ANNAI MATHAMMAL SHEELA ENGINEERING COLLEGE

DEPARTMENT OF MECHANICAL ENGINEERING

UNIT I

BASICS OF METROLOGY

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: An Instrument has a scale reading of 0.01mm to 100mm. Here, 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: Measurement.
Measuring 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 = 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 1500^0 C means span = 200 - 150 = 50^0 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 time's 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?

1. Industrial Measurements.
2. Commercial transactions.
3. Public health and human safety ensuring.

24. 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.

25. What are the important elements of measurements?

The important elements of a measurement is

1. Measurand.
2. Reference.
3. Comparator.

26. What is Legal Metrology?

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

Part – B (16 Marks)

1. Draw the block diagram of generalized measurement system and explain different stages with examples.
2. Distinguish between Repeatability and reproducibility
3. Distinguish between Systematic and random errors
4. Distinguish between Static and dynamic response.
5. Describe the different types of errors in measurements and the causes

1) Explain the various systematic and random errors in measurements?
2) What is the need of calibration? Explain.the classification of various measuring methods.
3) Write detailed notes on : (i) sensitivity. (ii) Calibration (iii) Precision (iv) Interchangeability
4) Define precision, accuracy, readability and sensitivity with respect to measurement.
5) Describe loading errors and environmental errors.
6) What are elements of a measuring system? how they affect accuracy and precision? How error due to these elements are eliminated

UNIT II

LINEAR AND ANGULAR MEASUREMENTS

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 calipers.
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. 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.

7. What are comparators?

Comparators are one form of linear measurement device which is quick and more convenient for checking large number of identical dimensions.

8. How the mechanical comparator works?

The method of magnifying small movement of the indicator in all mechanical comparators are effected 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 0.0 1 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 meter for actuation.
(ii) Variation of voltage or frequency may affect the accuracy of output.
(iv) Due to heating coils, the accuracy decreases.
(v) 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.
(iv) Table
(v) Base.

23. What are the advantages of pneumatic comparators?

(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 taperness of circular bore.

Part – B (16 Marks)

1. What is the constructional difference between an autocollimator and an angle dekkor?
2. How the displacements are measurement using laser interferometer?
3. Explain with the help of neat sketches, the principle and construction of an autocollimator.
4 Explain the working principle of opto – mechanical comparator with a neatsketch.
5. Explain the working principle of Electrical comparator with a neat sketch
6. Explain the working principle of pneumatic comparator with a neat sketch.
7. Explain with the help of neat sketches, the principle and construction of an Angle dekkor.

UNIT III

ADVANCES IN METROLOGY

1. 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.

2 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.

3. Name the different types of interferometer?

1) NPL flatness interferometer.
2) Michelson interferometer.
3) Laser interferometer.
4) Zesis gauge block interferometer.

4.Name the common source of light used for interferometer?

a. Mercury 198.
b. Cad minus.
c. Krypton 86.
d. Helium.
e. Hydrogen.

5. 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 is called is trough.

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.

6. 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. What is wavelength?

The distance between two crusts or two rough is called the wavelength.

9. 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.

10. What are the main spindle errors?

a) Out of round.
b) Eccentricity.
c) Radial throws of an axis.
d) Run out.
e) Periodical axial slip.

11. Write the various tests conducted on any machine tools?

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.

12. 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.

13. Classify the machine tool test.

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

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

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

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. 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 *E2* then 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.

17. Define axial length measuring accuracy.

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

18. Write the types of coordinate measuring machines?

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

19. Explain CNC, CMM briefly.

A computer numerical control system can be used with CN4M 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.

20. Write some features of CMM software.

Measurement of diameter, center distance can be measured as follows:

1. Measurement of plane and spatial curves.
2. Minimize CNC programme.
3. Data communications.
4. Digital input and output command
5. Interface to CAD software.

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.
(i) Integrated automation of dimensional verification
(ii) Defect detection.

23. 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.

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.
(v) 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) Styius 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 an rnicroscope system to' examine an electronic replica of the Surface texture of part. Such a system is non-contact 3-1) Surface measurement system and provide image of the surface. The images are processed on a PC using vertical scanning interferometer and vision analysis software to produce 2D-profile, 3-D plots and counters 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.

