SRM VALLIAMMAI ENGINEERING COLLEGE

(An Autonomous institution)

SRM Nagar, Kattankulathur– 603203

DEPARTMENT OF MECHANICAL ENGINEERING

QUESTION BANK

V SEMESTER

ME3561 - METROLOGY AND MEASUREMENTS

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Prepared by

Mr. P. VIJAYAN, Assistant Professor (O.G)/MECH

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SUBJECT NAME : METROLOGY AND MEASUREMENTS

Sem / Year: V/III

UNIT 1: BASICS OF METROLOGY

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. Calibration of measuring instruments, Principle of air gauging ISO standards.

PART-A

Q.No.	Questions	BT Level	Competence
1.	What is the difference between allowance and tolerance?	BT-2	Understanding
2.	Distinguish between Line standard and End standard.	BT-2	Understanding
3.	Define primary measurement. Give an example.	BT-1	Remembering
4.	Define the term range and span.	BT-1	Remembering
5.	What are the factors affecting the measuring system?	BT-2	Understanding
6.	Define legal metrology.	BT-1	Remembering
7.	Explain the role of N.P.L.	BT-2	Understanding
8.	Summarize the basic components of a measuring system.	BT-1	Remembering
9.	Differentiate between repeatability and reproducibility.	BT-2	Understanding
10.	Explain the term Sensitivity of an instrument.	BT-2	Understanding
11.	Differentiate between precision and accuracy.	BT-2	Understanding
12.	Define the term reliability and Traceability.	BT-1	Remembering
13.	Give any four methods of measurement.	BT-1	Remembering
14.	Define Span.	BT-1	Remembering
15.	Give classification of measuring instruments.	BT-1	Remembering
16.	Explain the term parasitic and illegitimate error.	BT-2	Understanding
17.	Point out the sources of error.	BT-1	Remembering
18.	Illustrate the objectives of metrology	BT-2	Understanding

19.	Compare the term correction and correction factor.	BT-2	Understanding
20.	Differentiate between static and random error.	BT-2	Understanding
21.	Define the term metrology as applied to engineering industry.	BT-1	Remembering
22.	Explain the significance of measurements.	BT-2	Understanding
23.	State the uses of metrology.	BT-1	Remembering
24.	Difference between gauging and measurements?	BT-2	Understanding
25.	While taking measurements, the operator is often advised to use of an instruments in the middle third of its range. Why?	BT-2	Understanding

PART-B

Q.No	Questions	Marks	BT Level	Competence
1.	Explain the classification of various measuring methods.	16	BT-3	Applying
2.	Explain the need of standards of measurements in the modern industrial system and describe the term traceability in connection with standards.	16	BT-3	Applying
3.	What are the various elements of metrology? With examples, explain how these elements influence the accuracy of measurements.	16	BT-3	Applying
4.	Give the structure of generalized measurements system and explain in detail.	16	BT-4	Analyzing
5.	(a)Illustrate the desirable characteristics of precision measuring instruments. (b) Discuss the fundamental and derived units in details.	8 8	BT-3 BT-3	Applying Applying
6.	Explain briefly about,(a) Uncertainty, (b) Reporting results.	13	BT-3	Applying
7.	(a)With suitable example explain the difference between precision and accuracy. (b) Give an example for the Zero order system.	8 8	BT-3 BT-3	Applying Applying
8.	Distinguish between and give appropriate examples in each case, (a) Repeatability and Reproducibility (b) Systematic and random error (c) Static and dynamic Response	16	BT-4	Analyzing

9.	Obtain the expression for the step response of a second order system with neat diagram.	16	BT-4	Analyzing
10.	Describe briefly about, (a) Sensitivity and readability. (b) Calibration.	 8 8	 BT-3 BT-3	 Applying Applying
11.	Enumerate the desirable characteristics of precision measuring instruments.	16	BT-3	Applying
12.	Explain the various errors in measurements.	16	BT-3	Applying
13.	What are the various possible sources of errors in measurements? Explain in detail.	16	BT-3	Applying
14.	What is the need of calibration? Explain the classifications of various standards.	16	BT-4	Analyzing
15.	(a) List and explain the factors to be considered for selecting an instrument. (b) Explain the applications of measuring instruments.	 8 8	 BT-3 BT-3	 Applying Applying
16.	Explain with neat sketch about, (a) Imperial Standard yard (b) International Prototype meter	 8 8	 BT-3 BT-3	 Applying Applying
17.	(a) Describe wavelength standard with neat diagram and its advantages. (b) Define material standard. State the limitations of material standard.	8 8	BT-3 BT-3	Applying Applying
18.	Explain briefly about primary standard, secondary standard, territory standard and working standard with example.	16	BT-3	Applying

