SET A

SCHEME OF VALUATION

Course title: Material Science and Metrology

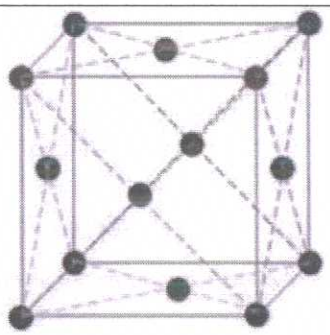
I. Answer all the following questions in one word or sentence. (9 x 1 = 9 Marks)

Qs No.	Scoring indicator	Split up score	Sub total	Total
	PART A			**9**
I.1.	Space lattice		1	
I.2.	Ductile and brittle fracture		1	
I.3.	Case hardening		1	
I.4.	Alloys		1	
I.5.	Accuracy		1	
I.6.	Sensitivity		1	
I.7.	Plug gauge		1	
I.8.	Least count		1	
I.9.	Weight		1	

PART B

II. Answer any eight questions (8 x 3 = 24 Marks)

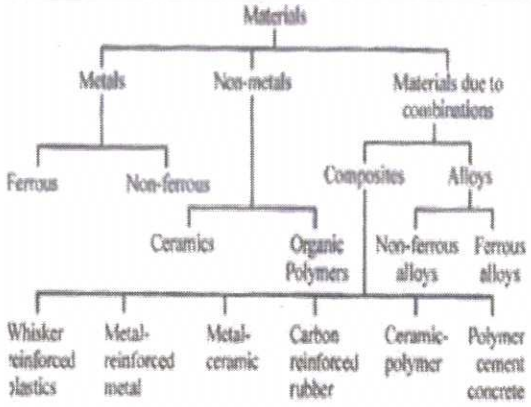
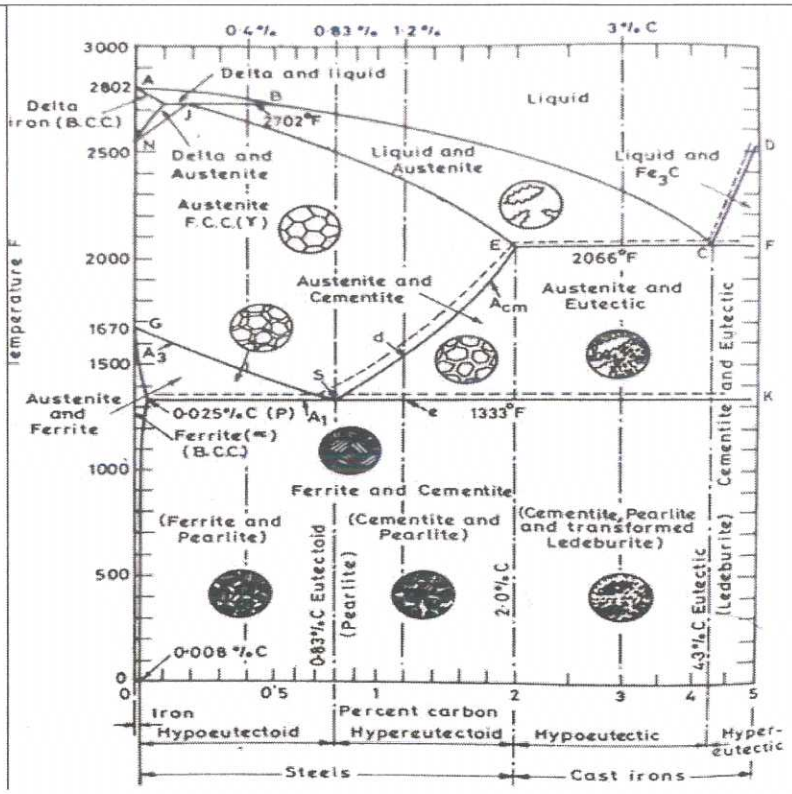
Qs No.	Scoring indicator	Split up score	Sub total	Total
	PART B			**24**
II.1.	Low-carbon steel consists of less than 0.30% carbon. Medium-carbon steel consists of 0.30% to 0.60% carbon. High-carbon steel contains more than 0.60% carbon.	1*3	3	
II.2.	Engine block, fly wheels, brake disc and drums, gears, punches, rail	Any 3	3	

