# ME8501 METROLOGY AND MEASUREMENTS L T P C

**3 0 0 3**

# OBJETCTIVES:

* To provide knowledge on various Metrological equipments available to measure the dimensionof the components.
* To provide knowledge on the correct procedure to be adopted to measure the dimension ofthe components.

[UNIT I BASICS OF METROLOGY 9](#_TOC_250000)

Introduction to Metrology – Need – Elements – Work piece, Instruments – Persons – Environment – their effect on Precision and Accuracy – Errors – Errors in Measurements – Types – Control – Types of standards.

UNIT II LINEAR AND ANGULAR MEASUREMENTS 9

Linear Measuring Instruments – Evolution – Types – Classification – Limit gauges – gauge design – terminology – procedure – concepts of interchange ability and selective assembly – Angular measuring instruments – Types – Bevel protractor clinometers angle gauges, spirit levels sine bar – Angle alignment telescope – Autocollimator – Applications.

UNIT III ADVANCES IN METROLOGY 9

Basic concept of lasers Advantages of lasers – laser Interferometers – types – DC and AC Lasers interferometer – Applications – Straightness – Alignment. Basic concept of CMM – Types of CMM – Constructional features – Probes – Accessories – Software – Applications

– Basic concepts of Machine Vision System – Element – Applications.

UNIT IV FORM MEASUREMENT 9

Principles and Methods of straightness – Flatness measurement – Thread measurement, gear measurement, surface finish measurement, Roundness measurement – Applications.

UNIT V MEASUREMENT OF POWER, FLOW AND TEMPERATURE 9

Force, torque, power - mechanical , Pneumatic, Hydraulic and Electrical type. Flow measurement:Venturimeter, Orifice meter, rotameter, pitot tube – Temperature: bimetallic strip, thermocouples,electrical resistance thermometer – Reliability and Calibration – Readability and Reliability.

# TOTAL : 45 PERIODS

**OUTCOMES:**

Upon the completion of this course the students will be able to

CO1-Describe the concepts of measurements to apply in various metrological instruments.

CO2-Outline the principles of linear and angular measurement tools used for industrial applications

CO3-Explain the procedure for conducting computer aided inspection

CO4-Demonstrate the techniques of form measurement used for industrial components

CO5-Discuss various measuring techniques of mechanical properties in industrial applications

# TEXT BOOKS:

1. Jain R.K. “Engineering Metrology”, Khanna Publishers, 2005.
2. Gupta. I.C., “Engineering Metrology”, Dhanpatrai Publications, 2005.

# REFERENCES:

1. Charles Reginald Shotbolt, “Metrology for Engineers”, 5th edition, Cengage Learning EMEA,1990.

**ME 8501–METROLOGY AND MEASUREMENTS COURSE OUTCOMES**

On completion of this course, the student will be able:

|  |  |
| --- | --- |
| C303.1 | To understand the basics of metrology its relationship with the working  Environment and its effects on measurements. |
| C303.2 | To understand the various devices used and principle behind linear and angular  measurement. |
| C303.3 | To understand the usuage of laser interferometers and Coordinate measuring  machine. |
| C303.4 | To understand the various devices used and principle behind form measurements. |
| C303.5 | To Understand the the various devices used and principle behind measurement of  power , Flow and Temperature. |

**MAPPING BETWEEN CO, PO AND PSO WITH CORRELATION LEVEL 1/2/3**

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **ME 6505** | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PO6** | **PO7** | **PO8** | **PO9** | **PO10** | **PO11** | **PO12** | **PSO1** | **PSO2** | **PSO 3** |
| C303.1 | 3 | 3 | 2 | 1 | 0 | 1 | 1 | 0 | 2 | 1 | 2 | 3 | 3 | 3 | 2 |
| C303.2 | 3 | 3 | 2 | 3 | 0 | 1 | 1 | 0 | 2 | 1 | 2 | 3 | 3 | 3 | 2 |
| C303.3 | 3 | 3 | 2 | 3 | 0 | 1 | 1 | 0 | 2 | 1 | 2 | 3 | 3 | 3 | 2 |
| C303.4 | 3 | 3 | 2 | 3 | 0 | 1 | 1 | 0 | 2 | 1 | 2 | 3 | 3 | 3 | 2 |
| C303.5 | 3 | 3 | 2 | 3 | 0 | 1 | 1 | 0 | 2 | 1 | 2 | 3 | 3 | 3 | 2 |

**RELATION BETWEEN COURSE CONTENT WITH COs UNIT I BASICS OF METROLOGY**

|  |  |  |  |
| --- | --- | --- | --- |
| **S.No** | **Knowledge level** | **Topics** | **Course Outcomes** |
| 1 | U | Introduction to Metrology | C303.1 |
| 2 | U | Need – Elements – Work piece, | C303.1 |
| 3 | U,Ap | Persons – Environment –  their effect on Precision and Accuracy | C303.1 |
| 4 | U,Ap | Errors – Errors in Measurements | C303.1 |
| 5 | U,Ap | Types – Control – Types  of standards. | C303.1 |

# UNIT II LINEAR AND ANGULAR MEASUREMENTS

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| --- | --- | --- | --- |
| **S.No** | **Knowledge**  **level** | **Topics** | **Course**  **Outcomes** |
| 1 | U, Ap | Linear Measuring Instruments | C303.2 |
| 2 | U | Evolution – Types – Classification | C303.2 |
| 3 | U,Ap | Limit gauges – gauge design –  Terminology | C303.2 |
| 4 | U, Ap, An | concepts of interchange ability and selective  assembly | C303.2 |
| 5 | U,Ap | Angular measuring instruments – Types | C303.2 |
| 6 | U, Ap | Bevel protractor clinometers angle gauges | C303.2 |
| 7 | U,Ap | spirit levels sine bar –Angle alignment telescope,  Autocollimator – Applications. | C303.2 |