UNIT-II: LINEAR AND ANGULAR MEASUREMENT

Linear Measuring Instruments: Evolution, types, classification, Vernier caliper, Micrometer, Vernier height gauge, Depth Micrometer, Bore gauge, Telescoping gauge; Gauge blocks – Use and precautions, Comparators – Working and advantages; Opto-mechanical measurements using measuring microscope and Profile projector- Angular measuring instruments – Bevel protractor, Clinometer, Angle gauges, Precision level, Sine bar, Autocollimator, Angle dekkor, Alignment telescope. Measurement of Screw threads Single element measurements

PART-A

Q.No.	Questions	BT Level	Competence
1.	Point out any four precautions to be taken while using gauge blocks.	BT-1	Remembering
2.	Why rocking procedure is followed when measuring with a dial bore gauge?	BT-2	Understanding
3.	A vernier scale consists of 25 divisions on 12 mm spacing and the main scale has 24 divisions on12 mm. What is the least count?	BT-2	Understanding
4.	What is difference between gauging and measurements?	BT-2	Understanding
5.	Summarize the various types of linear measuring instruments.	BT-1	Remembering
6.	What is the use of Feeler gauges?	BT-2	Understanding
7.	List out any four angular measuring instruments used in metrology.	BT-1	Remembering
8.	A 100 mm sine bar was used to measure the tapper angle of the specimen and the gauge block was 5.055mm. Calculate the tapper angle.	BT-2	Understanding
9.	Define least count.	BT-1	Remembering
10.	Define sine center.	BT-1	Remembering
11.	What are the construction requirements of a good sine bar?	BT-2	Understanding
12.	State the function of a dial indicator.	BT-1	Remembering
13.	Illustrate briefly about wringing of slip gauges.	BT-2	Understanding
14.	Name any four instruments used measuring internal diameters in components.	BT-1	Remembering
15.	Explain the concept of selective assembly.	BT-2	Understanding
16.	Define clinometers.	BT-1	Remembering
17.	Describe the usage of autocollimator.	BT-2	Understanding

18.	Explain an angle alignment telescope.	BT-2	Understanding
19.	List out the need of angle gauges.	BT-1	Remembering
20.	Explain the concept of interchangeability.	BT-2	Understanding
21.	State the possible source of error in micrometer.	BT-1	Remembering
22.	Differentiate between vernier caliper and micrometer.	BT-2	Understanding
23.	Write the difference between measuring instrument and comparator.	BT-2	Understanding
24.	Write the difference between allowance and tolerance.	BT-2	Understanding
25.	Write short note on bevel protractor.	BT-1	Remembering

PART-B

Q.No	Questions	Marks	BT Level	Competence
1.	Describe briefly about, (a) Write notes on interchangeability. (b) Sketch the construction and working of solex pneumatic comparator.	8 8	BT-3 BT-3	Applying Applying
2.	Describe the construction, working, and applications of a Vernier Caliper with neat sketch.	16	BT-3	Applying
3.	Explain the construction and working principle of an autocollimator with neat a diagram and its application.	16	BT-2	Understanding
4.	(a)Explain the classification of linear measuring instruments. (b) Explain the vernier height gauge with neat sketch.	8 8	BT-3 BT-3	Applying Applying
5.	Explain the following with neat sketches. (a) Differential screw micrometer and (b) Thread micrometer	16	BT-4	Analyzing
6.	(a) What is a slip gauge? Write notes on its classifications. (b) How slip gauges are manufactured? Write notes on slip gauge accessories and its calibration.	8 8	BT-3 BT-3	Applying Applying
7.	(a)What is a comparator? Explain Dial gauge type of Mechanical comparator. (b)Describe the working principle, advantages and disadvantages of optical comparator.	8 8	BT-3 BT-3	Applying Applying

