Shree Sathyam
College of Engineering and Technology
Approved by AICTE, New Delhi & Affiliated to Anna University, Chennai.
NH-544, Salem - Coimbatore Highways, Kuppanur, Sankari Taluk, Salem - 637301, TamilNadu, India.
Email : principal@shreesathyam.edu.in Web : www.shreesathyam.edu.in Phone : 04283 - 244080

Name of the Department : Mechanical Engineering

Subject Code & Name : ME3592 / METROLOGY AND MEASUREMENTS

Year & Semester : II & IV

Unit-I Concept of Measurement

PART A

1. What is Range of measurement?
The physical variables that are measured between two values. One is the higher calibration value H, and the other is Lower value L, The difference between H, and L, is called range.

2. What is Resolution?
The minimum value of the input signal is required to cause an appreciable change in the output known as resolution.

3. Differentiate between sensitivity and range with suitable example.
Example: A Instrument have a scale reading of 0.01mm to 100mm.

- The sensitivity of the instrument is 0.0lmm i.e. the minimum value in the scale by which the instrument can read.
- The range is 0.01 to 100mm i.e. the minimum to maximum value by which the instrument can read.

4. Define system error and correction.
Error: The deviation between the results of measured value to the actual value.

Correction: The numerical value which should be added to the measured value to get the correct result.

5. Define measurand.
Measurand is the physical quantity or property like length, diameter, and angle to be measured.

6. Define deterministic metrology.
The metrology in which part measurement is replaced by process measurement. The new techniques such as 3D error compensation by CNC systems are applied.

7. Define over damped and under damped system.
Over damped - The final indication of measurement ii approached exponentially from one side.
Under damped - The pointer approach the position corresponding to final reading and makes a number of oscillations around it.

8. Give any four methods of measurement
1. Direct method. 2. Indirect method. 3. Comparison method. 4. Coincidence method.

9. Give classification of measuring instruments.

1. Angle measuring Instruments. 2. Length measuring Instruments.
3. Instruments for surface finish. 4. Instruments for deviations.

10. Define True size.

True size is Theoretical size of a dimension

11. Define Actual size

Actual size is size obtained through measurement with permissible error.

12. What is Hysteresis?

All the energy put into the stressed component when loaded is not recovered upon unloading. So, the output of measurement partially depends on input called hysteresis.

13. Differentiate accuracy and Uncertainty with example.

Accuracy - Closeness to the true value.

Example: Measuring accuracy is ± 0.02mm for diameter 25mm. Here the measurement true values lie between 24.98 to25.02 mm

Uncertainty about the true value = ± 0.02mm.

14. Define Span.

The algebraic difference between higher calibration values to lower calibration value.
Example: In a measurement of temperature higher value is 200°C and lower value is 150°C means span = 200 - 150 = 50°C.

15. Differentiate between precision and accuracy.

Accuracy - The maximum amount by which the result differ from true value.
Precision - Degree of repetitiveness. If an instrument is not precise it will give different results for the same dimension for the repeated readings.

16. What is Scale interval?

It is the difference between two successive scale marks in units.

17. What is Response time?

The time at which the instrument begins its response for a change measured quantity.

18. Define Repeatability?

The ability of the measuring instrument to repeat the same results g the act measurements for the same quantity is known as repeatability.

19. Explain the term magnification.

It means the magnitude of output signal of measuring instrument times increases to make it more readable.

20. Classify the Absolute error.

The absolute error is classified into 1. True absolute error 2. Apparent absolute error.

21. What is Relative error?

Relative error is defined as the results of the absolute error and the, value of comparison used for calculation of that absolute error. The comparison may be true value or conventional true value or arithmetic mean for series of measurement.

22. Classify the errors.

The errors can be classified into

1. Static errors - Reading errors, Characteristic errors, Environmental errors
2. Loading errors
3. Dynamic error

23. What is the basic Principle of measurement?

It is the physical phenomenon utilized in the measurement. If energy kind of quantity measured, there must be a unit to measure it. So this will give the quantity to be measured in number of that unit.