**UNIT III ADVANCES IN METROLOGY**

|  |  |  |  |
| --- | --- | --- | --- |
| **S.No** | **Knowledge**  **level** | **Topics** | **Course**  **Outcomes** |
| 1 | U | Basic concept of lasers Advantages of lasers | C303.3 |
| 2 | Ap, U | laser Interferometers – types – DC and AC Lasers  interferometer – Applications | C303.3 |
| 3 | Ap, U | Straightness – Alignment | C303.3 |
| 4 | Ap, U | Basic concept of CMM – Types of CMM – Constructional features – Probes – Accessories –  Software – Applications | C303.3 |
| 5 | Ap, U | Basic concepts of Machine Vision System – Element  – Applications. | C303.3 |

# UNIT IV FORM MEASUREMENT

|  |  |  |  |
| --- | --- | --- | --- |
| **S.No** | **Knowledge**  **level** | **Topics** | **Course**  **Outcomes** |
| 1 | U, Ap | Principles and Methods of straightness | C303.4 |
| 2 | Ap, U | Flatness measurement, Thread measurement | C303.4 |
| 3 | U, Ap | Gear measurement, surface finish measurement | C303.4 |
| 4 | U, Ap | Roundness measurement – Applications | C303.4 |

**UNIT V MEASUREMENT OF POWER, FLOW AND TEMPERATURE**

|  |  |  |  |
| --- | --- | --- | --- |
| **S.No** | **Knowledge level** | **Topics** | **Course Outcomes** |
| 1 | U | Force, torque, power | C303.5 |
| 2 | U | Mechanical , Pneumatic, Hydraulic and Electrical type | C303.5 |
| 3 | U, Ap | Flow measurement: Venturimeter, Orifice meter,  rotameter, pitot tube | C303.5 |
| 4 | U, Ap | Temperature: bimetallic strip, thermocouples,  electrical resistance thermometer | C303.5 |
| 5 | U | Reliability and Calibration,Readability and Reliability | C303.5 |

Ap – Apply; An – Analyze; U – Understand, E- Evaluate, C-Create

# UNIT I BASICS OF METROLOGY

**Part A-C303.1**

1. **What is the difference between correction and correction factor?(Nov/Dec 2017)** Correction is defined as a value which is added algebraically to the uncorrected result of measurement to compensate for an assumed systematic error.

If a numerical value is multiplied with uncorrected results to compensate for an assumed systematic error, it is known as correction factor.

# Define deterministic Metrology.

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

# Define Traceability.(April/May 2017)

Traceability is defined as the ability to trace the accuracy of a standard back to its ultimate source of standard.

1. **What is the difference between gauging and measurements.(April/May2017)** Deviations in size or shape of any object are determined (tested) by comparison with a gauge.

The measuring instrument is to be used for the proper purpose and range of accuracy.

Too big measuring forces (deflections), oblique location or location on faces or edges not cleaned or deburred may result in wrong values measured.

# Define Sensitivity. (Nov/Dec 2018, 2019)

Sensitivity maybe defined as the following relation:

Sensitivity = Change in the output signal Change in the input signal

# Differentiate between accuracy and precision.(Nov/Dec 2016,2020)

The closeness of the measured value with respect to the true value is called as accuracy.Precision refers to the ability of an instrument to reproduce its readings again and again inthe same manner for a constant input signal.

# What are the factors affecting the inherent characteristics of measuring instruments?(May/June 2016)

Scale error

Effect of friction, backlash, hysteresis, zero drift error

Deformation in handling or use, when heavy work pieces are measured -Calibration errors Mechanical parts (slides, guide ways or moving elements) -Repeatability and readability Contact geometry for both work piece and standard.

# Explain line and end standards .(May/June 2016)

In the line standards the unit of length is defined as the distance between the centers of engraved lines as in a steel rule. The International prototype metre and the imperial standard yard are line standards, since the measure of length is determined as between two lines. When the length being measured is expressed as the distance between two surfaces, this is referred to as end standard.

# What is primary measurement? Give an example.(May/June 2016)

The primary sensing element isthe first element of a measurement system. This element takes energy from the measuredmedium and it produces an output depending on the measurand.

Matching of two lengths when determining the length of an object with a meter rod. Matching of two weights when determining the mass of the grossary items.

# What are seismic instruments? (May/June 2016)

Seismic instruments are absolute motion measurement devices to indicate or record absolute displacement, velocity acceleration of the vibrating body.

# What are random errors?(Nov/Dec Dec 2015)

Some errors result through the systematic and instrument errors arereduced or at least accounted for. The causes of such errors are unknown and hence, the errors are called random errors.

# Define Range.(Nov/Dec 2015)

Range is the minimum and maximum values of a quantity for which an instrument is designed to measure.

# Why measuring instruments should be calibrated?(April/May 2015)

Calibration is necessary to get meaningful results. Incases where sensing system and measuring system are different, it is then imperative to calibrate the system as an integrated whole to take into account the error producing properties of each component.

# 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 1500C means span = 200 - 150 = 50'C.

# What is legal Metrology?(May/June 2014)

Legal metrology is that part of metrology which treats units of measurement, methods of measurement and measuring instruments, in relation to the statutory, technical and legal requirements. It assures security and appropriate accuracy of measurements.

# What are the important elements of measurements?. (Nov/Dec 2018)

Primary Sensing Element Variable Conversion Element Variable Manipulation Element Data Processing Element

Data Transmission System Data Presentation Element

1. **Differentiate the terms reproducibility and repeatability. (Nov/Dec 2015)** Reproducibility is the degree of closeness between measurements of the same quantity where the individual measurements are made under different conditions. Repeatability is the closeness between successive measurements of the same quantity with the same instrument by the same operator over a short time span.

# What is the difference between allowance and tolerance?(Nov/Dec 2015)

Tolerance is the limit of random deviation of a dimension from its nominal value.Allowance is the amount of designed deviation between two mating dimensions in a fit, which, in combination with their respectivetolerances, results into a maximum and minimumclearance or interference.

