheme**			
L	**T**	**P**	**Total Credit**	**CCE**	**SEE (Th)**	**SEE (Pr)**	**TOTAL**
3	0	2	4	50	50	50	150

Legends:
L: Lectures T: Tutorial P: Practical
CCE: Continuous & Comprehensive Evaluation
SEE (Th): Semester End Evaluation (Theory)
SEE (Pr): Semester End Evaluation (Practical)

2. Prerequisites

- ✓ Fundamentals of physics
- ✓ Fundamentals of Mathematics

3. Rationale

Measurement and metrology deal with the application of science in mechanical engineering. It provides a means of assessing the suitability of measuring instruments, their calibration, and the quality control of manufactured products. A product that is not manufactured according to metrological specifications will have to incur heavy costs or comply with the specifications later. Any compromise in quality creates rapid negative sentiments in the market and the cost of recovering the original market position would be quite high. Hence, an organization should strive towards a ZERO–DEFECT regime to survive in a highly competitive market, ensuring this aspect of manufacturing is the responsibility of a quality control engineer, who must be completely familiar with measurements and metrology and also their limitations.

4. Objectives

- ✓ Select suitable instrument / gauge / method of inspection for determining geometrical and dimensional measurements.
- ✓ Calibrate measuring instruments and also design inspection gauges.
- ✓ Principles of measuring instruments and gauges and their uses.
- ✓ Evaluation and inspection of surface roughness.
- ✓ Inspection of the spur gear and thread elements.
- ✓ Inspection of engineering parts with various precision instruments.

5. Contents

Unit No.	Unit Name	Topics	Learning Outcome	% Weightage	Hours
1.	**Introduction to Metrology & Linear Measurement and Angular Measurements**	1.1. Inspection, quality and quality control-definitions and differences. 1.2. Define accuracy, precision and error. 1.3. Principle of vernier scale and least count. 1.4. Surface plate-types, important features, standards/important sizes, applications and precautions in use. 1.5. Types, constructional sketch, major parts and their functions, least count, measuring methods and measurement. 1.6. Slip gauge-types, applications, and wringing method. 1.7. Sketch, major parts and their functions, least count measuring methods and measurement illustration of: i. Bevel Protector. ii. Sine bar. iii. Angle gauges. iv. Angle Dekker. v. Spirit level. vi. Clinometers. vii. Autocollimator. 1.8. Calibration – concept and need. 1.9. Bars (Numerical), standardization.	• Distinguish between accuracy, precision and error. • Determine the least count of the given measuring instrument • Select a suitable linear measurement instrument and measure the linear dimension of a given component. • Describe the procedure for wringing the slip gauge and set given dimension • Select suitable angular measurement instrument • Describe the measurement procedure for the angular dimension of a given component	25	10
		2.1. Dial indicators/gauge-types, constructional sketch and applications. 2.2. Principle of vernier scale and least count,definition, symbol and measuring methods of: i. Straightness. ii. Flatness. iii. Squareness.	• Select the measuring method and describe the measurement procedure for geometrical tolerance of a given part/assembly.		

2.	**Measurement of Geometrical Tolerances and Surface Roughness**	iv. Parallelism. v. Perpendicularity. vi. Roundness. vii. Concentricity. viii. Cylindricity. ix. Run out and ovality 2.3. Terminology used in connection with surface finish. 2.4. Comparison methods to inspect surface finish-concept and applications. 2.5. Direct instrument measurement methods-types and concepts. 2.6. Construction, working and applications of talysurf surface roughness tester and tomlinson tester. 2.7. Centreline average and root mean square systems of surface texture evaluation-terminology used, concept, equations and numerical examples. 2.8. Indication of various surface roughness characteristics with surface roughness symbol interpretation.	• Define various terminology used for surface roughness • Explain the working of direct instrument methods. • Determine surface roughness of given data.	20	8
3.	**Gear and Thread Measurement**	3.1. Types of gears 3.2. Forms of gear teeth-types and concept. 3.3. Gear tooth terminology. 3.4. Sketch, major parts and their functions, least count measuring methods and measurement illustration of gear tooth vernier. 3.5. Derivation and numerical example to measure gear tooth thickness using: i. Gear tooth vernier. ii. Constant chord method iii. Base tangent method 3.6. Gear tooth profile measurement.	• Define various terms used for gear nomenclature. • Use gear tooth vernier to measure gear tooth thickness • Explain the working of the profile projector. • Define various terms used for thread nomenclature.	20	8