24. What are the applications of Legal metrology?

Industrial Measurement, Commercial transactions, Public health and human safety ensuring.

25. What is the need of inspection?

To determine the fitness of new made materials, products or component part and to compare the materials, products to the established standard.

26. What are the important elements of measurements?

The important elements of a measurement are 1. Measurand 2. Reference 3. Comparator.

27. What is legal metrology?

Legal metrology is part of Metrology and it is directed by a National Organisation which is called "Notional service of Legal Metrology". The main objective is to, maintain uniformity of measurement in a particular country.

28. What is measurement? Give its types.

It is the process of comparing the input signals with pre-defined standard and gives out the result. It is a word used to tell us about physical quantities such as length, weight, temperature, pressure, force etc.

Types: 1. Primary measurements, 2.Secondary measurements. 3. Tertiary measurements.

29. Name the fundamental measuring process in measurement.

a. Direct comparison

b. Indirect comparison

30. Where the secondary measurement is used?

A secondary measurement involves only one translation to be done on the quality under the measurement.

31. Define the standard of measurement.

Standard is a physical representation of a unit of measurement. A known accurate measure of physical quantity is termed as standard.

32. What are the different types of standard in measurement?

1. International standard, 2. Primary standard, 3. Secondary standard, 4. Working standard.

33. Define 'precision' and 'accuracy'.

Accuracy: It is defined as the closeness with which the reading approaches an accepted standard value or true.

Precision: Term 'precision' refers to ability of an instrument to reproduce its readings again in the same manner for constant input signal.

34. Define readability.

It is a term frequently used for analog type instruments. It is obvious that this characteristic depends on both the instrument and observer.

35. What is hysteresis?

Hysteresis is defined as the difference in the output for a given input when this value is approached from the opposite direction.

36. What do you meant by dynamic characteristics?

As the input varies from instant to instant, output also varies from instant to instant. The behaviours of system under such condition are called dynamic response.

37. State the dynamic characteristics of simplified measuring system.

i) Speed of response ii) Lag iii) Fidelity iv) Dynamic error.

PART B (16 marks)

1. Define "errors" and explain the causes of those errors in engineering measurements with suitable examples.

2. Define calibration. Explain the purpose of calibrating the instrument and discuss the various calibrating systems. Also discuss the primary and secondary calibration.

3. Explain the need for measurement and classification of various measuring methods.

4. Give brief note on accuracy, precision, sensitivity, readability, repeatability, reproducibility and interchangeability.

5. Draw the block diagram of the functional elements of a pressure gauge and explain the functions of different functional elements.

6. Explain with examples the difference between a primary and a secondary standard. What are working standards?

7. Explain the following terms in precision measurements: (a) Repeatability (b) Sensitivity, (c) Lag and (d) Derived unit.

8. Enumerate the desirable characteristics of precision measuring instruments.

UNIT II – Linear and Angular Measurements

PART A

1. What are the considerations while manufacturing the slip gauges?
The following additional operations are carried out to obtain the necessary qualities in slip gauges during manufacture.
1. First the approximate size of slip gauges is done by preliminary operations.
2. The blocks are hardened and wear resistant by a special heat treatment process.
3. To stabilize the whole life of blocks, seasoning process is done.
4. The approximate required dimension is done by a final grinding process.

2. How do you calibrate the slip gauges?
Comparators are used to calibrate the slip gauges.

3. List the various linear measurements?
(i) Length (ii) Heights and (iii) Thickness

4. What are the various types of linear measuring instruments?
The various devices used for measuring the linear measurements are i. Vernier callipers ii. Micrometers iii. Slip gauge or gauge blocks iv. Comparator

5. List out any four angular measuring instrument used in metrology
(i) Angle gauges (ii) Divided scales (iii) Sine bar with slip gauges (iv) Autocollimator (v) Angle dekkor

6. What is comparator?
Comparator is a form of linear measurement device which is quick and more convenient for checking large number of identical dimensions.

7. Classify the comparator according to the principles used for obtaining magnification.
The common types are: (i) Mechanical comparators. (ii) Electrical comparators. (iii) Optical comparators. (iv) Pneumatic comparators.