# Define interchangeable system. (Nov/Dec 13)

Interchangeability means ease of replacement in the event of failure. Any one component selected at random should assemble correctly with any other mating component, that too selected at random.

# Differentiate static and dynamic response. (Nov/Dec 13)

The behaviour of systems subjected to inputs that do not vary with time is termed as static response. The behaviour of systems subjected to dynamic inputs(continuously changing) is termed as dynamic response.

# Define Systematic error. (Nov/ Dec 2019)

Systematic errors are errorsthat are not determined by chance but are introduced by an inaccuracy (involving either the observation or measurement process) inherent to the system. Systematic error may also refer to an errorwith a non-zero mean, the effect of which is not reduced when observations are averaged

# Define grass error. (Nov/ Dec 2020)

Due to human mistakes grass error occour. Like careless reading, mistke in recording observation, incorrect applications of a correction, improper application of insturments. It can be avoided only by taking care in reading and recording the measurement data.

**Part B -C303.1**

1. Classify standard methods of measurements in detail**(Nov/Dec 2018)**
2. Describe briefly the different sources of errors in measurement**(Nov/Dec 2018)**
3. What is the need of calibration? Explain the classification of various standards.**(April/May 17)**
4. Explain various errors in measurements.**(April/May 17)**
5. With a suitable example explain the various elements of generalized measuring system.**(Nov/Dec 2016)**
6. Describe the types of measurement.**(Nov/Dec 2018)**
7. What are the various elements of metrology? with examples, explain how these elementsinfluence the accuracy of measurements?**(Nov/Dec 2015)**
8. i) Write short notes on sensitivity and readability. **(Nov/Dec 2012 ,2014)**
   1. Differentiate between 'precision' and 'accuracy' with suitable examples. **(Nov/Dec 2018 )**
9. i) Distinguish between repeatability and reproducibility. **(Nov/ Dec 2014 )**
   1. Discuss on calibration, error and correction curves.
10. i) Write short notes on interchangeability. **(Nov/Dec 2014 )**
    1. Briefly discuss on calibration procedure. **(April/May2017)**
11. Discuss metrological characteristics of Measuring Instruments. **(Nov/ Dec 2019)**
12. i)What are random errors? Discuss ther characteristics?
    1. Compare line and end standards. **(Nov/ Dec 2019)**
13. Explain the classification of various measuring methods. **(Nov/ Dec 2020)**
14. Explain the various systematic and random errors in measurements**. (Nov/ Dec 2020)**

**Part C -C303.1**

1. Define calibration and explain the procedure to calibrate thermometer.
2. Explain the need of standards of measurements in modern industrial system and describe the term traceability in Connection with standards.**(May/June 2013)**
3. Explain the purpose of calibrating the instrument and discuss the primary and secondary calibration. **(May/June 2014)**

**UNIT II LINEAR AND ANGULAR MEASUREMENTS Part A -C303.2**

1. **What is the use of feeler gauges?(Nov/Dec 2017)**

A feeler gauge is a [tool](https://en.wikipedia.org/wiki/Tool) used to measure gap widths. Feeler gauges are mostly used in [engineering](https://en.wikipedia.org/wiki/Engineering) to measure the clearance between two parts.

# Why is rocking procedure followed when measuring with a dial bore gauge?(April/May2017)

The rocking will first align the gauge with the bore axis and the act of moving the handle to the other side of the bore will bring it to the exact bore diameter. This action compresses the two anvils where they remain locked at the bores dimension after being withdrawn.

# Name any four instruments used measuring internal diameters in components.(April/May2017, 2019)

* + Bore Gauge
  + Inside Micrometer
  + Telescopic Gauge

# Define interferometry.(Nov/Dec 2015)

* Vernier caliper

Interferometry is a field of science used to measure the surface nature by using light wave interference.

# Mention the various applications of comparators.(May/June 2016)

The following are some of the ways in which the comparators used :i) In mass production, where components are to be checked at a very fast rate. ii) As laboratory standards from which working or inspection gauges are set and correlated. iii) For inspecting newly purchased measuring gauges and iv) Comparators can be used as working gauges to prevent work spoilage and to maintain required tolerances at all stages of manufacturing by attaching with the machines.

# How do you find the least count of a micrometer?(Nov/Dec 2018)

least count is the lowest value from an measuring instrument. Divide the Smallest division from number of divisions.Themicrometer least count can be calculated by below formula Least count= Pitch((least division value)/ number of divisions on the scale.

Least Count = 1/100 = 0.01mm. So least count of a Micrometer is 0.01mm

# Define sine bar and mention its limitation.(Nov/Dec 2018)

Sine bar is an angular measuring device working on the sine principle. The devices operating on sine principle are capable of „self generation‟. So the measurement is usually limited to 450 from loss of accuracy point of view.

# Differentiate between sine bar and sine centre. (May/June 13)

Sine bar is used for locating any work to a given angle and to change unknown angle.Theconical work is difficult to mount on sine bars, to overcome this sine centre is used. In this two blocks are mounted on top surface of sine bar at each end, these block have centres and can be clamped at any position.

# Why the sine bars are impractical and inaccurate as the angle exceeds 450? (Nov/Dec 2018, 2019)

The sine bars are impractical and inaccurate as the angle exceeds 450, because of the following reasons:

1. The sine bar is physically clumsy to hold in position.
2. The body of the sine bar obstructs the gauge block stack even if relieved.
3. Slight errors of the sine bar cause large angular errors.
4. Long gauge stacks are not nearly as accurate as when compared with shorter gauge blocks.
5. Temperature variation affects the accuracy.

# Define angle decker.(Nov/Dec 2015)

Angle decker is an optical instrument used for the measurement of small angular differences, changes or deflection, plane surface inspection etc.

# State the various uses of angle decker.(May/June 2016)

The angle decker is used in the measurement of angle of a component Checking the slope angle of a V-block

Measurement of angle of cone or taper gauge and Precise angular setting of machines for operations.