8.	Explain the construction and working of a Vernier Depth Gauge. Mention its applications	16	BT-3	Applying
9.	Describe with the help of a neat sketch, any two bevel protractors.	16	BT-3	Applying
10.	Describe the working of a Depth Micrometer with a neat diagram. How does it differ from Vernier Depth Gauge?	16	BT-3	Applying
11.	Explain working principle of sine bar and why sine bars are not suitable for measuring angles above 45^0?	16	BT-4	Analyzing
12.	Describe working principle of angle Dekkor with the neat sketch and also write its application.	16	BT-3	Applying
13.	Explain the construction, uses, and method of setting angles using angle gauges.	16	BT-4	Analyzing
14.	Explain the construction, uses, and precautions of gauge blocks.	16	BT-4	Analyzing
15.	Explain the construction, working, applications, and advantages of an Alignment Telescope.	16	BT-4	Analyzing
16.	Explain the construction, working, types, and applications of a clinometer with a neat sketch.	16	BT-3	Applying
17.	Explain the construction and working principle of vernier bevel protractor with neat sketch and also uses of vernier bevel protractor for checking V block and measuring acute angle.	16	BT-4	Analyzing
18.	Explain read type of Mechanical comparator with neat sketch and also explain the concept of Sigma comparator with sketch.	16	BT-4	Analyzing

UNIT III: TOLERANCE ANALYSIS

Tolerancing– Interchangeability, Selective assembly, Tolerance representation, Terminology, Limits and Fits, Problems (using tables IS919); Design of Limit gauges, Problems. Tolerance analysis in manufacturing, Process capability, tolerance stackup, tolerance charting.

PART A

Q.No.	Questions	BT Level	Competence
1.	Define tolerance.	BT-1	Remembering
2.	What is interchangeability?	BT-2	Understanding
3.	Define selective assembly.	BT-1	Remembering
4.	What is unilateral tolerance?	BT-2	Understanding
5.	What is bilateral tolerance?	BT-2	Understanding
6.	Define basic size.	BT-1	Remembering
7.	What is deviation?	BT-2	Understanding
8.	What is tolerance zone?	BT-2	Understanding
9.	Define upper limit and lower limit.	BT-1	Remembering
10.	Define hole basis and Shaft basis system.	BT-1	Remembering
11.	What is a fit? Name types of fits.	BT-2	Understanding
12.	What is H7/g6?	BT-2	Understanding
13.	What is meant by 'fundamental deviation'?	BT-2	Understanding
14.	What is GO and NO-GO gauge?	BT-2	Understanding
15.	What is Taylor’s principle?	BT-2	Understanding
16.	Why are limit gauges used?	BT-2	Understanding
17.	What is the purpose of plug gauge and ring gauge?	BT-2	Understanding
18.	What is gauge tolerance?	BT-2	Understanding
19.	What is wear allowance?	BT-2	Understanding
20.	What is process capability?	BT-2	Understanding
21.	What is a clearance fit?	BT-2	Understanding
22.	What is an interference fit?	BT-2	Understanding
23.	Define transition fit.	BT-1	Remembering
24.	Define zero line in tolerance.	BT-1	Remembering
25.	What is the meaning of "M6" tolerance grade?	BT-2	Understanding

PART-B				
Q.No	**Questions**	**Marks**	**BT Level**	**Competence**
1.	Explain the concept of selective assembly with neat sketch, Discuss its significance in manufacturing.	16	BT-3	Applying
2.	Discuss in detail about the various types of limit gauges with neat diagram.	16	BT-3	Applying
3.	a) Explain the concept of interchangeability and selective assembly with suitable examples. b) Explain hole basis and shaft basis systems with standard fit notations (use IS 919).	8 8	BT-3 BT-3	Applying Applying
4.	Describe the various types of fits with neat sketches and examples.	16	BT-3	Applying
5.	Explain the types of tolerances and methods of tolerance representation on drawings.	16	BT-3	Applying
6.	Calculate the tolerances, fundamental deviations and limits of sizes for the shaft designated as 40H8/f7.Standard tolerance for IT 7 is 16i and IT 8is 25i. Where 'i' is the standard tolerance unit. Upper deviation for 'f' shaft is $-5.5D^{0.41}$,40 mm lies in the diameter range 30-50 mm.	16	BT-5	Evaluating
7.	a) Explain Taylor's Principle of Gauge Design with suitable examples. b) With neat sketches, explain the design and working of GO and NO-GO gauges.	8 8	BT-4 BT-4	Analyzing Analyzing
8.	Describe the construction and applications of plug, ring, and snap gauges.	16	BT-3	Applying
9.	Calculate the limits for a hole shaft pair designated 25 H8/d9.Show graphically the deposition of tolerance zones with reference to the zero line. The lower deviation for a H type hole is zero. 25 mm lies in the diameter range 18mm to 30 mm. Standard tolerance foe IT 8 is 25i and IT 9 is 40i, where "i" is the standard tolerance unit in microns and is given as $i(\mu m)=0.45\sqrt[3]{D}+0.001D$, (D is in mm).The upper	16	BT-5	Evaluating

