COURSE NAME : DIPLOMA IN MECHANICAL ENGINEERING

COURSE CODE : ME /PT/PG

SEMESTER : FIFTH

SUBJECT TITLE : METROLOGY AND QUALITY CONTROL

SUBJECT CODE :

Teaching and Examination Scheme:

Teaching Scheme			Examination Scheme					
TH	TU	PR	PAPER HRS	TH	PR	OR	TW	TOTAL
03	--	02	03	100	25#	--	25@	150

External Assessment, @ Internal assessment, TH-Theory, PR- Practical, TW-Term Work

NOTE: Two tests each of 25 marks to be conducted as per the schedule given by

MSBTE. Total of tests marks for all theory subjects are to be converted out of 50

and to be entered in mark sheet under the head Sessional Work. (SW)

Rationale:

The Diploma mechanical Engineer should understand, select and use various measuring instruments as he often comes across measuring different parameters of machined components and the appropriate fitment of interchangeable components in the assemblies.
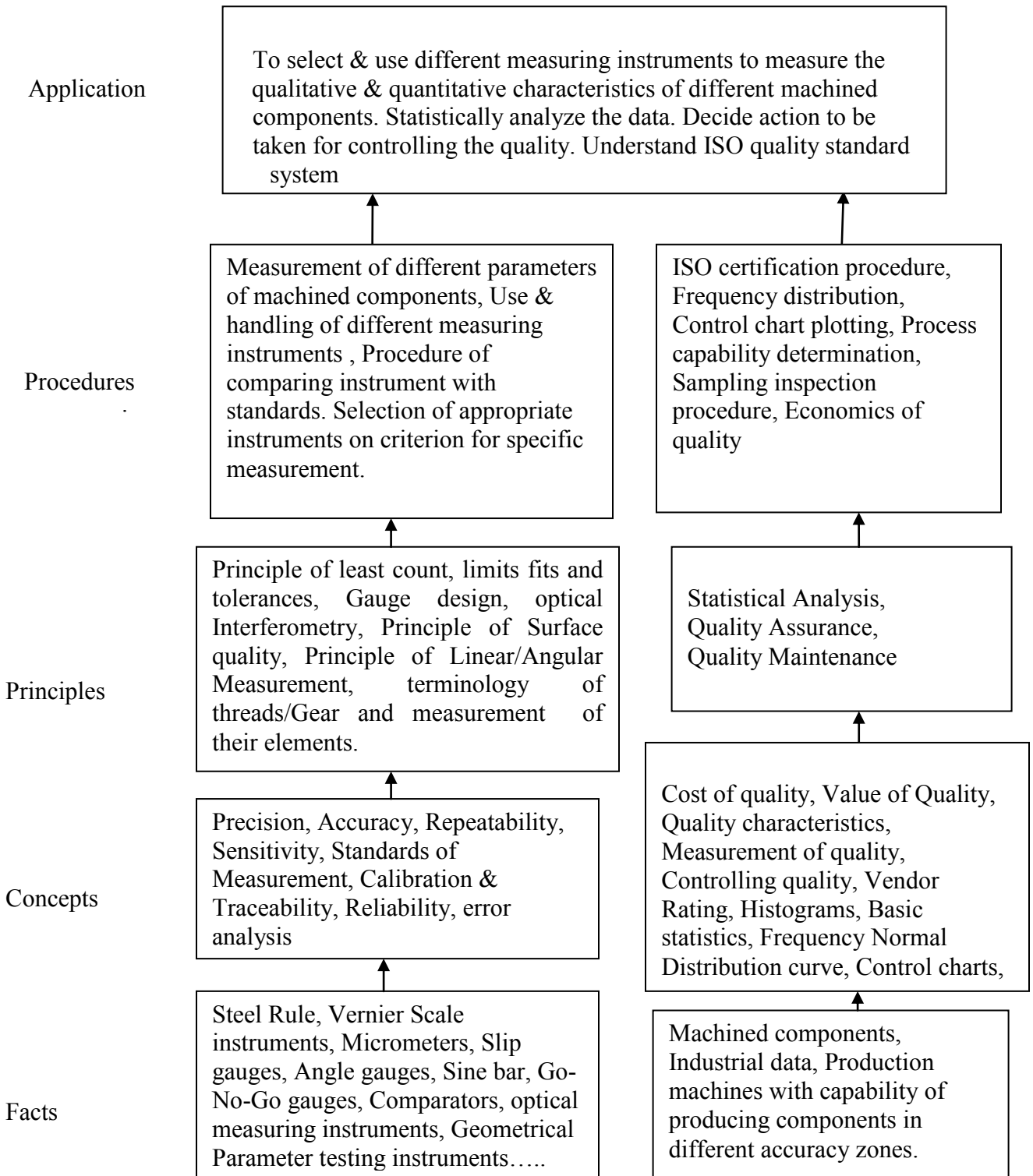
The knowledge of the subject also forms the basis for the design of mechanical measurement systems, design & drawing of mechanical components.