1. **What is the constructional difference between an autocollimator and an angle decker?** The illuminated target used in the auto collimator is replaced by an illuminated scale on a glass screen which is set in the focal plane of the objective lens.

# Write the constructional requirements of the sine bar for accurate measurement. (Nov/Dec 2014)

1. The rollers must have equal diameter and equal cylinders.
2. The rollers must be placed parallel to each other and also to the upper face.
3. The accurate center to center of rollers must be known.
4. The top surface of the bar must be flat with high degree of accuracy.

# Write short notes on bevel protractor.(Nov/Dec 2016)

The bevel protractor is a type of protractor that is circular and has a pivoted arm used for measuring and marking off angles. This type of protractor is commonly used for architectural and mechanical purposes.

# What is meant by interchangeability? (Nov/Dec 2016)

Component selected randomly should assemble correctly correctly with any other mating component this component.This is interchangeability

# What are limit gauges?

These are also called „go‟ and „no go‟ gauges. These are made to the limit sizes of the work to be measured. One of the sides or ends of the gauge is made to correspond to maximum and the other end to the minimum permissible size.

# Define tolerance and zero line.(Nov/Dec 2013)

The maximum allowable error in the measurement is called tolerance

the line at which the measurements are done is zero line. it is simply a reference line for the measurement.

# What is floating carriage micrometer(May/June 2013)

The micrometer which has the upper surface of the lower carriage having two 'V' grooves on ball bearings and the upper carriage floating freely on balls is called floating carriage micrometer. it is used to measure the effective diameter of the screw thread

# Differentiate between dimensional and form tolerance.(Nov/Dec 2013)

An allowance given as a permissible range in the nominal dimensions of a finished magnet is a called dimensional tolerance.

Form tolerance is a group of geometric tolerance which limit the amount of error in the shape of a feature. Form tolerances are independent tolerances.

# 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.

# Give the various types of linear measuring instruments.(Nov/Dec 2020)

Vernier calipers, vernier height gauges, vernier depth gauges, micrometers, dial indicators, slip gauges, comparators.

# Write any four precations to be followed when using slip gauges.(Nov/Dec 2020)

* + The surface plate, slip gauge set and sine bar should be degreased properly.
  + The dial gauge should be clamped to the stand properly so that the plunger is veritical to the base.
  + The dial gauge plunger should be handled gently and the gauge was set to zero after giving slight intital compression to the plunger.
  + The slip gauges should be placed gently under the roller of the sine bar.

**Part B-C303.2**

1. Discuss about various types of limit gauges with a neat sketch.

# (May/June 16)(Nov/Dec 16)

1. Explain the construction and working aned applications of any two angular measuring instruments**.(Nov/Dec 18)**
2. i) How slip gauges are manufactured?**(Nov/Dec 17)**

ii) Explain the construction and working principle of angle dekkor with a neat diagram**(Nov/Dec 17)**

1. Explain the working principle of Angle Dekkor. **(Nov/Dec 2016)**
2. State the principle of intereferometry**. (Nov/Dec. 12)**
3. Explain the construction, working principle and applications of sine Bar°.(**April/May17**)

# (Nov/Dec 15)

1. i) Explain the working of the „Johansson Micrometer‟. **(May/June 2016)**
2. Explain the use of sine bar.
3. Explain why sine bars are not suitable for measuring angles above 45°.**(Nov/Dec 15)**
4. Describe with sketch the working principle of Toolmaker‟s microscope. **(Nov/Dec 14)**
5. Explain with a neat sketch, the principle and working of an autocollimators and also list its application.**(Nov/Dec 18)**
6. Explain sigma comparator with neat sketch**. (May/June 2016)**
7. Discuss the construction , working principle, advantages and limitation of mechanical and pneumatic comparators. **(Nov/ Dec 2019)**
8. i) Discuss the Purpose of Limit gauge and list the factots considered for designing it.

ii) What are adjustable snap gauge and how it differs from snap gauge **(Nov/ Dec 2019)**

1. With neat sketch explain the working principle of micro optic autocollimator.**(Nov/Dec. 2020)**
2. Explain the following with neat sketch. i) Sine bar ii) Bevel Protractor. **(Nov/Dec 2020)**

**Part C -C303.2**

1. Design general type GO and No Go gauges for a 40H7/d8 fit. 40mm lies in the diameter range 30 to 50 mm. Show graphically the disposition of gauge tolerance zones relative to the work tolerance zones. Standard tolerance for IT7 is 16i and IT8 is 25i, where T is the standard tolerance unit. The upper deviation for „d‟ shaft is 16D0.44 (**April/May17**) **(Nov/Dec 2020)**
2. Design general type GO and No Go gauges for the components having 20H7f8 fit. Given: (i) 'i' (micron) = 0.45 (D)1/3 + 0.001D
   1. upper deviation of 'f' shaft = -5.5D0.41
   2. 20mm fall in the diameter step of 18mm to 30mm.
   3. IT7=16i
   4. Wear allowance 10% of gauge tolerance.**(Nov/Dec 18)**
3. Design a workshop type progressive type Go- Not-Go plug gauge suitable for 25 H7, with following information:

25mm lies in the diameter step of 18-30mm

i = 0.453√𝐷

+ 0.001𝐷

IT7 = 16 i **(Nov/Dec 17)**

An electronic caliper was used to measure the length of an object. Five measurements were made. The results of the five measurements are : 21.53 mm, 21.51 mm, 20.52 mm, 21.48 mm and 21.42 mm. The workshop temperature during measurement was 210C. the calibration certificate of the electronic caliper says that the device will read within ± 0.02 mm of the correct answer if it is used correctly and when the temperature is with in 0 to 40 0C. estimate the expanded uncertainty at a coverage factor of 2 providing coverage probalbility of approximately 95%. **(Nov/Dec 2020)**

**UNIT III ADVANCES IN METROLOGY Part A-C303.3**

1. **What are diffraction gratings? (Nov/Dec 2015)**

The production of spectrum by diffraction and interference of light through a plate of glass called Diffraction gratings

# What are touch trigger probes? (Nov/Dec. 15)

Touch-trigger probes measure discrete points, making them ideal for inspection of 3- dimensional geometric parts.

