

81  
10/11/23

Set B

D-6

Nov-23

### SCHEME OF VALUATION

Course title: Material Science and Metrology

I. Answer all the following questions in one word or sentence. (9 x 1 = 9 Marks)

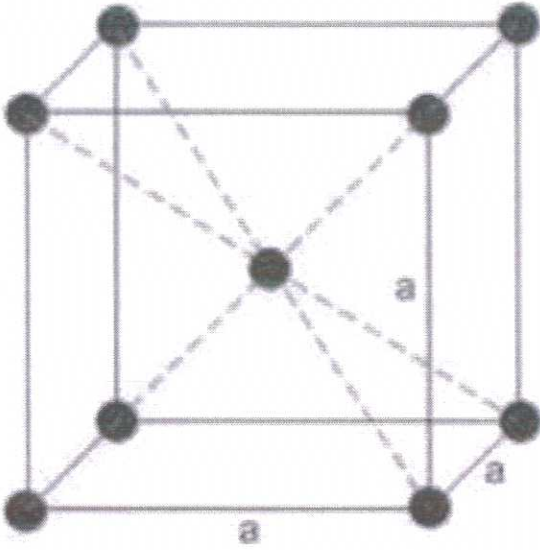
Qs No.	Scoring indicator	Split up score	Sub total	Total
<b>PART A</b>				<b>9</b>
I.1.	Annealing		1	
I.2.	Zinc		1	
I.3.	Unit cell		1	
I.4.	Chromium		1	
I.5.	Metrology		1	
I.6.	Statistically		1	
I.7.	Range		1	
I.8.	Plug gauge, Ring gauge, Snap gauge	Any one	1	
I.9.	Universal Bevel Protractor, Clinometer, Sine Bar, Spirit Level, Autocollimator, Angle Gauges	Any one	1	

### PART B

II. Answer any eight questions

(8 x 3 = 24 Marks)

Qs No.	Scoring indicator	Split up score	Sub total	Total
<b>PART B</b>				<b>24</b>


II.1.			3	
II.2.	<p>T-T-T diagram is also called isothermal transformation diagram [Temperature-Time – Transformation]. It is a plot of temperature versus the logarithm of time for a steel alloy of definite composition. The effect of time-temperature on the microstructure changes of steel can be shown by the TTT diagram.</p>		3	
II.3.	<p>Pipes, engine bolts, rivets, crane hooks, fences, gates, railings, roof cresting, grilles, nails,</p>	1*3	3	
II.4.	<p>The purpose of alloying steels are:</p> <ul style="list-style-type: none"> <li>-Strengthening of the ferrite.</li> <li>- Improved corrosion resistance.</li> <li>- Better hardenability</li> <li>- Grain size control</li> </ul> <p>Greater strength</p> <ul style="list-style-type: none"> <li>- Improved machine ability</li> <li>- Improved high or low temperature stability</li> <li>- Improved ductility</li> <li>- Improved toughness</li> </ul> <p>Better wear resistance</p>	1*3	3	