8. How the mechanical comparator works?
The method of magnifying small movement of the indicator in all mechanical comparators is affected by means of levers, gear trains or a combination of these elements.

9. State the best example of a mechanical comparator.
A dial indicator or dial gauge is used as a mechanical comparator.

10. Define least count and mention the least count of a mechanical comparator.
Least count - The least value that can be measured by using any measuring instrument known as least count. Least count of a mechanical comparator is 0.01 mm.

11. How the mechanical comparator is used? State with any one example.
Let us assume that the required height of the component I s 32.5mm. Initially, this height is built up with slip gauges. The slip gauge blocks are placed under the stem of the dial gauge. The pointer in the dial gauge is adjusted to zero. The slip gauges are removed- Now, the component to be checked is introduced under the stem of the dial gauge. If there is any deviation in the height of the component, it will be indicated by the pointer.

12. State any four advantages of reed type mechanical comparator.

(i) It is usually robust, compact and easy to handle.
(ii) There is no external supply such as electricity, air required.
(iii) It has very simple mechanism and is cheaper when compared to other types.
(iv) It is suitable for ordinary workshop and also easily portable.

13. Mention any two disadvantages of reed type mechanical comparator.

(i) Accuracy of the comparator mainly depends on the accuracy of the rack and pinion arrangement. Any slackness will reduce accuracy.
(ii) It has more moving parts and hence friction is more and accuracy is less.

14. What are the major types of on electrical comparator?

An electrical comparator consists of the following three major parts such as (i) Transducer (ii) Display device as meter (iii) Amplifier

15. On what basis the transducer works?

An iron armature is provided in between two coils held by a leaf spring at one end. The other end is supported against a plunger. The two coils act as two arms of an A.C. wheat stone bridge circuit.

16. How is the accuracy of an electrical comparator checked?

To check the accuracy of a given specimen or work, first a standard specimen is placed under the plunger. After this, the resistance of wheat stone bridge is adjusted that the scale reading shows zero. Then the specimen is removed. Now, the work is introduced under the plunger.

17. State the working principle of an electronic comparator.

In electronic comparator, transducer induction or the principle of application of frequency modulation or radio oscillation is followed.

18. Mention the important parts of an electronic comparator.

(i) Transducer (ii) Oscillator (iii) Amplifier (iv) Demodulator (v) Meter

19. Classify pneumatic comparators.

(i) Flow or Velocity type. (ii) Back pressure type

20. What are the advantages of electrical and electronic comparator?

(i) It has less number of moving parts.
(ii) Magnification obtained is very high.
(iii) Two or more magnifications are provided in the same instrument to use various ranges.
(iv) The pointer is made very light so that it is more sensitive to vibration.

21. What are the disadvantages of electrical and electronic comparator?

(i) External agency is required to metre for actuation.
(ii) Variation of voltage or frequency may affect the accuracy of output.
(iii) Due to heating coils, the accuracy decreases.
(iv) It is more expensive than mechanical comparator.

22. List the various parts of an optical comparator.

The optical comparator consists of the following parts such as (i) Pivoted lever. (ii) Objective lens (iii) Scale (iv) Plunger (v) Table and (vi) Base.

23. What are the advantages of pneumatic comparator?

(i) The wear of measuring heads is avoided due to absence of direct contact.
(ii) Friction is less due to less number of moving parts.
(iii) Work piece is cleaned by supplying of all during the measurement.

(iv) High magnification is possible.
(v) There is no interference of measuring head and indicating device because the measuring head is kept away from the indicating device.
(vi) It is a suitable method to check ovalty and taperness of circular bore.

24. Why laser is preferred in engineering metrology?
It is used in engineering metrology because of its properties such as high precision high, high accuracy, rapid non-contact gauging of soft, delicate or hot moving points.

25. What is the main difference between linear and angular measurement?
The main difference between linear and angular measurement is the no absolute standard is required for angular measurement.