# Mention the various geometrical checks made on machine tools.(May/Jun 2014) (May/Jun 2016)

The geometrical checks made on machine tools are :

* + Straightness and flatness of guide ways and slide ways of machine tool.
  + Flatness of machine tables
  + Parallelism, equidistance and alignment of the slide ways.
  + True running and alignment of shaft and spindle.
  + Lead of lead screw or error in pitch.

# Differentiate geometrical test and practical test on a machine tool.

* The geometrical test is carried out to check the grade of manufacturing accuracy of the machine tool.

Practical test is carried out to check the accuracy of the finished component.

* Geometrical test consists of checking the relationship between various machine elements when the machine tool is idle.
* Practical test consists of preparing the actual test jobs on the machine and checking the accuracy of the jobs produced.

# Mention the various types of coordinate measuring machine.(Nov/Dec 2018)

Coordinate measuring machine is classified as: Cantilever type

Bridge type Horizontal bore mill

Vertical bore mill and

Spherical coordinate measuring machine.

# Define machine vision (computer vision or Intelligent Vision). (Dec 2012,May/Jun 2014)

Machine vision is defined as the means simulating the image recognition and analyze the capabilities of the human system with electronic and electromechanical techniques.

# List any three field application of machine vision system (Nov/Dec 2017)

Inspection

Part identification Guidance and control

# What are the advantages of machine vision system?(May/June 2016)

Inspection

Part identification Guidance and control

1. **What are the advantages of Laser in interferometry? (Nov/Dec 2014)(Nov/Dec 2016)** The laser provides a source of coherence and truly monochromatic light. The property of clearance enables it to be projected in a narrow pencil of beam without any scatter.

The advantages of machine vision system are:

* Reduction of tooling and fixture cash
* Elimination of precise part location
* Detection of defect
* Dimensional verification of integrated automation.

# Write the features of CMM.( Nov/Dec 2014)

1. In faster machines with higher accuracies, the stiffness to weight ratio has to be high in order to reduce dynamic forces.
2. All the moving members, the bridge structure Z-axis carriage and Z-column are made of hollow box construction.
3. Errors in machine are built up and fed into the computer system so that error compensation is built up into the software.
4. All machines are provided with their own computers and the CMM is able to measure three-dimensional object from the variable datums

# Name the different stages involved in the machine vision based measurements. (Nov/Dec 2016, 2019)

Analog to digital conversion

Removal of noise/patterns, improve contrast Find objects in the image

Take a measurement of the object/relationships

To match the above description with similar descriptions of known objects

# What is CMM?

CMM stands for Coordinate Measuring Machine and it measures the linear dimensions in three coordinates for various components. These machines have precise movement in X, Y and Z coordinates which can be easily controlled and measured. Slide in each direction is equipped with a precision linear measurement transducer which gives digital display and senses positive and negative directions.

# List the types of laser?(Nov/Dec 2018)

Solid-state laser.

Gas laser.

Liquid laser.

Semiconductor laser.

# State the principle of laser.(Nov/Dec 2019)

When the photon comes from higher energy level to lower energy level, it releases another photon. The sequence of triggered identical photon from stimulated atom 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.

# Name the various optical elements used in laser interferometry.

The following are some of the optical elements used in laser interferometry:

1. Beam splitter ii) Beam benders and iii) Retro reflectors.

# Mention the various advantages of AC laser interferometer.

The advantages of AC laser interferometer are listed below:

* High repeatability
* High accuracy
* Long range optical path
* Easy installation
* Wear and tear is less.

# What is meant by " Qualifying the tip" in CMMs?(April/May 2015)

Qualifying the tipis defined as Calibration of probe tip with respect to probe head in order to compensate for tip diameter.It is the process of avoiding errors due to tip in the CMM for the required accuracy.

# On what factor the accuracy of laser interferometer mainly depends?.( Nov/Dec 2017)

Laser Beam intensity Laser Beam Wavelength

Selection of signal Conditioner

# Write any four application of artificial vision system in manufacturing industries.( Nov/Dec 2017)

* Automatic inspection, e.g., in manufacturing applications;
* Assisting humans in identification tasks, e.g., a [species identification](https://en.wikipedia.org/wiki/Automated_species_identification) system
* Controlling processes, e.g., an [industrial robot](https://en.wikipedia.org/wiki/Industrial_robots);
* Detecting events, e.g., for visual surveillance or [people counting](https://en.wikipedia.org/wiki/People_counter);
* Navigation, e.g., by an [autonomous vehicle](https://en.wikipedia.org/wiki/Autonomous_vehicle) or [mobile robot](https://en.wikipedia.org/wiki/Mobile_robot); and

# Mention the various components present in the laser interferometry.

The various components present in the laser interferometry are two frequency laser source, optical elements, laser head‟s measurement receiver and measurement display.

# What is meant by alignment test on Machine tools? (Nov/Dec 2020)

Various geometric checks are carried out to check its manufacturing accuracy in a static conditions known as alignment test. Checking the position of component and displacement to one another. Ex: checking the alignment of axis of lathe spindle to saddle movement.

# Why the laser is used in alignment testing?(Nov/Dec 2020)

The alignment tests can be carried out over greater distances and to a greater degree of accuracy using laser equipment. Laser equipment produces read straight line, whereas an alignment telescope provides a imaginary line than can not be seen in space.

**Part B -C303.3**

1. Describe the working principle of a dual frequency laser interferometer and state its application. **(April/May 2015)**
2. (i) With the aid of sketches describe the laser telemetry system.
   1. Briefly explain principle of laser triangulation sensor.**(Nov/Dec 2018)**
3. i) Explain the working principle of DC laser interferometer **(Nov/Dec 2015)**
4. Explain the use of laser interferometer in angular measurement. **(May/June 2016)**
5. i) Explain the various geometrical tests that are to be done to get a better accuracyin the machine tool.

ii) Describe the use of Lasers as a means of alignment testing (or) Discuss the testing of machine tools using interferometer.**(Nov/Dec 2012)**

1. Explain in detail various stages involved in machine vision system. **(Nov/Dec 2015)**
2. i) With neat sketch explain the various types of CMM based on its construction.