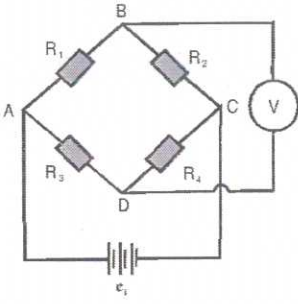
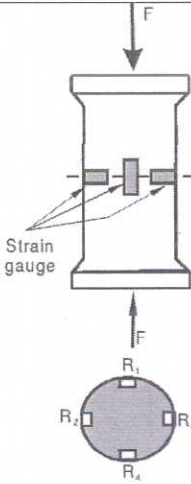
II.5.	<ol style="list-style-type: none"> <li>1. To obtain a hard and wear resistance surface on machine parts with enrichment of the surface layer with carbon to concentration of 0.75 to 1.2%.</li> <li>2. To obtain a tough core.</li> <li>3. To obtain close tolerances in machining parts</li> <li>4. To obtain a higher fatigue limit and high mechanical properties in the core.</li> </ol>			1*3	3									
II.6.	<p>Metrology literally means science of measurements. In practical applications, it is the enforcement, verification, and validation of predefined standards. Although metrology, for engineering purposes, is constrained to measurements of length, angles, and other quantities that are expressed in linear and angular terms, in a broader sense, it is also concerned with industrial inspection and its various techniques. Metrology also deals with establishing the units of measurements and their reproduction in the form of standards, ascertaining the uniformity of measurements, developing methods of measurement, analysing the accuracy of methods of measurement, establishing uncertainty of measurement, and investigating the causes of measuring errors and subsequently eliminating them</p>				3									
II.7.	<table border="1"> <thead> <tr> <th data-bbox="464 1352 576 1413">Sl.No.</th> <th data-bbox="576 1352 810 1413">Accuracy</th> <th data-bbox="810 1352 1062 1413">Precision</th> </tr> </thead> <tbody> <tr> <td data-bbox="464 1413 576 1760">1.</td> <td data-bbox="576 1413 810 1760">The closeness of measured value to true value is accuracy.</td> <td data-bbox="810 1413 1062 1760"> <p>The repeatability of a measuring process is precision.</p> <p>The closeness of measured values to each other is called precision.</p> </td> </tr> <tr> <td data-bbox="464 1760 576 1968">2.</td> <td data-bbox="576 1760 810 1968">Reducing systematic error will increase accuracy.</td> <td data-bbox="810 1760 1062 1968">Reducing random error will increase precision.</td> </tr> </tbody> </table>	Sl.No.	Accuracy	Precision	1.	The closeness of measured value to true value is accuracy.	<p>The repeatability of a measuring process is precision.</p> <p>The closeness of measured values to each other is called precision.</p>	2.	Reducing systematic error will increase accuracy.	Reducing random error will increase precision.			1*3	3
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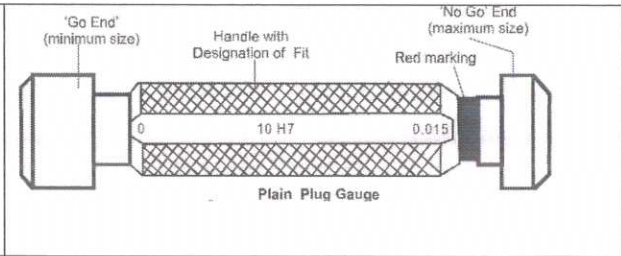
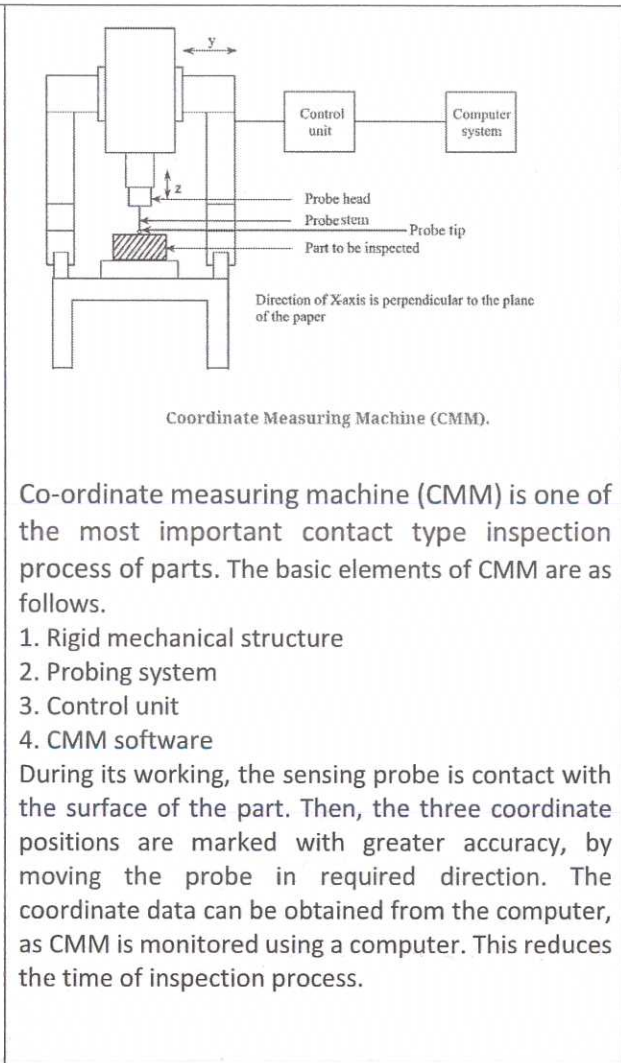
II.8.	Dynamic characteristics of a measuring system show the relationship between the input and output of the system, when the measured quantity is varying rapidly. Speed of response, lag, fidelity are all dynamic characteristics.		3	
II.9.	Mechanical, Electrical, Pneumatic, Hydraulic, Optical comparators	1x3=3 any 3	3	
II.10.	Rules, vernier calipers, vernier height gauges, vernier depth gauges, micrometers, dial indicators etc.	1x3=3 any 3	3	