		3.7. Threads-classification, elements, specifications and forms. 3.8. Measurement of major and minor diameters. 3.9. Three and two-wire method of measuring the effective diameter of external thread concept, the terminology used, best wire size, derivation of equation and numerical example. 3.10. Thread micrometre-sketch, the method to use and determination of dimension. 3.11. Pitch measurement methods.	• Determine best wire size • Use two and three-wire methods to determine the effective diameter of the thread • Describe the method for measuring the pitch of a given thread.		
4.	**Limit, Fit, Gauges, Transducers and Sensors**	4.1. Limit, gauges, classification, sketch and applications. 4.2. Comparators-concept, types and application 4.3. Transducers-concept classifications, physical quantities which can be measured, advantage and disadvantages. 4.4. Sensors- classification and applications. 4.5. Types of Fits 4.6. Numerical.	• Select and check the given dimension using a limit gauge. • Explain various transducers and sensors. • Define static characteristics of instruments	15	6
5.	**Semiconductor devices and its applications**	5.1. Introduction. 5.2. Classification, working principle, construction, working, advantages, limitations and applications temperature measuring devices: i. Mercury in glass thermometer. ii. Bimetallic thermometer. iii. Resistance thermometer. iv. Thermister. v. Thermocouple. vi. Radiation pyrometers.	• Select and describe the method for using an appropriate temperature measuring device to measure the temperature of a given hot body • Select and describe a method for using appropriate force measuring device	20	10

		vii. Optical pyrometers. 5.3. Direct methods and indirect method, force measuring instrument. 5.4. Torque measuring. 5.5. Types of dynamometers.			
				Total Hours	**42**

6. List of Practicals / Exercises

The practicals/exercises have been properly designed and implemented in an attempt to develop different types of skills, so that students can acquire the competencies/programme outcomes. Following is the list of practicals/exercises.

Sr. No.	Practical / Exercises	Key Competency	Hours
1.	To calibrate the given vernier caliper using Slip Gauge	Surface Plate, vernier scale, slip gauge.	2
2.	To calibrate the given micrometre over the entire range.	Micrometer stand slip gauge Box	2
3.	To set the required angle using slip gauges and sine bar and to measure the taper angle of the given specimen using sine centre and slip gauges.	Surface plate. , slip gauges, sine bar, bevel protractor combination square,sine centre dial indicator., vernier caliper, magnetic Stand/height gauge.	6
4.	To determine the parallelity, perpendicularity of a given specimen using an autocollimator.	Autocollimator, surface plate, highly polished mirror ,try square.	4
5.	Study and applications of profile projector and Tool maker's microscope.	Tool maker's microscope	2
6.	Two-wire and three-wire method of effective diameter measurement using floating carriage micromet	Micrometre	2
7.	To measure the gear tooth profile for the given spur gear using vernier gear tooth calliper.	Gear tooth vernier calliper disc micrometer, outside micrometre,mandrel dial indicator	4
8.	To determine cutting force and power absorbed in turning process on the lathe by using tool dynamometer	Lathe tool dynamometer.	2
9.	To study different thermocouples and their calibration	Thermocouple	2
10.	Mini project	-	2
		Total Hours	**28**

7. Suggested Specification Table for Evaluation Scheme

Unit No.	Unit Name	Distribution of Topics According to Bloom's Taxonomy					
		R %	U %	Ap %	C %	E %	An %
1.	Introduction to metrology linear measurement and angular measurements	40	10	20	10	10	10
2.	Measurement geometrical tolerances and surface roughness	16	10	16	20	22	16
3.	Gear and thread measurement	35	20	10	20	5	10
4.	Limit gauges, fit, transducer, sensor	30	20	15	10	10	15
5.	Temperature force torque and power measurement	20	10	40	12	8	10

Legends: R: Remembering U: Understanding
App: Applying C: Creating
E: Evaluating An: Analyzing

8. Textbooks

1) Textbook of metrology by Mahajan M. S., Dhanpatrai publication, New Delhi.
2) Mechanical measurements and control by Kumar, D.S., Metropolitan, New Delhi.

9. Reference Books

1) Engineering metrology by R. K. Jain, Khanna Publication, New Delhi.
2) Engineering metrology and instrumentation by R. K. Rajput, S. K. Katariya& Sons, New Delhi.
3) Mechanical measurements by , Beckwith Thomas G., Narosa Publishing House, New Delhi.

10. Open Sources (Website, Video, Movie)

1) https://www.youtube.com/watch?v=_VfXMs4iIYk
2) https://www.youtube.com/watch?v=anCnrtjNLQM
3) https://www.youtube.com/watch?v=_kESh9174lc
4) https://www.youtube.com/watch?v=iamxq4Jsimo
5) https://youtu.be/iJnnsQNFuDQ
6) https://youtu.be/YxrL55vVDj8
7) https://youtu.be/mhOSPOw4YOw
8) https://youtu.be/jIOwGWQByFk
9) https://youtu.be/txwwSaf7OCI
10) https://youtu.be/KBzkDmNBreo