# (May/Jun2013) (May/Jun 2014) (Nov/Dec 2017, 2019) (April/May 2017)

ii) State the possible sources of errors in CMM.**(May/June 2016)**

1. i) Write short notes on applications and advantages and disadvantages of CMM.**(May/Jun 2014)**

ii) List out the various probes used in CMM and explain the working principle of touch trigger probe.**(April/May 2017)**

1. i)Explain the construction details of column type CMM. **(May/Jun 2014)**

ii) What is CMM **?**what are the basic elements of CMM ? **(Nov/Dec 2015)**

1. Explain in detail the various methods of testing acc uracy of horizontal milling machine and lathe using laser interferometer.**(May/Jun 2014)**
2. With a neat sketch explain the working of AC laser interferometer and how straightness is measured. **(April/May 2017)(Nov/Dec 14, 16, 17, 19,20)**
3. (i) Explain the construction,measuring principle of Bridge type CMM.
   1. Enumerate the role of computer in metrology.**(Nov/Dec 18)**
4. With neat sketch explain the various types of CMM based on its construction. Also write the advantages of computer aided inspection. **(Nov/Dec 2020)**

**Part C-C303.3**

1. A machine vision system recovers useful information about a scene from its two dimensional digitized image. What are the stages in machine vision process **(Nov/Dec 2017, 2019)**
2. Explain indeatail the various methods of testing accuracy of horizontal milling machine and lathe using laser interferometer. **(April/May 2014)**
3. Explain how CMM's are used in measuring diameter, depth and height in a specimen?

**UNIT IV FORM MEASUREMENT Part A- C303.4**

1. **Define Drunken thread error. (Nov/Dec 2016)**

In any screw thread if the thread is not cut to the true helix then the Drunken thread error will form. The thread is having erratic pitch in which the advance of helix is not regular in one complete turn of the thread.

# What is best size of wire?(Nov/Dec 2018)

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

# What do you mean by lead angle? (Nov/Dec. 13, 2019)

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

# Mention the various methods used for measuring the gear tooth thickness.(Jun 2014)

To measure the gear tooth thickness, the methods used are:

* + Gear tooth vernier
  + Base tangent method
  + Constant chord method and
  + Measurement over pins or balls

# What are the various factors affecting surface roughness?

The surface roughness is affected by:

* + Work piece material
  + Vibrations of the work and machine
  + Method of machining and
  + Type of tool and fixtures used.

# Define degree of emptiness in form factor.

Degree of emptiness is defined as the ratio between the area of empty space and the total area of the enveloping portion.

# Briefly explain straightness of a line in two planes.(Jun 2014)

A line is said to be straight over a given length if the variation of the distance between the two points on the two planes perpendicular to each other and parallel to the direction of a line remaining within the specified tolerance limits.

# Name the four reference circles used in measurement of roundness. (Dec 2014)

Least squares circle

Minimum zone or minimum radial separation circles Maximum inscribed circle and

Minimum circumscribed circle

# Derive the expression for „Best size of wire‟ in screw thread measurement.( Nov/Dec 2014)

Db=2AP sec x

Where ,Db= wire diameter, X= included angle

AP=P/4, Therefore, Db=2(P/4)\*sec x,

# Db=P/2\*sec x

1. **Name the various devices used for the measurement of roundness.**

The roundness is measured by,

* Diametral gauge,
* Circumferential conferring gauge
* Rotating on centre, Three point probe and Accurate spindle

# What do you mean by roundness?

Roundness is defined as a condition of a surface of revolution where all the surfaces intersected by any plane perpendicular to a common axis in case of cylinder and cone.

# Define degree of fullness in form factor.

Degree of fullness is defined as the ratio between the area of metal present and the area of the enveloping portion.

# Write the formula used for measuring the radius of the circle.

Radius of the circle R = ((l – d)2) / 8d Where, R = Radius of the circle

l = Distance between the balls d = diameter of pins.

# What are the instruments used for direct measurement of surface finish?

The following instruments used for direct measurement of surface finish:

Stylus probe instruments Tomlinson surface meter

Profilometer and

Taylor – Bobson - Talysurf .

# A spur gear of 4 mm module has 60 teeth. Calculate the pitch circle diameter and base pitch for pressure angle of 200.

Pitch circle diameter = Module x number of teeth = 4 x 60 = 240 mm. Base pitch = Module x πcos(pressure angle) = 4πcos(20) = 11.7 mm

# List out the sources of out of roundness. ( Nov/Dec 2017)

several reason when machining parts can be attributed to cause out of roundness. These are clamping distortion, spindle run out, presence of dirt and chips on clamping surface, imbalance, heat and vibration

# How is surface roughness assessed. ( Nov/Dec 2017)

Surface roughness can be assessed by considering the variation of ordinate heights of the points on the surface profile. A reference line , usually M-line is chosen from which the ordinate heights of the points are measured and the surface roughness is evaluated with reference to this reference line.

# How will you measure the effective diameter of a screw thread?

The effective diameter of a screw thread can be measured by using the following methods: One wire method, Two wire method and Three wire method.

# Name any four elements of Gear which are checked for accuracy.(Nov/Dec 18, 2019)

Tooth Thickness Addendum Depth

Pitch Variation Backlash

# How will you measure the minor diameter of a screw thread?

The minor diameter of a screw thread can be measured by using either taper parallels or rollers and slip gauges.

# Define Constant Chord. (Nov/Dec 2020)

Constant chord is the chord joining those points, or opposite aaces of the tooth . Constant chord of a gear is measured where the tooth flanks touch the flnks of the basic rack. The teeth of the rack are straight and inclined to their centre lines at the pressure angle. It is seen that both the chordal thickness and chordal addendum are dependent upon the number of teeth. Hence for measuring a large number of gears for set, each having different number of teeth would involve.