26. What is laser micrometer?
It is used for checking the profile of complex components like turbine blades.

27. What is wringing of gauge blocks?
Wringing or slipping is nothing but the process combining the faces of slip gauge.

28. What are slip accessories?
1. Measuring jaw, 2. Scriber and centre point, 3.Holder and base.

29. What is the advantage of using laser beam in interferometry?
Laser provides a source of coherence and truly monochromatic light. The property of coherence enables it to be projected in a narrow pencil of beam without any scatter.

30. What are the major parts of an electrical comparator?
An electrical comparator consists of the following three major parts such as i. Transducer ii. Display as meter iii. Amplifier.

PART B

1. Shafts of 75 ± 0.02 mm diameter are to be checked by the help of a GO, NOGO snap gauges. Design the gauge, sketch it and show its GO size and NOGO size dimensions. Assume normal wear allowance and gauge maker's tolerance.
2. Explain with a neat sketch how a vernier caliper is used for linear measurements.
3. Describe the construction, various types, working principle of sine bar. Why is sine bar not suitable for measuring angles above 45°? Explain the process of 'Wringing' in slip gauges.
4. What are the classifications of sine bar? Enumerate it. Describe the uses of sine bar with limitations and sources of errors.
5. State the requirements of slip gauges. How it is manufactured and checked for surface quality? Also enumerate its classifications.
6. Enumerate the following with neat sketch: (i) Differential screw micrometer (ii) Thread micrometer (iii) Blade type micrometer (iv) Micrometer thread gauge.
7. Describe the working principle of angle dekkor and its applications with neat sketch.
8. Give a brief note on rollers. Explain the angular measurements methods using rollers.
9. Explain the working principle of tool maker's microscope with neat sketch.
10. Discuss the operation of following types of comparators: (i) Mechanical, (ii) Pneumatic and (iii) Electrical comparator.
11. Explain the various types of bevel protractor with neat sketch and write its applications.
12. State and explain the 'Taylor's principle of gauge design'.
13. Explain with the help of neat sketches, the principle and construction of an auto-collimator.

UNIT 3 - Advances in Metrology

PART A

1. What is interferometer?
Interferometer is optical instruments used for measuring flatness and determining the lengths of slip gauges by direct reference to the wavelength of light.

2. Name the different types of interferometer?
1) NPL flatness interferometer 2) Michelson interferometer
3) Laser interferometer 4) Zesis gauge block interferometer.

3. Name the common source of light used for interferometer
(a) Mercury 198 (b) Cad minus (c) Krypton 86 (d) Helium (e) Hydrogen.

4. What is crest and trough?
The light is a form of energy being propagated by electromagnetic waves, which is a sine curve. The high point of the wave is called crust and the low Point iscalled is trough.

5. What is wavelength?
The distance between two crust or two rough is called the wavelength.

6. What is meant by alignment test on machine tools?
The alignment test is carried out to check the grade of manufacturing accuracy of the machine tool.

7. List the various geometrical checks made on machine tools.
a. Straightness of guide ways and slide ways of machine tool.
b. Flatness of machine tables and slide ways.
c. Parallelism, equidistance and alignment of the slide ways.
d. True running and alignment of shaft and spindle.
e. The pitch error or lead of lead screw.
f. Pitch errors of gears.

8. Distinguish between geometrical test and practical test on a machine tool
The alignment test is carried out to check the grade of manufacturing accuracy of the machine tool. Performance test consist of checking the accuracy of the finished component. Alignment test consist of checking the relationship between various machine elements when the machine tool is idle. Performance test consists of preparing the actual test jobs on the machine and checking the accuracy of the jobs produced.

9. What are the main spindle errors?
(a) Out of round (b) Eccentricity (c) Radial throw of an axis (d) Run out (e) Periodical axial slip

10. Write the various tests conducted on any machinetools.
1. Test for level of installation of machine tool in horizontal and vertical planes.
2. Test for flatness of machine bed and for straightness and parallelism of bed ways on bearing surface.
3. Test for perpendicularity of guide ways to other guide ways.
4. Test for true running of the main spindle and its axial movements.

11. Why the laser is used in alignment testing?
The alignment tests can be carried out over greater distances and to a greater degree of accuracy using laser equipment. Laser equipment produces real straight line, whereas an alignment telescope provides a, imaginary line that cannot be seen in space.