### PART C

Answer ALL questions. Each question carries 7 marks. (6 x 7 = 42Marks)

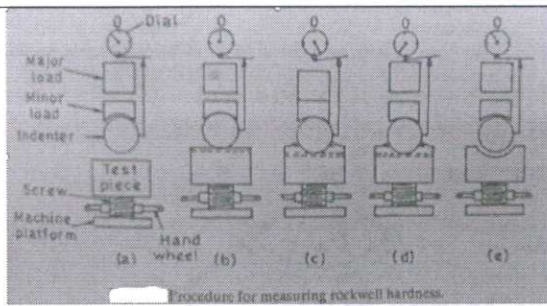
Qs No.	Scoring indicator		Split up score	Sub total	Total
	<b>PART C</b>				<b>42</b>
III. 	<b>Systematic error</b>	<b>Random error</b>	1*7	7	
	Not easy to detect	Easy to detect			
	Cannot be eliminated by repeated measurements	Can be minimized by repeated measurements			
	Can be assessed easily	Statistical analysis required			
	Minimization of systematic errors increases the accuracy of measurement	Minimization of random errors increases repeatability and hence precision of the measurement			
	Calibration helps reduce systematic errors	Calibration has no effect on random errors			
	Characterization not necessary	Characterized by mean, standard deviation, and variance			

	Reproducible inaccuracies that are consistently in the same direction	Random in nature and can be both positive and negative			
OR					
<p>IV</p>	 <p style="text-align: center;">Strain gauge arrangement For a Load Cell</p>		<p>Sketch- 4, Description - 3</p>	7	
<p>IV</p>	<p>Plug gauges are of cylindrical form used in the manner of a plug for inspecting internal dimensions. Plain plug gauge is used to check the size of a hole. The gauging portion is made of suitable wear resisting steel and hardened, ground and lapped. If the hole size is correct within tolerable limits, the 'Go' end will enter the hole while the 'No Go' end will not. If the 'Go' gauge does not pass, the hole is under size and if the 'No Go' gauge passes, the hole is over size.</p>	<p>Sketch- 4, Description - 3</p>	7		