# What are the appliations of toolmakers microscope? (Nov/Dec 2020)

Linear measurement Device, Measurement of Pitch & Thread angle

**Part B -C303.4**

1. Define various terminologies of screw thread with suitable diagram. **(May/June 16)**
2. Derive the expression for finding the effective diameter by three wire method.

# (May/June 16)(Nov/ Dec 19,20)

1. What is the symbol for fully defining surface roughness and explain each term?

# ( May/Jun 14)

1. i) Explain constant chord method for tooth thickness measurement**.(Nov/Dec 2014,2017)**

ii) Describe any one method of roundness measurement.**(Nov/Dec 2014)(Nov/Dec 16, 19)**

1. i) Explain with sketch the functioning of surface finish measurement system. **(Nov/Dec 18)**

ii) Describe the various elements of surface Roughness.

1. i) Describe a method for inspecting the involute profile of a spur gear tooth. Describe the construction of gear tooth verniercaliper. **(Nov/Dec 2016,2017)**
2. i) What is the “Best wire size”? Derive an expression for the same in terms of the pitch and angle of the thread. **(May/Jun 2013, May/Jun 2014)**

ii) Explain the principle of measuring gear tooth thickness by base tangent method.

1. i) Describe the two wire method of finding the effective diameter of screw threads**. (May/Jun 14)**

ii) How to measure the pitch of a screw thread by using the Tool maker‟s Microscope? Discuss in detail.

1. Name the methods of measuring gear tooth thickness and explain any one in detail.**(Nov/Dec 2018)**
2. With a neat sketch explain the working principle of tomlinson surface finish tester**(Nov/Dec 2017)**
3. Describe a gear tooth vernier caliper and explain its use for checking tooth thickness and depth of tooth. **(Nov/Dec 2020)**

**Part C-C303.4**

1. Explain the principle of measuring gear tooth thickness by base tangent method. What is the span length over 5 teeth of gear having 45 teeth module 4mm and pressure angle 20o
2. Explain in detail the alignment test on pillar type drilling machine
3. It is desired to measure the a) Effective diameter of a 32 x 3.5 mm pitch metric plug screw gauge. For this purpose following reading were noted. Micrometer reading over the standard cylinder of 30.500 mm and the wires of 2.000mm diameter as 13.3768mm. Micrometer reading over the gauge and wires as 12.248mm. ii) Derive the expression for finding the effective diameter by two wire method.

**UNIT VMEASUREMENT OF POWER, FLOW AND TEMPERATURE Part A-C303.5**

1. **What is a load cell?(Dec 12)(May/June 2016)**

When the strain gauge – elastic member combination is used for weighing it is called a load cell. Load cells utilize an elastic member as the primary transducer and strain gauge as secondary transducer.

1. **What are the physical characteristics of temperature measuring sensor?(Dec 14)** Resistance Temperature Detectors are the sensors used to measure the temperature by correlating the resistance of the RTD element with temperature.

# What are the materials used for thermocouples?(Nov/Dec 2016)

Iron, Copper, Rhodium, Tungsten and Iridium.

1. **Give the principle of hot wire anemometer. (Jun 14) (Nov/Dec 2016) (Nov/Dec 2017)** 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.

# What is the principle involved in fluid expansion thermometer? (Jun 14)

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

# State “ Law of intermediate temperatures ” in thermocouples. (Nov/Dec 2017)

The thermal emf produced when a circuit of two homogeneous metals exists between a first temperature and a second and thermal emf produced when the same circuit exists between the second temperature and a third are algebraically equal to the thermal emf produced when the circuit exists between first and third temperatures.

# What is the principle used in thermocouples? (or) What is “Principle of thermo electricity”? (or) What is seebeck effect?( Dec 14)

The principle states that “ When two conductors of two different metals A and B are joined together at one end to form a junction, and this junction is heated to a higher temperature with respect to the free ends, a voltage is developed at the free ends and if these two conductors of metals at the free ends are connected, then the emf setup will establish a flow of current”.

# How is temperature measured using pressure thermometer?

When a liquid, gas or vapour filled system is subjected to a temperature change, the volume of the liquid, gas or vapour changes causing a pressure difference in the filled system. This pressure difference becomes an indication of temperature changes when calibrated.

# What is a bimetallic strip? Name its types.(Dec. 12)(May/June 2016)

A bimetallic strip is made of two thin strips of metal which have different thermal co- efficients of expansion. The two metal strips are joined together by brazing, welding or riveting so that the relative motion between them is arrested. Different common forms of bimetallic sensors are:

* 1. Helix type 2. Spiral type, 3. Cantilever type and 4.Flat type.

# How is torque measured using Electrical torsion meter?(Nov/Dec 2018)

When a torque is applied to the shaft of the torsion meter, there is a relative displacement between the two slotted discs. This produces a phase shift between the pulses generated in the inductive pickups. When these pulses are compared with the help of an electronic timer, it will show a time interval between the two pulses. This time interval is proportional to the twist of the shaft and hence is proportional to torque.

# What is the working principle of pendulum scale?(Dec. 12)

The unknown force is converted into a torque which is then balanced by the torque of a fixed standard mass arranged as a pendulum.

# Write the working principle of pyrometer.

When temperature being measured is very high and physical contact with the medium to be measured is impossible or impractical, optical pyrometers based on the principle of thermal radiation are used.

These [Pyrometer Working Principle](http://www.eeeguide.com/pyrometer-working-principle/) are used under condition where corrosive vapours or liquids would destroy [thermocouples](http://www.eeeguide.com/thermocouple-circuit/), [resistance](http://www.eeeguide.com/resistance/) thermometer and thermostat, if made to come in contact with the measured medium.

# State the various types of commercially available Thermocouples.

Type J, K, T, & E are “Base Metal” thermocouples, the most common types of thermocouples.Type R, S, and B thermocouples are “Noble Metal” thermocouples, which are used in high temperature applications.