	deviation for d shaft is -16 D 0.44.			
10.	Differentiate between unilateral and bilateral tolerances with diagrams. Design **GO** and **NO-GO** gauges for a **hole** 25H7 (basic size = 25 mm). Use: • Work tolerance from IS 919: H7 = 0 to -0.021 mm • Gauge tolerance = 10% of work tolerance • Wear allowance = 0.002 mm	16	BT-5	Evaluating
11.	Design a workshop type progressive type Go-Not-GO plug gauge suitable for 25H7, with following information: i. 25 mm lies in the diameter step of 18-30 mm ii. $i = 0.45\sqrt[3]{D}+0.001D$ iii. IT7 = 16i	16	BT-5	Evaluating
12.	A shaft and hole assembly has a basic size of 50 mm. Given fit: H7/f8. Using IS 919 data, calculate: a) Upper and lower limits for the hole and shaft b) Maximum and minimum clearance c) Type of fit Assume (from standard tables): • For 50 mm size: ○ H7: Upper deviation = 0 mm, Lower deviation = -0.025 mm ○ f8: Upper deviation = -0.030 mm, Lower deviation = -0.074 mm	16	BT-5	Evaluating
13.	A shaft and hole have a nominal size of 40 mm, and the fit specified is H8/e8. Using IS 919 data, calculate: a) Limits of hole and shaft b) Type of fit	16	BT-5	Evaluating

	c) Maximum and minimum clearance Given: Fit Upper Deviation (μm) Lower Deviation (μm) H8 (hole) 0 +33 e8 (shaft) -70 -120			
14.	For a nominal size of 30 mm, design a transition fit using the hole basis system. Suggest a suitable shaft tolerance grade and calculate the limits. Assume: • Hole = H7 → 0 to +21 μm • Choose Shaft = j6 → +6 to -6 μm	16	BT-5	Evaluating
15.	A shaft is manufactured with a fixed size of 60 mm. You want a clearance fit. Using the shaft basis system, choose a suitable hole tolerance and calculate limits. Given: • Shaft = h6 → 0 to -16 μm • Hole = H7 → 0 to +25 μm	16	BT-5	Evaluating
16.	A precision sliding fit is required for a nominal size of 75 mm.Choose a suitable shaft and hole fit to achieve this, and calculate: a) Hole and shaft limits b) Maximum and minimum clearance c) Comment on fit type d) Suggest a suitable limit gauge for the shaft Use IS 919 standard. Suggest H7/g6. Given from IS 919: • H7: 0 to +35 μm • g6: –22 to –40 μm	16	BT-5	Evaluating
17.	What are the elements of a fit? Discuss limits and fits with examples.	16	BT-4	Analyzing
18.	Explain the principle and procedure of designing limit gauges for a hole-shaft pair.	16	BT-4	Analyzing

UNIT IV: FORM MEASUREMENT			
Principles and Methods of straightness – Flatness measurement – Thread measurement, gear measurement, surface finish measurement, Roundness measurement – Applications.			
PART A			
Q.No.	**Questions**	**BT Level**	**Competence**
1.	What is straightness?	BT-1	Remembering
2.	Calculate the "best size wire" for checking a effective diameter of a M10 X 2.5 thread.	BT-2	Understanding
3.	Define a) Lead and b) Pitch.	BT-1	Remembering
4.	What is flatness?	BT-2	Understanding
5.	List out the reasons for the occurrence of progressive errors in screw threads.	BT-1	Remembering
6.	Name a method to measure straightness.	BT-1	Remembering
7.	Explain the drunken error in screw threads.	BT-2	Understanding
8.	Name the various methods for measuring pitch diameter.	BT-1	Remembering
9.	Summarize how Taylor's principle is applied for screw thread gauge?	BT-2	Understanding
10.	The outside diameter of a gear is 110 mm and the number of teeth is 20. Calculate the module of gear?	BT-2	Understanding
11.	Describe the term back lash and run out in the spur gear?	BT-1	Remembering
12.	Discuss about "material ratio" with reference to surface finish measurement.	BT-2	Understanding
13.	Give any four methods by which surface finish can be measured.	BT-1	Remembering
14.	Discuss about a profilometer.	BT-2	Understanding
15.	Define pitch of a thread.	BT-1	Remembering
16.	Name the devices used for roundness measurement.	BT-1	Remembering
17.	Point out any four methods of measuring roundness.	BT-1	Remembering
18.	List out the sources of Out of roundness.	BT-1	Remembering
19.	How is roundness measured in the laser squared circle method?	BT-2	Understanding
20.	Summarize the limitations of using V block to check lobes on work piece.	BT-2	Understanding