Objectives:

Students will be able to:

1. Understand and calculate the least count of all basic measuring instruments.
2. Select and use appropriate instrument/s for specific measurement.
3. Understand the systems of limits, fits and tolerances and correlate with machine drawing and manufacturing processes.
4. Analyze and interpret the data obtained from the different measurements processes and present it in the graphical form, statistical form for understanding the concepts of SQC.
5. Construct, draw and interpret the control charts.

Learning Structure:

Application

> To select & use different measuring instruments to measure the qualitative & quantitative characteristics of different machined components. Statistically analyze the data. Decide action to be taken for controlling the quality. Understand ISO quality standard system

Procedures

> Measurement of different parameters of machined components, Use & handling of different measuring instruments , Procedure of comparing instrument with standards. Selection of appropriate instruments on criterion for specific measurement.

> ISO certification procedure, Frequency distribution, Control chart plotting, Process capability determination, Sampling inspection procedure, Economics of quality

Principles

> Principle of least count, limits fits and tolerances, Gauge design, optical Interferometry, Principle of Surface quality, Principle of Linear/Angular Measurement, terminology of threads/Gear and measurement of their elements.

> Statistical Analysis, Quality Assurance, Quality Maintenance

Concepts

> Precision, Accuracy, Repeatability, Sensitivity, Standards of Measurement, Calibration & Traceability, Reliability, error analysis

> Cost of quality, Value of Quality, Quality characteristics, Measurement of quality, Controlling quality, Vendor Rating, Histograms, Basic statistics, Frequency Normal Distribution curve, Control charts,

Facts

> Steel Rule, Vernier Scale instruments, Micrometers, Slip gauges, Angle gauges, Sine bar, Go-No-Go gauges, Comparators, optical measuring instruments, Geometrical Parameter testing instruments…..

> Machined components, Industrial data, Production machines with capability of producing components in different accuracy zones.

Theory

Topic & Content	Hours	Marks

1.Introduction to metrology   --------------------------------18 Marks
Specific Objectives
    • To understand the basics of Metrology & calculate the least count of measuring instruments.
    • To understand various standards, comparators, gauge selection and limit system.
1.1Metrology Basics   ---------------------06Marks
Definition of metrology, objectives of metrology, Categories of metrology, Scientific metrology, Industrial metrology, Legal metrology, Need of inspection, **Revision of --**Precision, Accuracy, Sensitivity, Readability, Calibration, Traceability, Reproducibility, Sources of errors, Factors affecting accuracy, Selection of instrument, Precautions while using an instruments for getting higher precision and accuracy. Concept of least count of measuring instruments **(No questions to be set on revision).**
 	
1.2Standards and Comparators   -------------------12Marks
Definition and introduction to line standard end standard, Wavelength standard and their comparison, Slip gauge and its accessories.
Definition, Requirement of good comparator, Classification, use of comparators, Working principle of comparators, Dial indicator, Sigma comparator, Pneumatic comparator- high pressure differential type, Electrical (LVDT), Relative advantages and disadvantages.
	09	18

2 Limits, Fits ,Tolerances and Gauges   ----------------08Marks
Specific Objectives
    • To understand the basics of limits, fits & tolerances
    • To calculate the basic and gauge tolerances.
    • To understand various types of gauges and their applicability.
 	