II.3.	Shaft, gear, valves, hammer, Hand rails, Culinary uses, Kitchen sinks, Cutlery, Cookware, Surgical tools and medical equipment.	Any 3	3	
II.4.			3	
II.5.	Static characteristics refer to the performance of a measuring system for the measurement of quantities that remain constant over a period of time. Example: accuracy, sensitivity, repeatability hysteresis, etc.		3	
II.6.	Threshold If the input to the instrument is gradually increased from zero, a minimum value of that input is required to detect the output. This minimum value of the input is defined as the threshold of the instrument. The numerical value of the input to cause a change in the output is called the threshold value of the instrument.		3	
II.7.	Direct method In this method, the quantity to be measured is directly compared with the primary or secondary standard. Scales, vernier callipers, micrometers, bevel protractors, etc., are used in the direct method. Indirect method In this method, the value of a quantity is obtained by measuring other quantities that are functionally related to the required value. Measurement of the quantity is carried out directly and then the value is determined by using a mathematical	1.5*3	3	

	relationship. Some examples of indirect measurement are angle measurement using sine bar, measurement of strain induced in a bar due to the applied force, determination of effective diameter of a screw thread, etc.			
II.8.	1. It should be compact. 2. It should be easy to handle. 3. It should give a quick responses or quick results. 4. It should be reliable, while in use. 5. There should be no effects of the environment on the comparator. 6. Its weight must be less. 7. It must be cheaper. 8. It must be easily available in the market. 9. It should be sensitive as per the requirement.	Any 3	3	
II.9.	Universal Bevel Protractor, Clinometer, Sine Bar, Spirit Level, Angle gauge	Any 3	3	
II.10.	1. Visual 2. Magnetic Particle 3. Liquid Penetrant 4. Radiographic 5. Ultrasonic 6. Eddy current	1x3=3 (Any 3)	3	

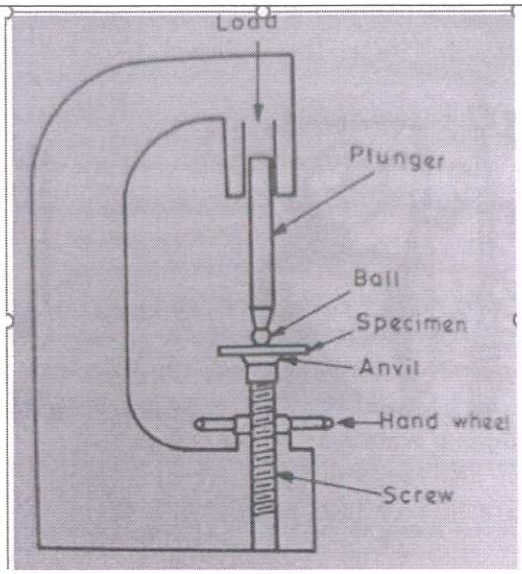
PART C

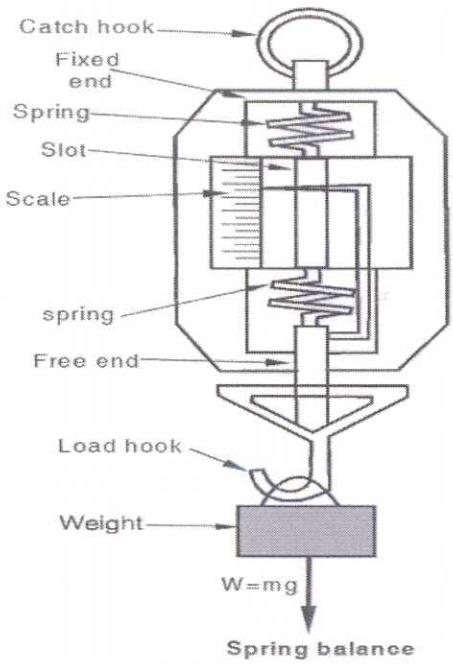
Answer ALL questions. Each question carries 7 marks. (6 x 7 = 42Marks)