21.	Define module of a gear.	BT-1	Remembering
22.	What is surface roughness?	BT-2	Understanding
23.	Explain the term base circle, pitch circle and pitch circle diameter with the help of diagram.	BT-2	Understanding
24.	Differentiate between direct and indirect method of measurement of surface roughness.	BT-2	Understanding
25.	Define the term form factor method of surface roughness measurement.	BT-1	Remembering

PART - B

Q.No	Questions	Marks	BT Level	Competence
1.	(a)Define straightness. Explain the principle of testing straightness using laser interferometer.	8	BT-4	Analyzing
	(b)How will you test the straightness using Spirit level and autocollimator?	8	BT-4	Analyzing
2.	Briefly explain the step by step procedure for determining the flatness of a surface with the neat sketch.	16	BT-2	Understanding
3.	(a)Explain gear tooth vernier method of measuring the gear tooth thickness.	8	BT-3	Applying
	(b) Explain Constant chord method of measuring the gear tooth thickness.	8	BT-3	Applying
4.	(a) Summarize how the tooth thickness of the gear is measured in the base tangent method.	8	BT-4	Analyzing
	(b) Derive the expression for the tooth thickness of the gear in this method.	8	BT-4	Analyzing
5.	Describe the gear tooth vernier caliper and explain how it is used to measure:	16	BT-4	Analyzing
6.	Explain how a gear can be checked using Parkinson gear tester also mentions its limitations.	16	BT-3	Applying
7.	Describe the various methods of numerical assessment of surface finish with neat diagram, and also explain the profilometer with neat sketch.	16	BT-3	Applying

8	(a) Discuss about Tomlinson surface meter. (b) Describe a method to find out flatness of a surface plate.	8 8	BT-3 BT-3	Applying Applying
9.	(a)Describe the method of roundness measurement using V- block. (b)Explain V block and three point probe methods of measurement of roundness.	8 8	BT-4 BT-4	Analyzing Analyzing
10.	Explain the important elements of screw thread with neat sketch.	16	BT-3	Applying
11.	(a) Write the difference between surface roughness and surface waviness (b)Describe the various symbols used for representation of surface texture.	8 8	BT-3 BT-3	Applying Applying
12.	(a) Illustrate briefly the measurement of effective diameter of a screw thread using three wires. (b)Explain how to measure the specifications of the screw thread by using the tool makers' microscope? Discuss in details.	8 8	BT-3 BT-4	Applying Analyzing
13.	With neat sketch explain the Talysurf measurement for surface measurement.	16	BT-3	Applying
14.	Describe the working principle of a stylus-type surface roughness measuring instrument.	16	BT-3	Applying
15.	(a) Explain about bench micrometer for measuring major diameter of threads. (b)Explain the thread micrometer with a neat sketch.	8 8	BT-3 BT-3	Applying Applying
16.	With neat sketch, discuss the gear tooth nomenclature by indicating the different parts.	16	BT-3	Applying
17.	Discuss the various elements of surface roughness, and explain the importance of sampling length in surface roughness measurement.	16	BT-4	Analyzing
18.	Explain the different methods of measuring surface finish with example.	16	BT-3	Applying

UNIT V: ADVANCES IN METROLOGY

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.

