



Academic year 2025 – 2026 (ODD Sem)

DEPARTMENT OF INDUSTRIAL ENGINEERING & MANAGEMENT

Date	14 th January 2026	Maximum Marks	10 + 50
Course Code	IM235AI	Duration	120 Min
Sem	III Semester	Improvement CIE	
Digital Metrology Scheme & Solution			

Part – A

Sl. No.	Questions		M	BT	CO								
1.	<p>When an optical flat is placed on the surface to be tested and illuminated with monochromatic light, a thin air film is formed between the optical flat and the test surface. Light reflected from the bottom surface of the optical flat and the top surface of the test piece interferes with each other.</p> <p>Due to the path difference caused by variation in air film thickness, interference fringes (bright and dark bands) are formed. These fringes indicate the flatness and surface irregularities of the test surface.</p>	<p>WORKING PRINCIPLE OF AN OPTICAL FLAT</p>	01 + 01	L1	CO4								
2.	<table border="1"> <tr> <td>Type-A Optical Flat</td> <td>Type-B Optical Flat</td> </tr> <tr> <td>One surface is optically flat</td> <td>Both surfaces are optically flat and parallel</td> </tr> <tr> <td>Used for flatness testing only</td> <td>Used for flatness and parallelism testing</td> </tr> <tr> <td>Slip gauges, surface plates, measuring tables</td> <td>Micrometer anvils, measuring faces</td> </tr> </table>	Type-A Optical Flat	Type-B Optical Flat	One surface is optically flat	Both surfaces are optically flat and parallel	Used for flatness testing only	Used for flatness and parallelism testing	Slip gauges, surface plates, measuring tables	Micrometer anvils, measuring faces		01 + 01	L2	CO4
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3.	<p>Progressive Error</p> <ul style="list-style-type: none"> It is an error that accumulates progressively along the length of the screw thread. The error increases or decreases gradually as measurement proceeds. <p>Causes: Incorrect lead screw pitch, Tool wear, Accumulated manufacturing errors</p> <p>Periodic Error</p> <ul style="list-style-type: none"> It is an error that repeats at regular intervals, usually once per revolution of the screw. <p>Causes: Gear tooth errors, Lead screw errors, Eccentric mounting of gears</p>		01 + 01	L2	CO3								
4.	<p>The Ten-Point Height Average value is defined as the average difference between the heights of the five highest peaks and the depths of the five lowest valleys measured over a sampling length of the surface.</p> <p>It provides a better representation of surface roughness than single peak-to-valley measurement.</p>	$S_2 = \frac{1}{5} (h_1 + h_2 + h_3 + h_4 + h_5) - (h_6 + h_7 + h_8 + h_9 + h_{10})$	01 + 01	L1	CO3								
5.	<p>First-Order Irregularities</p> <ul style="list-style-type: none"> These are large-scale surface deviations. <p>Cause: Lack of straightness of machine guideways or slideways.</p> <ul style="list-style-type: none"> Affect the overall form of the surface. 		01 + 01	L2	CO3								



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	<p>Second-Order Irregularities</p> <ul style="list-style-type: none"> These are medium-scale irregularities. <p>Cause: Vibrations during machining.</p> <ul style="list-style-type: none"> Appear as waves or chatter marks on the surface. 		
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Part – B

Sl. No.	Questions	M	BT	CO
1.	<p>1. Tool Maker's Microscope (TMM) Principle ---- (02 + 02) Tool Maker's Microscope works on the principle of optical magnification combined with accurate displacement measurement using micrometer screws. The measurement is obtained by aligning the cross-hair (reticle) with different points of the object and noting the movement of the microscope stage.</p> <p>2. Working of TMM --- (02)</p> <ul style="list-style-type: none"> The microscope stage can move in X and Y directions using micrometer screws. The cross-hair is aligned with the object profile. Linear dimensions, angles, and profiles are determined by measuring the stage displacement required for alignment. Applications include measuring threads, tools, small components, and gear teeth. <p>3. Two-Wire Method for Screw Thread Measurement – (04)</p> <ul style="list-style-type: none"> Used to measure the effective diameter (pitch diameter) of an external thread. Procedure: <ol style="list-style-type: none"> Two precision wires of known diameter are placed in the thread grooves (flanks) at the pitch line. The TMM cross-hair is aligned with the top of the wires. The microscope stage displacement is recorded. Using the wire diameter and thread geometry, the effective diameter of the screw thread is calculated. 	(10)	L3	CO3
2.	<p>Radial Runout --- 01 Radial runout is the variation of the pitch circle radius of the gear measured perpendicular to the axis of rotation.</p> <p>Axial Runout ---- 01 Axial runout is the variation measured parallel to the axis of rotation, causing wobbling of the gear.</p> <p>Measurement of Gear Tooth Thickness using Vernier Caliper --- 04 + 04 The outside diameter of the gear is measured using a vernier caliper. From this, the pitch circle diameter is calculated. The vernier jaws are positioned at the pitch circle and the tooth thickness is measured directly.</p>	(10)	L2	CO3



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<p>3. Construction -- 02</p> <ul style="list-style-type: none"> • Diamond stylus • Spring-loaded arm • Horizontal lapped cylinder • Rollers • Smoked glass plate • Optical projector <p>Principle of Operation --- 04 + 03</p> <p>It works on a mechanical-cum-optical magnification principle. Vertical movement of the stylus due to surface irregularities causes the lapped cylinder to roll, which moves the scribe and produces a trace on the smoked glass.</p> <p>Applications --- 01</p> <ul style="list-style-type: none"> • Measurement of surface roughness • Surface finish analysis • Inspection of machined components 		(10) L3 CO3
<p>4. Principle ---- 03</p> <p>An autocollimator works on the principle of reflection of a collimated light beam. Any angular tilt of the reflecting surface causes a lateral displacement of the reflected image.</p> $d = 2\alpha f$ <p>Working --- 03 +03</p> <p>Light from the source is collimated and directed onto a reflecting surface. The reflected beam returns through the optical system and the displacement of the image is measured using a CCD or eyepiece scale.</p> <p>Applications ---01</p> <ul style="list-style-type: none"> • Straightness measurement • Flatness measurement • Alignment of machine tools 		(10) L3 CO4



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<p>5. Major Diameter --- 02+ 02 The bench micrometer is first set using a standard cylindrical gauge. The threaded workpiece is then placed between the anvils and the difference in readings gives the major diameter.</p> <p>Minor Diameter - 03 + 03 The minor diameter is measured by a comparative method using V-pieces placed in contact with the thread roots. Readings are taken and compared with a standard reference cylinder to obtain the minor diameter.</p> <div style="display: flex; justify-content: space-around; margin-top: 10px;"> <div style="text-align: center;"> <p>Measurement of Minor diameter</p> </div> <div style="text-align: center;"> <p>Measurement of Major diameter</p> </div> </div>	<p>(10)</p>	<p>L2</p>	<p>CO4</p>
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BT-Blooms Taxonomy, CO-Course Outcomes, M-Marks

Marks Distribution	Particulars		CO1	CO2	CO3	CO4	CO5	L1	L2	L3	L4	L5	L6
	Quiz	Max Marks	--	--	06	04	--	04	06	--	--	--	--
	Test		--	--	30	20	--	--	20	30	--	--	--