# How is flow measured using Venturimeter?

When a venturimeter is placed in a pipe carrying the fluid whose flow rate is to be measured, a pressure drop occurs between the entrance and throat of the venturimeter.

This pressure drop is measured using a differential pressure sensor and when calculated this pressure drop becomes a measure of flow rate.

# Mention any two temperature measuring devices.

* 1. Bimetallic thermometers 2.Pressure thermometers 3.Thermistorsand 4.Thermocouples.

# What are the important properties a material should have to be selected for bimetallic thermometers?

The following properties should be high:

* 1. Co-efficient of expansion 2.Modulus of elasticity 3. Elastic limit after cold rolling

4. Electrical conductivity 5.Ductility and6.Metallurgical ability.

# State the two principles on which Bimetallic thermometers work.

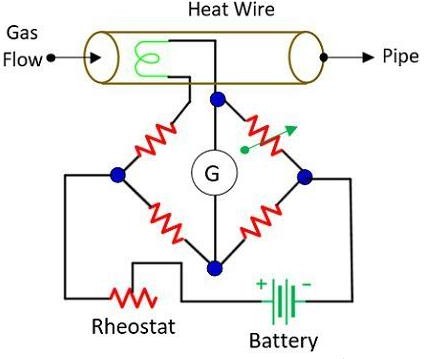
* 1. All metals change in dimension, i.e. expand or contract when there is a change in temperature.
  2. The rate at which this expansion or contraction takes place depend on the thermal co- efficient of expansion of the metal and this thermal co-efficient of expansion is different for different metals.

Hence the difference in thermal expansion rates is used to produce deflections which are proportional to temperature changes.

# How is temperature measured using pressure thermometer?

When a liquid, gas or vapour filled system is subjected to a temperature change, the volume of the liquid, gas or vapour changes causing a pressure difference in the filled system. This pressure difference becomes an indication of temperature changes when calibrated.

# Mention few methods of torque measurements? (Nov/Dec 2019)

* Measuring the strain produced in a rotating body due to an applied torque
* An optical method
* Measuring the reaction force in cradled shaft bearings
* Using equipment known as the Prony brake.

# State the principal of hot wire animometer. (Nov/ Dec 2019)

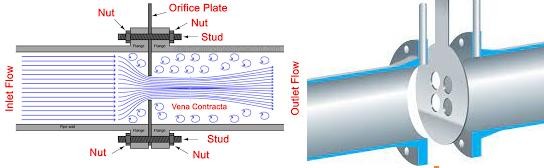
It works on the principle of transfer of heat from high temperature to low temperature.When an electrically heated wire is placed in a flowing gas stream, heat is transferred from the wire to the gas and hence the temperature of the wire reduces, and due to this, the resistance of the wire also changes.

# State “ Law of intermediate metals ” in thermocouples

In a circuit consisting of two dissimilar homogeneous metals having the junctions atdifferenttemperatures, the emf developed will not be affected when a third homogeneous metal ismade a part of the circuit, provided the temperature of its two junctions are the same.

# Write the working principle of Orifice meter. (Nov/Dec 2020)

The liquid or gas whose flow rate is to be determined is passed through the orifice plate. This creates a pressure drop across the orifice plate which varies with the flow rate, resulting in a differential pressure between the outlet and inlet segments.



# List various types of temperature sensors. (Nov/Dec 2020)

There are four types of temperature sensors that are most commonly used in modern-day electronics: thermocouples, RTDs (resistance temperature detectors), thermistors, and semiconductor based integrated circuits (IC).



**Part B-C303.5**

1. i) Describe the force measurement using hydraulic load cell. **(Nov/Dec 18)**

ii) Summarize the relative merits of venturi, Flow nozzle and orifice.

1. i) Explain the working of pneumatic load cell. **(Jun 12)**

ii) Explain the principle and working of an electrical torsion meter with a sketch.

1. i) Explain with a neat diagram the purpose and operating principle of aventurimeter.

# (Nov/Dec 2017)

ii) Explain in detail about the measurement of fluid velocity. **(Jun 13)**

1. i) Write short notes on thermocouples. **(Nov/Dec 18) (May/June 2016)**

ii) How does a thermistor work? Explain. **(Nov/Dec 12, 2019) (May/June 2016)**

1. Explain the working principle of an electrical resistance thermometer and state its advantages.
2. i) Explain the method of measuring force using a strain gauge load cell.**(May 14)**

ii) Explain how an Eddy current dynamometer works.**(May 14)(Nov/ Dec 2019)**

1. i) Explain the working principle of an electrical resistance thermometer.**(May 14)(Nov/Dec 2016) (Nov/Dec 2017) (April/May 2017)**

ii) What are thermo couples? State its applications.**(May 14)**

1. i) With a neat sketch explain Proving ring for force measurement**.( Dec 2014)**

ii) Explain the working principle of Hydraulic dynamometer to measure the shaft power.**(Dec 14)**

1. i) Explain the rotameter and orificemeterwith neat sketch. **(Nov/Dec 2018)**

ii) Explain any one type of pyrometer for measuring temperature. **(Nov/Dec 2017)**

1. Explain pitot tube with neat sketch and state its advantages and limitations **(Nov/ Dec 19)**
2. (i) Describe the force measurement using hydralic load cell.**(Nov/Dec 2018)**

(ii) summarize the relative ,merits of venturi, flow nozzle and orifice.

1. With neat diagram explain the construction and working principle of the following: i) Pilot tube ii) Venturi meter.**(Nov/Dec 2020)**
2. With neat diagram explain the construction and working principle of the following:
   1. Thermocouple ii) Bi-Metallic strips. **(Nov/Dec 2020)**

**Part C-C303.5**

1. How to measure the power by using rope brake dynamometer? Explain with a neat diagram
2. Explain how cup and vane type anemometers are used to measure air movement.
3. With neat sketch explain the construction and working principle of vapor pressure thermometer.