12. Classify the machine tool test.

It can be classified into 1. Static tests 2. Dynamic tests.

13. What are the different types of geometrical tests conducted on machine tools?

1. Straightness. , 2. Flatness. 3. Parallelism, equi-distance and coincidence.

14. What is the principle of laser?

The photon emitted during stimulated emission has the same energy, phase and frequency as the incident photon. This principle states that the photon comes in contact with another atom or molecule in the higher energy level E2then it will cause the atom to return to ground state energy level E, by releasing another photon. The sequence of triggered identical photon from stimulated at In is known as stimulated emission. This multiplication of photon through stimulated emission leads to coherent, powerful, monochromatic, collimated beam of light emission. This light emission is called laser.

15. What is CMM?

It is a three dimensional measurements for various components. These machines have precise movement is x, y, z coordinates which can be easily controlled and measured. Each slide in three directions is equipped with a precision linear measurement transducer which gives digital display and senses positive and negative direction.

16. Define axial length measuring accuracy

It is defined as difference between the reference length of gauges aligned with a machine axis and the corresponding measurement results from the machine.

17. Write the types of coordinate measuring machines

1. Bridge type 2. Horizontal bore mill 3. Vertical bore mill 4. Spherical coordinate measuring machine

18. Explain CNC, CMM briefly.

A computer numerical control system can be used with CNM to do calculations while measuring complex parts. Error can be stored in memory while doing calculations. For automatic calibration of probe, determination of co-ordinate system, calculation, evaluation and recording etc., special software's are incorporated.

19. Write some features of CMM software.

Measurement of diameter, center distance can be measured as follows:
(i) Measurement of plane and spatial curves
(ii) Minimise CNC programme
(iii) Data communications
(iv) Digital input and output command
(v) Interface to CAD software.

20. Define machine vision.

Machine vision can be defined as a means of simulating the image recognition and analysis capabilities of the human system with electronic and electromechanical techniques.

21. What are the four basic types of machine, vision system?

(i) Image formation. (ii) Processing of image. (iii) Analyzing the image (iv) Interpretation of image.

22. Write the advantages of machine vision system.

(i) Reduction of tooling and fixture cash. (ii) Elimination of need for precise part location. (iii) Integrated automation of dimensional verification. (iv) Defect detection.

23. Define grayscale analysis.

In these techniques, discrete areas or windows are formed around only the portions of the image to be inspected. For determining if brackets are present, high intensity lighting is positioned. This type of discrete area analysis is a powerful tool and can be used for inspection of absence, correct part assembly, orientation, part, integrity, etc.

24. Mention the advantages of CMM.

(i) The inspection rate is increased.
(ii) Accuracy is reduced.
(iii) Operator's error can be minimized. Skill of the operator is reduced.
(iv) Reduction in calculating, recording and set up time.
(iv) No need of GO/NOGO gauges.
(vi) Reduction of scrap and good part rejection.

25. Mention the disadvantages of CMM.

(i) The table and probe may not be in perfect alignment.
(ii) The stylus may have run out.
(iii) The stylus moving in z-axis may have some perpendicularity errors.
(iv) Stylus while moving in x and y direction may not be square to each other.
(v) There may be errors in digital system.

26. Mention the application of CMM.

(i) CMM's to find application in automobile, machine to electronics, space and many other large companies.
(ii) These are best suited for the test and inspection Of test equipment, gauges and tools.
(iii) For aircraft and space vehicles of hundred Percent inspections is carried out by using CMM.
(iv) CMM can be used for determining dimensional accuracy of the component. (v) CMM can also be used for sorting tasks to achieve optimum pacing of components within tolerance limits.

27. Describe the features of a flexible inspection system.

(i) A powerful computer serves as a real time processor to handle part dimensional data and as a multi programming system to perform such tasks as manufacturing process control.
(ii) The terminal provides interactive communication with personnel Computer where the programmes are stored.
(iii) Input devices microprocessor based gauges and other inspection devices are used in CMM.