2.1 Concept of Limits, Fits, And Tolerances, Selective Assembly, Interchangeability, Hole And Shaft Basis System, Taylor's Principle, Design of Plug, Ring Gauges, IS919-1993 (Limits, Fits & Tolerances, Gauges IS 3477-1973), Study of relation gauges, concept of multi gauging and inspection.
	06	08

3 Angular Measurement ---------------------08Marks **Specific Objectives** • To understand the basics of angular measurement and measure angles using different instruments. 3.1Concept, Instruments For Angular, Measurements, Working And Use of Universal Bevel Protractor, Sine Bar, Spirit Level, Principle of Working of Clinometers, Angle Gauges (With Numerical on Setting of Angle Gauges).Angle dekkor as an angular comparator.	04	8
4.Threads and Gear Metrology -------------------------------16Marks **Specific Objectives** • To Understand & use various methods of calculating thread elements and elements of gear tooth **4.1Screw thread Measurements** 08Marks ISO grade and fits of thread, Errors in threads, Pitch errors, Measurement of different elements such as major diameter, minor diameter, effective diameter, pitch for internal and external threads , Three wire method, Thread gauge, screw thread micrometer, Working principle of floating carriage micrometer. **4.2 Gear Measurement & Testing** 08Marks Analytical and functional inspection, Measurement of tooth thickness by constant chord method, base tangent method, gear tooth vernier, Errors in gears such as backlash, run out, composite, concentricity. Parkinson gear tester.	06	16
5.Testing Techniques -------------------------------10Marks **Specific Objectives:** • To know terminology of surface finish & measure the surface finish of various components. **5.1Measurement of surface finish** --------------------06Marks Primary and secondary texture, Sampling length, Lay, terminology as per IS 3073- 1967, direction of lay, Sources of lay and its significance, CLA, Ra, RMS values and their interpretation, Symbol for designating surface finish on drawing, Various techniques of qualitative analysis **5.2Machine tool testing** ------------------------04Marks Parallelism, Straightness, Squareness, Coaxiallity, roundness, run out,	06	10

alignment testing of machine tools such as lathe, milling machine and drilling machine as per IS standard procedure. Study of optical flat for flatness testing.		
6.Quality Control -------------------------12Marks **Specific Objectives:** • To understand the concept of Quality, cost of quality. • To understand the concept and principles of TQM. **6.1 Quality :** -------------------------06Marks Definitions, meaning of quality of produce& services, Quality characteristics, Quality of design, Quality of conformance, Quality of performance, Concept of reliability, Cost, Quantity assurance, Cost of rework & repair, Quality & Inspection, Inspection stages. **6.2 Total Quality Management :** ----------------06Marks Principles and concept of total quantity management. a) Quality Audit: Concept of audit practices, lead assessor certification. b) Six sigma: Statistical meaning, methodology of system Improvement. c) Introduction of ISO 9001-2008.ISO-14000 and TS 16949.	07	12
7 Statistical Quality Control ----------------28Marks **Specific Objectives:** • to know the basics of statistics. • To understand different data types and analyze & interpret the data **7.1 Statistical Quality Control** --------------------20Marks Basics of Statistical concepts, Meaning and importance of SQC, Variable and attribute Measurement. control charts – inherent and assignable sources of variation, control charts for variables – X & R charts, control charts for attributes p, np, C charts, process capability of machine, , C_p and C_{pk} calculations, determination of statistical limits, different possibilities, Rejection area, Statistically capable and incapable processes (20 marks) **7.2Acceptance Sampling** --------–-08Marks Concept, Comparison with 100% inspection, Different types of sampling plans, sampling methods, merits and demerits of acceptance sampling. OC Curve. (08 marks)	10	28
Total	**48**	**100**

PRACTICALS:
Skills to be developed:
Intellectual skills:
1 To select basic measuring instruments.
2 To calculate least count of various measuring instruments.
3. To collect, record and analyze the data.
4. To interpret the results of data analysis.
Motor skills:
1. Measure the dimensions of component using various instruments.
2. To take care of instruments.
3. To draw various charts and curves related to data.
4. To handle various instruments.