PART A

Q.No.	Questions	BT Level	Competence
1.	Name the different types of interferometer.	BT-1	Remembering
2.	Why is laser preferred in engineering metrology?	BT-2	Understanding
3.	On what factor the accuracy of laser interferometer mainly depends?	BT-2	Understanding
4.	Point out the application of Laser Interferometry.	BT-1	Remembering
5.	Give the advantages of laser interferometer.	BT-1	Remembering
6.	Why monochromatic light used in an interferometer instead of white light?	BT-2	Understanding
7.	Define interferometer.	BT-1	Remembering
8.	Differentiate straightness and flatness.	BT-2	Understanding
9.	Discuss the applications of computer aided inspection.	BT-2	Understanding
10.	State the component present in the machine vision system.	BT-1	Remembering
11.	Explain briefly about wavelength.	BT-2	Understanding
12.	List any four possible causes of errors in CMM.	BT-1	Remembering
13.	Point out the applications of CMM in machine tool metrology	BT-1	Remembering
14.	Describe the term “Qualifying the tip” in CMMs?	BT-2	Understanding
15.	List the advantages of CMM.	BT-1	Remembering
16.	Give the disadvantages of CMM.	BT-1	Remembering
17.	Briefly describe the term Machine vision.	BT-2	Understanding
18.	Describe the term CNC CMM?	BT-2	Understanding
19.	Point out the advantages of machine vision system?	BT-1	Remembering
20.	List out any four application of artificial vision system in manufacturing industries.	BT-1	Remembering
21.	What are the properties of Laser?	BT-2	Understanding
22.	Write the features of CMM.	BT-2	Understanding

23.	List the types of CMM?	BT-1	Remembering
24.	Name the different stages involved in the machine vision based measurement.	BT-1	Remembering
25.	Define gray scale analysis.	BT-1	Remembering

PART-B				
Q.No	**Questions**	**Marks**	**BT Level**	**Competence**
1.	(a) Discuss the different types of light sources? (b)Explain the working principle of DC Laser interferometer with neat diagram.	8 8	BT-3 BT-3	Applying Applying
2.	Sketch and describe the optical system used in Michelson interferometer and also explain the method of checking the height of the component with the help of optical flat.	16	BT-3	Applying
3.	Explain the construction and working of a laser Telemetric system with a neat sketch.	16	BT-3	Applying
4.	(a)With a neat sketch explain the dimensional measurements using laser gauge. (b)Summarize how to use laser interferometer to predict machine tool accuracies.	8 8	BT-3 BT-3	Applying Applying
5.	(a)With a neat sketch describe the working of AC laser interferometer. (b) Describe the different types of ACLI and also Discuss the sources of errors in ACLI.	8 8	BT-4 BT-4	Analyzing Analyzing
6.	Explain the construction and working of various types of CMM.	16	BT-3	Applying
7.	(a)Explain the working principle of laser scanning gauge. (b) What is meant by alignment test on machine tools? Give its importance.	8 8	BT-3 BT-3	Applying Applying
8.	Describe the working principle of a dual frequency laser interferometer with a neat sketch.	16	BT-3	Applying
9.	Generalize the needs, types & constructional features of Co-ordinated Measuring Machine.	16	BT-4	Analyzing

10.	(a) Discuss about the various causes of errors in CMM.	8	BT-4	Analyzing
	(b)List out the methods of operating and controlling a Coordinated measuring machine.	8	BT-4	Analyzing
11.	(a) Briefly explain the important features available in CMM software.	8	BT-3	Applying
	(b) With neat diagram explain the working principle of tough trigger probes.	8	BT-3	Applying
12.	(a) Define machine vision. Name four types of machine vision systems.	8	BT-4	Analyzing
	(b) Describe the functions of machine vision system.	8	BT-4	Analyzing
13.	(a) Illustrate the features of flexible inspection system.	8	BT-4	Analyzing
	(b)Explain the various steps of machine vision system in metrology.	8	BT-4	Analyzing
14.	(a) Explain the applications of machine vision system.	8	BT-3	Applying
	(b)Discuss the advantages and disadvantages of Machine vision system.	8	BT-3	Applying
15.	(a) Explain briefly about the causes of error in coordinated measuring machine.	8	BT-3	Applying
	(b)Explain the different types of coordinated measuring machine controls.	8	BT-3	Applying
16.	What is optical flat? Explain how interference fringes are formed when optical flat is placed on a surface to be tested.	16	BT-4	Analyzing
17.	Sketch and interpret the different pattern of interference bands observed through optical flats for the following: i) A perfectly flat surface ii) A concave surface iii) A convex surface iv) A block with beveled edge v) A gauge block with edges rounded off.	16	BT-4	Analyzing
18.	Discuss the working principle of the NPL Flatness interferometer with neat diagram.	16	BT-3	Applying

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