28. Write brief note about (i) Co-ordinate measuring machine equipped with a laser probe (ii) Virtual measuring system

(i) A CMM equipped with a laser probe can convert a part of physical model into a digitize file. Such a file can be compared with other file and can be manipulated by designers to improve quality. Manufactures can verify that each finished part measures exactly as designed.
(ii) Virtual measuring System uses a Microscope system to examine an electronic replica of the Surface texture of part. Such a system is non-contact. 3-D Surface measurement system and provide image of the surface. The images are processed on a PC using vertical scanning interferometry and vision analysis software to produce 2D-profile, 3-D plots and counter plots. It generates statistics for average roughness, average profile height, reduced peak height, cares roughness depth, reduced valley depth and a number of other parameters. It also determines the depth; spacing and angle of groove in a hard surface optical probe of a cylinder bore can be rotated 360 degrees and moved vertically along the cylinder wall.

29. Explain briefly the three important fields of machine vision system.

Inspection: It is the ability of an automated vision system to recognize well-defined pattern and if these pattern match these stored in the system makes machine vision ideal for inspection of raw materials, parts, assemblies etc.

Part identification: It is the ability of part recognition provides positive identifications of an object for decision-making purposes.
Guidance and Control: Machine vision systems are used to provide sensor feedback for real time guidance.

30. What are the load cells?
Load cells are device for the force measurement through indirect methods.

31. What is the purpose of torque measurement? Also name the instrument used for measuring torque.
The main purpose of torque measurement is to determine the mechanical power required power or developed by a machine.
Instrument used for measurement of torque.
(a) Mechanical torsion meter (b) Optical torsion meter (c) electrical torsion meter (d) strain gauge torsion meter.

32. Mention the need for using strain gauge in Wheatstone network circuits.
The need is that the change in the resistance due to strain in the gauges can either be measured or made to give an output which can be easily displayed or recorded.

33. Mention a few material used on binding of strain gauges.
(a) Ceramic cement, (b) Epoxy, (c) Nitrocellulose.

34. What is meant by pressure?
Pressure is the force exerted by a medium on a unit area due to the interaction of fluid particles among themselves.

35. Name any four elements that can be used in elastic pressure transducer.
Diaphragms, capsules, bellows and bourdon or helical tubes.

36. What is a kentometer?
It is a device for measurement of absolute pressure.

PART B

1. With neat sketch explain the various types of CMM based on its construction. Write the advantages of computer aided inspection.
2. Explain the construction and working principle of laser interferometer with neat diagram? Explain the use of laser interferometer in angular measurement.
3. Give brief note on working principle of laser interferometer. State its application in machine tool metrology. Explain in details the various method of testing accuracy of horizontal milling machine and lathe using laser interferometer.
4. How laser equipment is used for alignment testing? What are the alignment test carried out in lathe, milling machine and pillar type grinding machine?
5. What are the applications of coordinate measuring machine? List the performance of CMM.
6. Define machine vision. List the types and advantages of machine vision system.
7. Briefly explain the important fields of machine vision system with applications.
8. Explain the working principle of machine vision system in detail with neat sketch.
9. Write a brief note on machine vision system functions.
10. Explain how the straightness error of a Lathe bed is checked using an auto-collimator.

Unit 4 - Form Measurement

PART A

1. Name the various types of pitch errors found in screw?
(i) Progressive error (ii) Drunken error (iii) Periodic error (iv) Irregular errors.

2. Name the various methods of measuring the minor diameter of the thread.
(i) Using taper parallels. (ii) Using rollers and slip gauges.

3. Name the various methods used for measuring the major diameter
(i) Ordinary micrometer (ii) Bench micro meter

4. Name the various methods for measuring effective diameter.
(i) One wire method (ii) Two wire method (iii) Three wire method.

5. Name the various methods for measuring pitch diameter.
(i) Pitch measuring machine (ii) Tool maker microscope (iii) Screw pitch gauge.

6. Name the two corrections are to be applied in the measurement of effective diameter.
(i) Rake corrections (ii) Compression correction.

7. What is best size of wire?
Best size of wire is a wire of such diameter that it makes contact with the flanks of the thread on the pitch line.