Part – B (16 Marks)

1. Briefly explain various terminologies used in a screw thread
2. Briefly explain Computer Aided inspection and Digital devices
3. Explain the working of Laser Interferometer
4. Explain Different types of CMM
5. Explain the constructional features and application of CMM.
6. Describe the working principle of a dual frequency laser interferometer and state its application.
7. Explain the construction details of column type CMMs.What are the advantages of bridge type CMMs? State the possible sources of errors in CMM.
8. Explain with a neat sketch the working of talysurf instrument for surface finish measurement.
9. What is the symbol for fully defining surface roughness and explain each term?

UNIT IV
FORM MEASUREMENT

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.
(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?

(1) Involutes.
(2) 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.
(ii) Alignment error.
(iii) Composite error.
(iv) Thickness error.

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

(iii) Step by step method.
(iv) Direct angular measurement.

19. What are the direct angular measurements methods?

1. Profile checking:
    a) Optical projection method.
    b) Involutes 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 Aces of the tooth.

21. Give the formula for measuring radius of circle.

$$R = \frac{(I - d)^2}{8d}$$

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) Profilo meter.
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.
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. 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.

Part – B (16 Marks)

1. Explain the construction and working of floating carriage micrometer
2. How are the major and minor diameters of thread measured?
3. Define various terminologies related with screw thread
4. Define various terminologies related with screw gears
5. Explain any two taper measurements method.
6. Explain the construction and working of Gear tooth vernier
7. Explain a method used in the measurement of surface finish and flatness

UNIT V
MEASUREMENT OF POWER, FLOW AND TEMPERATURE

1. What are 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 flow meters?

- Venturi meter.
- Orifice meter.
- Rota meter.
- 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 some instruments used to measure negative pressures.

- McLeod gauge
- Kundsen Gauge.
- Pirani Gauge.
- Ionization Type Gauge.

6. Name the two types of hot wire anemometer.

- Constant Current Type.
- Constant Temperature Type.

7. What is an Anemometer?

An anemometer is a device for measuring mean and fluctuating velocities in fluid flows. The reduction of temperature of a surface resulting from the heat transferred owing to the fluid flow is related to flow rate.

8. What is thermocouple?

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

9. What is a Kentometer?

It is a device for measurement of absolute pressure.

10. What is thermopile?

When thermocouples are connected in series it is called thermopile.

11. Write the working principles of hot wire anemometer.

When the fluid flows over heated surface heat is transferred from the surface and so, its temperature reduces. The rate of reduction of temperature is related to floe rate.

12. What is the use of thermometer and pyormeter?

Thermometer is used to measure the absolute temperatures. The pyrometer is used to measure high temperatures.

13. Name the instruments used for measurement of torque.

- Mechanical torsion meter (Stroboscopic method).
- Optical torsion meter.
- Electrical torsion meter.
- Strain gauge torsion meter.

14. Classify the types of strain gauges.

- Unbonded strain gauge.
- Bonded strain gauge.
- Fine wire strain gauge.
- Metal foil strain gauge.
- Piezo-resistive strain gauge.

15. Mention a few materials used in binding of strain gauges.

- Ceramic cement.
- Epoxy.
- Nitrocellulose.

16. Mention the types of dynamometers.

- Absorption dynamometer.
- Driving dynamometer.
- Transmission dynamometer.

17. Mention the types of electrical strain gauges.

- Inductive.
- Capacitive.
- Piezo electric.
- Resistance types.

18. Give any ttwo applications of an ultrasonic flow meter.

- Measurement of flow between the blades of turbines.
- Remote sensing of wind velocities.

19. Name any four inferential types of flow meters.

- A venturimeter.
- A orifice meter.
- A rotometer.
- A pitot tube.

20. What is the principle involved in fluid expansion thermometer?

In fluid expansion thermometers, the change in pressure in the bulb is taken as an indication of the temperature.

Part – B (16 Marks)

1. Explain various methods of measuring torque
2. Explain various methods of measuring temperature
3. Explain various methods of measuring flow
4. Explain various methods of measuring power
5. Explain various methods of measuring force
6. Explain working of Pressure thermometer and resistance thermometer.
7. Explain the construction and working of Venturimeter and Rotameter
8. Explain the construction and working of bimetallic strip and Thermocouple
9. List the advantages of temperature measurement by using the resistance thermometer.
10. Explain with neat diagram the purpose and operating principle of a venturimeter.
11. What are rotameters? State its applications.
12. Explain the working principle of an electrical resistance thermometer.
13. What are thermo couples? State its applications.