Qs No.	Scoring indicator	Split up score	Sub total	Total
	PART C			**42**
III.			7	
	OR			
IV.	 The Fe - C diagram (also called the iron - carbon phase or equilibrium diagram) is a graphic representation of the respective microstructure states of the alloy iron - carbon (Fe-C) depending on temperature and carbon content. Temperature is plotted on y-axis and composition is plotted on x- axis.	Sketch- 4, Description- 3	7	

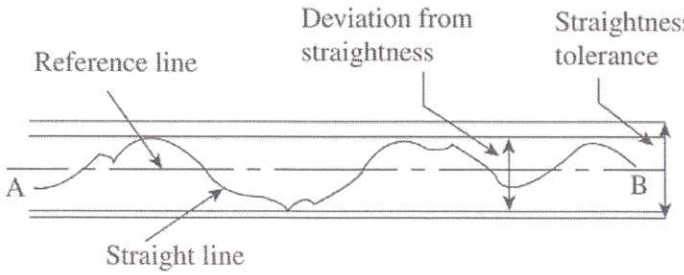
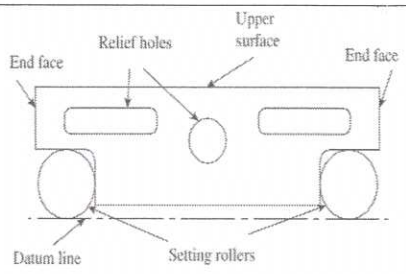
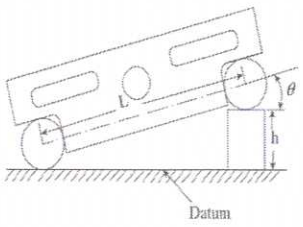
V.	UT- Advantages Size & depth information On stream inspection Low cost Useful for testing metals, non metals & ceramics Useful for condition monitoring UT- Applications -In service inspection for preventive maintenance & life prediction Thickness measurement of pressure vessels & ship hull To inspect bonds produced by welding, brazing, soldering & adhesive bonding To identify internal flaws in products To inspect archaeological structures & monuments	Advantages-4, Applications-3	7	
	OR			
VI	Tin Bronze: This is the simplest type of bronze in which 90% copper, 9 % tin and 1 % phosphorus are present. Tin improves the wear and corrosion resistance of the alloy in comparison with pure copper. Phosphorus functions as a deoxidizer during melting and also contributes to hardness and wear resistance. This alloy is also called as phosphor bronze. It is used to manufacture springs, bellows, electrical contacts, bushes, clutch discs, taps etc. Gun metal: When zinc replaces phosphorus in tin bronze, the resulting alloy is called gun metal. Zinc also functions as a deoxidiser, at a lower cost. A typical gun metal has a composition of 88% Cu, 10% Sn and 2% Zn. This alloy is usually used for marine components due to the better corrosion resistance. Aluminium bronze: Alloys of copper and aluminium are called aluminium bronzes which usually contains 4 to 11% aluminium. Other elements like iron, nickel, manganese and silicon may be added to the alloy to obtain specific desired properties. Though it is having better strength and corrosion resistance, is not suitable for casting. Of all copper alloys, this one is having the finest colour and is often called imitation gold.	Any 3	7	