8. Define drunken thread.
This is one, having erratic pitch, in which the advance Of the helix is irregular in one complete revolution of thread.

9. What is the effect of flank angle error?
Errors in the flank cause a virtual increase in the effective diameter of a bolt and decrease in that, of nut.

10. What are the applications of toolmaker's microscope?
(i) Linear measurement (ii) Measurement of pitch of the screw (iii) Measurement of thread angle.

11. Define periodic error.
The periodic error repeats itself at equal intervals along the thread.

12. What are the commonly used forms of gear teeth?
(i) Involute (ii) Cycloidal.

13. What are the types of gears?
(i) Spur (ii) Helical (iii) Bevel (iv) Worth and Worm wheel (v) Rack and pinion.

14. Define module.
Module= pitch circle diameter/ number of teeth.

15. Define lead angle.
It is the angle between the tangent to the helix and plane perpendicular to the axis of cylinder.

16. What are the various methods used for measuring the gear tooth thickness?
(i) Gear tooth vernier (ii) Constant chord method (iii) Base tangent method (iv) Measurement over pins.

17. Name four gear errors.
(i) Pitch error (iii) Alignment error (ii) Composite error (iv) Thickness error.

18. Name the method used for checking the pitch of the gear.
(i) Step by step method. (ii) Direct angular measurement.

19. What are the direct angular measurements methods?
1. Profile checking: a) Optical projection method b) Involute measuring method.
2. Thickness measurement: a) Chordal thickness method b) Constance chord method.

20. Define constant chord.
Constant chord is the chord joining those points, or opposite faces of the tooth.

21. Give the formula for measuring radius of circle.
R = (I - d)28d
Where, R=Radius of the job, I = Distance between the balls, d = Diameter of pins.

22. What are the two methods used in measuring radius of concave surface?
a) Edges are well defined. b) Edges are rounded up.

23. What are the factors affecting surface roughness?
a) Vibrations b) Material of the work piece c) Tool d) Machining type

24. What are the methods used for evaluating the surface finish?
a) Peak to valley height method. b) The average roughness method. c) Form factor method.

25. Define fullness and emptiness in form factor.
Degree of fullness (K) = area of metal /Area of enveloping rectangle.

Degree of emptiness = 1 – K.

26. What are the methods used for measuring surface roughness?
a) Inspection by comparison b) Direct instrument measurements.

27. What are the stylus probe instruments?
a) Profilometer b) Taylor Hobson Talysurf c) Tomlinson surface meter.

28. Define straightness of a line in two planes.
A line is said to be straight over a given length, of the variation of the distance of its points from two planes perpendicular to each other and parallel to the direction of a line remaining within the specified tolerance limits.

29. Define roundness. Name the four measurement of roundness.
It is a surface of revolution where all the surfaces intersected by any plane perpendicular to a common axis in case of cylinder and cone.

Four measurement of roundness
a. Heart square circle. b. Minimum radial separation circle. c. Maximum inscribed circle. d. Minimum circumscribed circle.

30. Name the devices used for measurement of roundness.
1. Diametral 2. Circumferential confining gauge. 3. Rotating on center.
4. V-Block 5. Three point probe 6. Accurate spindle.

31. Define lay

Lay: Direction of the predominate surface pattern.

32. What is run out?

Run out -Total range of reading of a fixed indicate Or with the contact points applied to a Surface rotated, without axial movement, about 3 fixed axis.

33. Define the effective diameter of thread.

Effective diameter is the average of minor and major diameter of thread.

34. Name the various methods for measuring effective diameter.

i) One wire method ii) two wire method iii) three wire method.

35. Name the two corrections to be applied for the measurement of effective diameter.

i) Rake correction ii) compression correction.

36. What is meant by "best size wire" in screw thread measurement?

Best size of wire is a wire of such diameter that it makes contact with flanks of the thread on the pitch line.

37. Define drunken thread.

This is one having erratic pitch, in which the advance of helix is irregular in one complete revolution of thread.

38. What is the effect of flank angle error?

Errors in the flank cause a virtual increase in the effective diameter of a bolt and decrease in that of nut.