List of Practical:

1. Measurement of various dimensions& dimensional parameters using instruments such as radius gauge, pitch screw gauge, filler gauge, vernier caliper, vernier height gauge, vernier depth gauge, dial type vernier caliper, micrometer, inside micrometer, tube micrometer.
   Note: -1) The student should measure at least 3 dimensions of given job and take 5 readings per dimension.
   2) Individual performing the measurement with one setup on one surface plate and simultaneous 4 to 5 setup should be kept ready for measurement.(At least 10 Vernier calipers, Micrometers with different range i.e. 0-25mm two nos. , 25- 50 two nos. Inside micrometer, tube micrometer, V anvil micrometer at least one.)

2. To set the Adjustable snap gauge GO end and NOGO end for a given dimensions using slip gauges.

3. Inspection of given components using Dial Indicator as a mechanical comparator.
4. To check the given component using high pressure Dial type pneumatic comparator.

5. To find unknown angle of component using bevel protractor and verify the same using sine bar/ sine center and slip gauges.
6. To measure the angle of component with the Angle Dekkor/Autocollimator using angle gauge.

7. Measurement of screw thread elements by using screw thread micrometer, screw pitch gauge & their verification with the help of profile projector/tool

maker's microscope.

8. Measurement of gear tooth elements by using gear tooth vernier caliper and verification of gear tooth profile using profile projector.

9. To measure surface roughness using surface roughness measuring instrument. Measure surface roughness of turning, milling ,shaping ,grinding and lapping surfaces.

10. Testing of lathe machine/drill machine for parallelism, squareness, trueness by Test Dial indicator.

11. Draw the frequency histogram, frequency polygon for given samples (min 50 readings) and find mean, mode, median.

12. To draw the normal distribution curve and find standard deviation, variance, range and determine process capability.

13. To draw and interpret the control Charts (X – bar and R – chart, P chart, C chart) for given data.

- **Batch size of students for experiment 2 to 13 shall be 4 to 5.**
- **4 to 5 experimental setups should be arranged simultaneously.**

Assignment:
1. Visit the industries to collect the data for p and c chart, study the coordinate measuring machine and study the quality management systems**.**
2. Selection of comparators for the given dimensional data

Learning Resources:

Sr.No.	Author	Title Of Book	Edition	Publisher
01	R. K. Jain	Engineering metrology	2010	Khanna Publisher, Delhi.
02	M. Mahajan	Text book of metrology	Second Reprint-2010	Dhanpat Rai & Co.
03	I.C. Gupta	A text book of Engineering metrology		Dhanpat Rai and Sons
04	M. Mahajan	Statistical Quality Control	2010	Dhanpat Rai and Sons
05	Douglas C. Montgomery	Statistical Quality Control	Sixth reprint 2011	Wiley India Pvt. Ltd.

06	Dale H. Besterfield and others	Total Quality Management	Third Reprint 2012	Pearson

2. IS/ International Codes:

IS 919 – 1993 Recommendation for limits, fits and tolerances

IS 2029 – 1962 Dial gauges.

IS 2103 – 1972 Engineering Square

IS 2909 – 1964 Guide for selection of fits.

IS 2921 – 1964 Vernier height gauges

IS 2949 – 1964 V Block.

IS 2984 – 1966 Slip gauges.

IS 3139 – 1966 Dimensions for screw threads.

IS 3179 – 1965 Feeler gauges.

IS 3455 – 1966 Tolerances for plain limit gauges.

IS 3477 – 1973 Snap gauges.

IS 6137 – 1971 Plain plug gauges.

IS 3651 – 1976 Vernier Caliper

IS 4218 -   Isometric screw threads

IS 4440 – 1967 Slip gauges accessories

IS 5359 – 1969 Sine bars

IS 5402 – 1970 Principle and applications of sine bars