DEPARTMENT OF MECHANICAL ENGINEERING
III YEAR – V SEMESTER
ME6504 – ENGINEERING METROLOGY AND MEASUREMENTS

TWO MARKS Q & A
UNIT I - Concept of Measurement

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 0.01mm 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. **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.

11. **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 to 25.02 mm
    Uncertainty about the true value = ± 0.02mm

12. **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

13. **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.

14. **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.
15. **Explain the term magnification**
   It means the magnitude of output signal of measuring instrument time’s increases to make it more readable.

16. **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.

17. **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.

18. **What are the important elements of measurements?**
   The important elements of a measurement is
   1. Measurand
   2. Reference
   3. Comparator

19. **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.

20. **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.
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. **What is comparator?**
   Comparators are one 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 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 0.01 mm

11. **How the mechanical comparator is used? State with any one example.**
    Let us assume that the required height of the component is 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. **What are the advantages of electrical and electronic comparator?**
   - It has less number of moving parts
   - Magnification obtained is very high.
   - Two or more magnifications are provided in the same instrument to use various ranges.
   - The pointer is made very light so that it IS more sensitive to vibration

19. **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.
   (iii) Due to heating coils, the accuracy decreases.
   (iv) It is more expensive than mechanical comparator.

20. **What are the advantages of pneumatic comparator?**
   - The wear of measuring heads is avoided due to absence of direct contact.
   - Friction is less due to less number of moving parts.
   - Work piece is cleaned by supplying of all during the measurement.
   - High magnification is possible.
   - There is no interference of measuring head and indicating device because the measuring head is kept away from the indicating device.
   - It is a suitable method to check ovalty and taperness of circular bore.
Unit III - 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 for measuring effective diameter.
   (i) One wire method (ii) Two wire method (iii) Three wire method.

3. 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.

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

5. 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.

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

7. Define - Periodic error
   The periodic error repeats itself at equal intervals along the thread.

8. Define - Module
   Module = pitch circle diameter/ number of teeth

9. Define - Lead angle
   It is the angle between the tangent to the helix and plane perpendicular to the axis of cylinder.

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

11. What are the direct angular measurements methods?

12. **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.

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

14. **Define - Fullness and Emptiness in form factor.**
    Degree of fullness (K)= Area of metal /Area of enveloping rectangle
    Degree of emptiness = 1 – K

15. **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.

16. **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.

17. **Name the devices used for measurement of roundness.**
    1. Diametral 2. Circumferential confining gauges 3. Rotating on center

18. **What is runout?**
    Run out. -Total range of reading of a fixed indicates Or with the contact points applied to a Surface rotated, without axial movement about 3 fixed axes.

19. **Define - lay**
    Lay: - Direction of the 'predominate surface pattern'

20. **What are the stylus probe instruments?**
    a) Profilo meter b) Taylor Hobson Talysurf c) Tomlinson surface meter
UNIT IV - Laser and advances in Metrology

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. **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 crest and the low Point is called is trough.

4. **What is wavelength?**
The distance between two crest or two trough is called the wavelength

5. **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.**
- Straightness of guide ways and slide ways of machine tool.
- Flatness of machine tables and slide ways.
- Parallelism, equidistance and alignment of the slide ways.
- True running and alignment of shaft and spindle.
- The pitch error or lead of lead screw. f. Pitch errors of gears.
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7. **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.
8. **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

9. **Write the various tests conducted on any machine tools**
   - Test for level of installation of machine tool in horizontal and vertical planes.
   - Test for flatness of machine bed and for straightness and parallelism of bed ways on bearing surface.
   - Test for perpendicularity of guide ways to other guide ways.
   - Test for true running of the main spindle and its axial movements.

10. **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.

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

12. **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 $E_2$ 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.

13. **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.
14. **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.

15. **Write the types of coordinate measuring machines**
   1. Bridge type
   2. Horizontal bore mill
   3. Vertical bore mill
   4. Spherical coordinate measuring machine

16. **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.

17. **Write some features of CMM software.**
   Measurement of diameter, center distance can be measured as follows
   1. Measurement of plane and spatial curves
   3. Data communications.
   4. Digital input and output command
   5. Interface to CAD software

18. **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.

19. **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.
20. **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.
UNIT V – Measurement of Power, Flow and Temperature related properties

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 types of flow meters.**
   Venturi meter, orificemeter, rotameter, 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. **Write any two methods employed for measuring torque.**
   - Torque reaction method
   - Proney brake
   - Torque measurement using strain gauges
   - Torque measurement using torsion bars
10. **What are the requirements of the Bourdon pressure gauges?**
   - Bourdon tube
   - Scale
   - Pointer
   - Mechanical linkage
   - Pivot Pinion

11. **Distinguish between primary and secondary transducers.**
    - Primary transducer: The Mechanical device which converts physical quantity to be measured into a mechanical signal.
    - Secondary transducer: The Electrical device which converts this mechanical signal to the electrical signal.

12. **What are the working principles of bimetallic thermometer?**
    Two piece of metal with different coefficients of thermal expansion are bonded together to form the bimetallic strip. It is in the form of a cantilever beam. When the strip is subjected to temperature higher than bonding temperature it will be bent in one direction.

13. **Write the principle of hot wire anemometer?**
    When a fluid flows over a heated surface heat is transferred from the surface and so, its temperature reduces. The rate of reduction of temperature is related to flow rate.

14. **Define – Force**
    The mechanical quantity which changes or tends to change the motion or shape of a body to which it is applied is called force.

15. **Define – Torque**
    Torque can be defined as a measure of the tendency of a force to rotate the body on which it acts about an axis.

16. **Define – Power**
    Power is defined as the capacity to do the work.
17. **What are the important elements of measurements?**
The important elements of a measurement is
- Measured
- Reference
- Comparator

18. **What is the principle of thermo couple?**
The basic principle of thermocouple is “when two dissimilar metals are joined together an e.m.f will exist between the two points A and B, which is primarily a function of the junction temperature”. The above said to be principle is Seeback effect.

19. **What are the differences between orifice and venturimeter?**

<table>
<thead>
<tr>
<th>Orifice meter</th>
<th>Venturimeter</th>
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<tbody>
<tr>
<td>➢ Loss of head is small.</td>
<td>➢ Loss of head is more.</td>
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<tr>
<td>➢ No wear and tear.</td>
<td>➢ More wear and tear.</td>
</tr>
<tr>
<td>➢ Initial cost is more.</td>
<td>➢ Low initial cost.</td>
</tr>
<tr>
<td>➢ Difficult to install and replace.</td>
<td>➢ Ease of installation and replacement</td>
</tr>
<tr>
<td>➢ Requires more space.</td>
<td>➢ Requires less space as compared with venturimeter.</td>
</tr>
<tr>
<td>➢ Suitable for large flow of water, process fluids, waste gases and suspended solids.</td>
<td>➢ Can be used in wide range of pipe sizes (0.01m to 1.5m).</td>
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