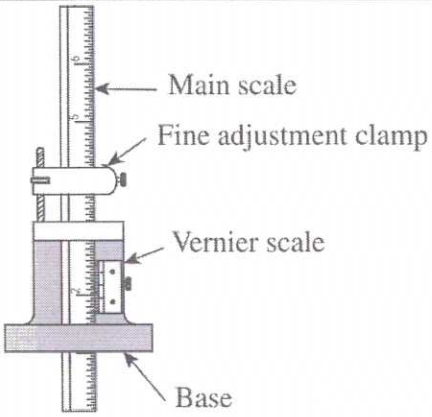
	Silicon bronze: Copper-silicon alloys are called silicon bronzes, which contain silicon in the range of 1 to 4%. In some cases, small amounts of manganese, zinc or iron is also alloyed. Presence of silicon improves strength. These alloys are suitable for cold and hot working, and have higher corrosion resistance and weldability. It is used to manufacture rivets, bolts and nuts, wood screws and similar fasteners. Beryllium bronze: Copper alloyed with beryllium in the range of 0.6 to 3% is known as beryllium bronze. Upon precipitation hardening, this alloy attains high strength. This alloy is relatively expensive but used for high conductivity and high strength applications. It is also called beryllium copper. Beryllium bronze is an excellent material for springs due to its high elasticity and fatigue resistance.			
VII	Brinell Testing (Procedure) Specimen is placed on the anvil; the hand wheel is rotated so that the specimen along with the anvil moves up and contacts with the ball. The desired load is applied mechanically (by a gear driven screw) or hydraulically (by oil pressure) and the ball presses into the specimen. The diameter of the indentation made in the specimen by the pressed ball is measured by the use of a micrometer microscope, having a transparent engraved scale in the field of view. The indentation diameter is measured at two places at right angles to each other, and the average of the two readings is taken.	Sketch- 4, Description- 3	7	

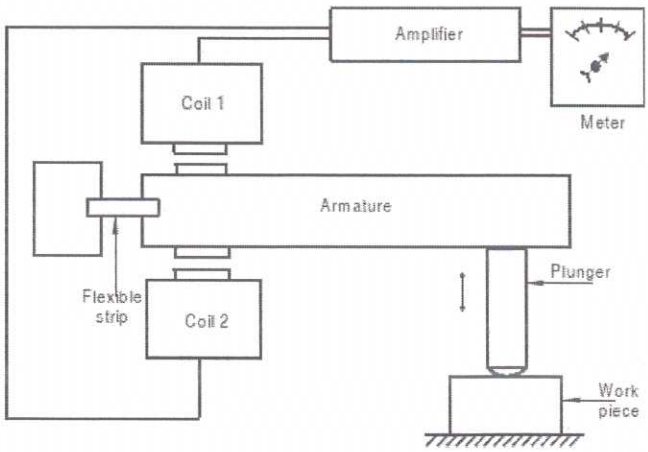
	 $BHN = \frac{W}{(\pi D/2)(D - \sqrt{D^2 - d^2})}$ where W is load on indenter, kg D is diameter of steel ball, mm d is average measured diameter of indentation, mm			
	OR			
VIII	Martempering: After heating the steel to the austenitisng temperature, it is quenched in a medium having a temperature, from 150° to 300°C. The article is held until it reaches the temperature of medium and then it is cooled further to room temperature in air and sometimes in oil. The holding time in the quenching bath should be sufficient to enable a uniform temperature to be reached throughout the cross-section but long enough to cause austenitic decomposition. Austenite is transformed into martensite during the subsequent period of cooling to room temperature. Austempering : After heating the steel to the austenitisng temperature, it is quenched in a medium having a temperature, from 250° to 400°C (bainitic range). The article is held until it reaches the temperature of medium and then it is cooled further to room temperature in air and sometimes in air or oil. The holding time in the quenching bath should be sufficient to enable a uniform temperature to be reached throughout the cross-section but long enough to cause austenitic decomposition. Austenite is transformed into bainite during the subsequent period of cooling to room temperature.	3.5*2	7	