				
OR				
<p>VI</p>	 <p style="text-align: center;">Coordinate Measuring Machine (CMM).</p> <p>Co-ordinate measuring machine (CMM) is one of the most important contact type inspection process of parts. The basic elements of CMM are as follows.</p> <ol style="list-style-type: none"> <li>1. Rigid mechanical structure</li> <li>2. Probing system</li> <li>3. Control unit</li> <li>4. CMM software</li> </ol> <p>During its working, the sensing probe is contact with the surface of the part. Then, the three coordinate positions are marked with greater accuracy, by moving the probe in required direction. The coordinate data can be obtained from the computer, as CMM is monitored using a computer. This reduces the time of inspection process.</p>	<p>Sketch- 4, Description - 3</p>	7	
<p>VII</p>	<p><b>RADIOGRAPHIC TESTING</b></p> <p>Is based on differential absorbtion of radiation</p> <p>Denser material absorb more radiation &amp; gives a lighter marks on radiographs.</p> <p>Radiation source can be X-ray machine or isotopes.</p>	<p>Sketch- 4, Description - 3</p>	7	



	<p>3. It is also extensively used for air planes and other machines where weight is a deciding factor</p> <p>4. It is also employed in surgical and orthopaedic work and for non-magnetic and other instrument parts.</p>			
<p><del>IX</del></p> <p>IX</p>	<p>The determination of the Rockwell hardness of a material involves the application of a minor load followed by a major load.</p> <p>The depth of penetration from the zero datum is measured from a dial, on which a harder material gives a higher number.</p> <p>The minor load establishes the zero position. The major load is applied, then removed while still maintaining the minor load.</p> <p>That is, the penetration depth and hardness are inversely proportional.</p> <p>The chief advantage of Rockwell hardness is its ability to display hardness values directly, thus avoiding tedious calculations involved in other hardness measurement techniques.</p> <p>The commonly used scales are "A" (50kgf), "B"(100kgf)" &amp; "C"(150kgf)</p>	<p>Sketch- 4, Description - 3</p>	<p>7</p>	



OR

<p><del>11.</del> X</p>	<p><b>Brittle fracture</b></p> <p>It means fracture of material without plastic deformation or with very small plastic deformation before fracture.</p> <p>Rock, concrete, glass, and cast iron all have such property, so they are called brittle materials</p> <p>Fast crack propagation</p> <p>Fracture surface is dull with hills and valleys</p> <p>Characterised by separation normal to tensile stress</p>	<p><b>Ductile fracture</b></p> <p>It means fracture of material with large plastic deformation before fracture.</p> <p>Fracture of soft steel and other soft metals, rubber, and plastics is ductile fracture.</p> <p>Slow crack propagation</p> <p>Fracture surface is shiny</p> <p>Characterised by formation of cup and cone</p>	<p>Any 3 points</p>	<p>7</p>
<p><del>11.</del> X</p>	<p><u>Carbon</u> Hardness Tensile strength Machine ability Melting point</p> <p><u>Nickel:</u> -Increases toughness and resistance to impact Lessens distortion in quenching Lowers the critical temperature of steel and widens the</p>	<p>Any 3</p>		