39. Define periodic error.

The periodic error repeats itself at equal interval along the thread.

40. Define lead angle.

It is the angle between the tangent to the helix and plane perpendicular to the axis of cylinder.

41. Name four gear error.

i) Pitch error ii) composite error iii) Alignment error iv) thickness error.

42. Name the method used for checking the pitch of gear.

[i] step by step method, [ii] Direct angular method.

PART B

1. Define various terminologies related with screw thread.
2. How to measure the pitch of the screw thread by using the tool maker's microscope? Discuss in detail.
3. How are the major and minor diameters of thread measured?
4. Briefly describe major, minor and effective diameter of thread?
5. What is the 'best wire size'? Derive an expression for the same in terms of the pitch and angle of the thread.
6. Explain the construction and working of floating carriage micrometer.
7. Explain the construction and working of Gear tooth vernier (chordal thickness method) used for tooth thickness.
8. Using constant chord method and base tangent method, how tooth thickness is measured in gears? And describe the method of inspecting the profile of spur gear by using involute measuring machine.
9. With a neat sketch, explain the Parkinson gear tester with its limitations.
10. Explain the following instruments used measure the surface finish (i) Tomlinson surface meter, (ii) Profilometer, (iii) Taylor – Bobson – Talysurf and (iv) Profilograph.
11. Explain a method used in the measurement of surface finish and flatness.

UNIT 5 – Measurement of Power, Flow and Temperature

PART A

1. What are load cells?
Load cells are devices for the measurement of force through indirect methods.

2. Give the principle of hot wire anemometer
When a fluid flows over a heated surface heat is transferred from the surface and so the temperature reduces. The rate of reduction of temperature is related to flow rate.

3. State any four inferential type of flowmeters.
Venturi meter, orifice meter, rotometers, pitot tube.

4. What is the principle involved in fluid expansion thermometer?
Change in pressure in the bulb is taken as an indication of the temperature.

5. Mention the principle involved in bimetallic strip.
It is based on change in dimension.

6. What is thermocouple?
When two metals are joined together it will create an emf and it is primarily a function of the junction temperature.

7. What is a Kentometer?
It is a device for measurement of absolute pressure.

8. What is thermopile?
When thermocouples are connected in series it is called thermopile.

9. State the principles of force measurements.
(i) Direct methods, (ii) Indirect methods.

10. What is the general rule used for accelerometers to provide satisfactory performance?
In order to provide satisfactory acceleration data for an accelerometer, it must be used at forcing frequencies below approximately 40% of its own under damped natural frequency should be on the order of 70% of critical damping.

11. Define torque. List the methods employed for measuring torque.
It is a measure of the tendency of a force to rotate the body on which it acts about an axis.
Methods to measure torque:
(i) Torque reaction methods.
(ii) Prony brake method.
(iii) Torque measurement using strain gauge.
(iv) Torque measurement using torsion bars.

12. Name the instruments used for temperature measurement.
(i) Thermocouple, (ii) Electrical thermal resistance, (iii) Thermistors and (iv) Pyrometers.

13. What is the working principle of thermocouple?
"When two dissimilar metals are joined together an emf will exist between the two points A and B, which is primarily a function of the junction temperature". The above said principle is Seeback effect.

PART B

1. Explain the following methods to measure force:
(i) Strain gauge load cell
(ii) Hydraulic load cell
(iii) Proving ring

2. Explain the working of bimetallic strip, electrical thermal resistance and thermistor.

3. What are thermocouples? Dram a neat sketch. State its applications.

4. Describe the pressure measuring equipment: (i) Piezo – electric pressure transducer, (ii) Variable capacitance transducer.

5. Describe with neat sketch, strain gauge torque meter.

6. Explain the flow measuring devices: (i) Pitot tube (ii) Rotometer (iii) Venturimeter.

7. Draw a simple sketch of non-contact type temperature instrument (pyrometer) and describe each element.

8. Describe the construction of eddy current dynamometer and hydraulic dynamometer and explain how it is used for power measurement?

9. With a neat sketch explain the velocity measurement using hot wire anemometer.