	It is performed in the same manner principally as martempering but with a longer holding time at hot bath temperature above the martensite point to ensure a sufficiently complete austenite decomposition to bainite.			
IX	 The spring balance is a device, which is used to measure the force directly with the help of coil spring deflection. The fixed end is attached to catch hook and free end is connected to the load hook. The displacement at the free end due to the applied force is shown by pointer moving on a scale. Here the deflection is a linear function of force and can be used to measure the force directly $F = k \cdot \delta$ F – Applied force, k – Stiffness, δ – Deflection	Sketch- 4, Description- 3	7	
	OR			
X	The error in measurement is a mathematical way to show the uncertainty in the measurement. It is the difference between the result of measurement and the true value of the measured quantity. Errors in measurement can be broadly classified as **1.Systematic or Controllable errors** A systematic error is a type of error that deviates by a fixed amount from the true value of measurement. These types of errors are controllable in both their magnitude and their direction, and can	Any 3 points	7	

	be assessed and minimized if efforts are made to analyse them. Minimization of systematic errors increases the accuracy of measurement. The following are the reasons for their occurrence: (a) Calibration Errors (b) Ambient Errors (c) Loading Errors (d) Errors caused by defective equipment (e) Avoidable Errors 2. Random or Precision errors Random errors provide a measure of random deviations when measurements of a physical quantity are carried out repeatedly. When a series of repeated measurements are made on a component under similar conditions, the values or results of measurements vary. Specific causes for these variations cannot be determined, since these variations are unpredictable and uncontrollable by the experimenter and are random in nature. These are caused by (a) disturbances to the equipment (b) fluctuating experimental conditions (c) lack of measuring system sensitivity			
XI	A line is said to be straight over a given length if the deviation of various points on the line from two mutually perpendicular reference planes remains within stipulated limits. The reference planes are so chosen that their intersection is parallel to the straight line lying between the two specific end points. The tolerance on the straightness of a line is defined as the maximum deviation of the spread of points on either side of the reference line, as shown in Fig. The maximum spread of deviation with respect to the reference line is a measure of straightness accuracy. The lesser the deviation or spread, the better the straightness accuracy of a machine part.	Sketch- 4, Description- 3		

	 Straightness of a line			
	OR			
XII	 Sine bar  Sine rule A sine bar is used to measure angles based on the sine principle. Its upper surface forms the hypotenuse of a triangle formed by a steel bar terminating in a cylinder near each end. When one of the cylinders, called a roller, is resting on a flat surface, the bar can be set at any desired angle by simply raising the second cylinder. The required angle is obtained when the difference in height between the two rollers is equal to the sine of the angle multiplied by the distance between the centres of the rollers. Figure illustrates the construction details of a sine bar. Accessories such as a surface plate and slip gauges are needed to perform the measurement process. Figure illustrates the application of a sine rule for angle measurement. The sine of angle θ formed between the upper surface of a sine bar and the surface plate (datum) is given by Sin (θ) = h/L, where h is the height difference between the two rollers and L is the distance between the centres of the rollers. Therefore, h = L Sin (θ) θ = Sin-1 (h/L)	Sketch- 4, Description- 3	7	

XIII	 Vernier depth gauge Working 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.	Sketch- 4, Description- 3	7	
	OR			
XIV	Electrical comparators generally depend on a wheatstone bridge circuit for measurement. In this comparator, we can get high magnification range A DC (Direct Current) is supplied to the system. The arrangement of electrical comparator is shown in Fig.. It consists of armature, coil, amplifier, meter, plunger and flexible strip etc.	Sketch- 4, Description- 3	7	



Electrical comparator

With the help of wheatstone bridge circuit, the meter is set to zero. When the plunger touches the workpiece surface, due to variation, the plunger will move up or down. Due to plunger movement, the armature also move either up or down. Due to this movement, the change in current or potential will be induced and the meter will show the value of displacement.