<p>heat treat indent Strengthens steels. Renders high-chromium iron alloy austenitic. Does not unite with carbon.</p> <p><u>Chromium:</u> Joint with carbon to form chromium carbide, thus adds to with improved resistance to abrasion and wear.</p> <p><u>Silicon:</u> Improves oxidation resistance Strengthens low alloy steels - Acts as a deoxidizes.</p> <p><u>Titanium:</u> Prevents localized depletion of chromium in stainless steels during long heating. -Prevent formation of austenite in high chromium steels. - Reduces martensitic hardness and harden ability in medium chromium steel</p> <p><u>Molybdenum:</u> Promotes harden ability of steels -Makes steel fine grained. Makes steel unusually tough at variousness level. - Counteracts tendency towards temper brittleness Raises tensile and creep strength at high temperatures. -Enhances corrosion resistance in stainless steel Forms abrasion resisting particles.</p> <p><u>Vanadium:</u> Promotes fine grains in steel -Increases hardenability Imparts strength and toughness to heat-treated steel -It is a powerful carbide former Stabilizes cementite and improves the structure of the chill.</p> <p><u>Tungsten:</u> - Increases hardness (and also red hardness) - Promotes fine grain Resists heat</p>			
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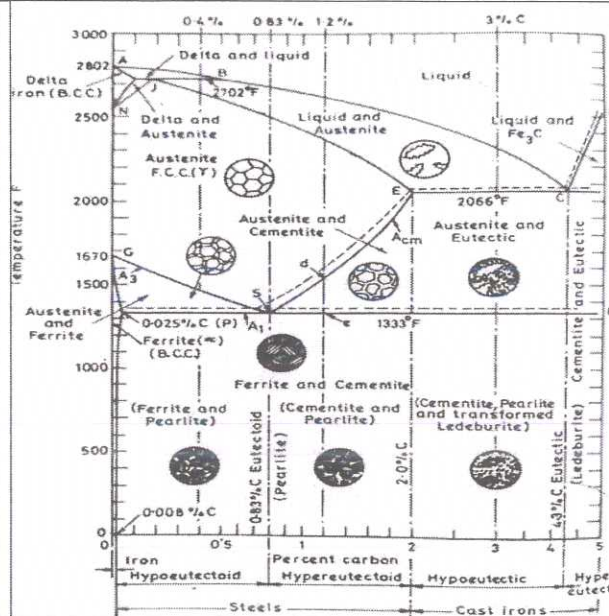
- Promotes strength at elevated temperature.

Manganese:

Contributes markedly to strength and hardness  
 - Counteracts brittleness from sulphur. Lowers both ductility and weldability if it presents in high percentage with high carbon content in steel.

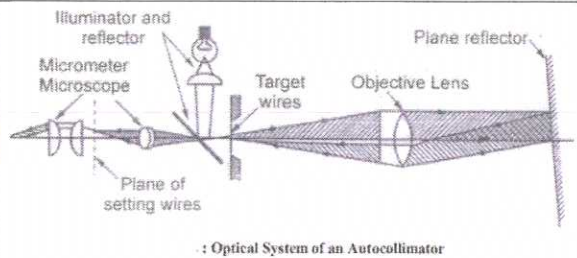
OR

XII



Sketch- 7

XIII



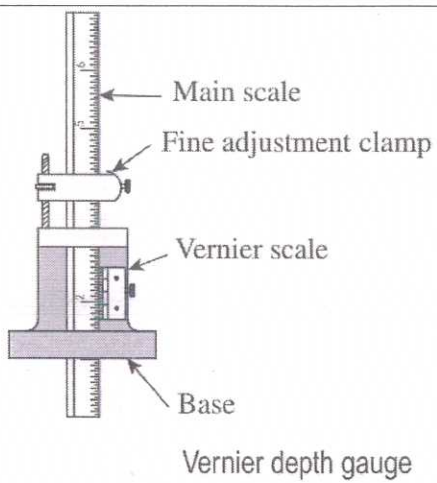
: Optical System of an Autocollimator

The optical system of an autocollimator is shown. The target wires are illuminated by the electric bulb and act as a source of light since it is not convenient to visualize the reflected image of a point and then to measure the displacement  $x$  precisely. The image of the illuminated wire after being reflected from the surface being measured is formed in the same plane as the wire itself. The eyepiece system containing the micrometer microscope mechanism has a pair of setting lines which may be used to measure the displacement of the image by setting to the original cross lines and then moving over to those of the image.

Sketch- 4,  
Description

7

- 3

OR				
10. 12 <u>XIV</u>	 <p style="text-align: center;">Vernier depth gauge</p>	Sketch- 4, Description - 3	7	
<p>Working</p> <p>These also operate on the vernier principle but differ in the design application of the basic concept, resulting in the reversal of the usual process. The slide is connected with the cross beam of the instrument, which by contacting a reference plane on the object surface, establishes the datum of measurement. The end face of the beam (main scale), functions as the movable jaw, in contacting the object element whose distance from the datum is to be measured.</p>				

12 pages only