Ref. No.: Ex/Met/PC/B/TS/222/2023

B.E. Metallurgical and Material Engineering 2nd Year 2nd Semester Exam 2023

Subject: Testing of Materials

Time: 3 hours **Full Marks = 100**

(Answer questions no 1 and 7 and any four from the rest)

1. Answer any ten questions: (10 × 2 = 20)

a. State the advantages of Mayer's hardness testing over Vicker's hardness testing.

b. What effect will be observed on the hardness value of a material when the indentation is made too close to an existing indentation?

c. Concrete has exceptional strength in compression, but it fails rather early in tension; why?

d. With an increase in strain rate, ductility _____ and tensile strength _____.

e. Sketch the transition-temperature curves in a single plot for plain carbon steel tested in tension and notched impact.

f. Three basic factors contribute to brittle-cleavage type fracture are _____ , _____, _____.

g. What type of fracture surface will you expect if the impact test is carried out at FATT?

h. Match with mechanical tests in Group 1 to the output parameters in Group 2:

Group 1		Group 2	
1.	Tensile test	I.	Fracture appearance transition temperature
2.	Impact test	II.	Slow and progressive deformation
3.	Fatigue test	III.	Cup and cone fracture
4.	Creep test	IV.	Striations and beach marks formation

i. Define cyclic hardening.

j. Give an example with a reason for which creep occurs at ambient temperature.

k. Which nondestructive testing will you prefer to detect the crack inside the material?

2. **5 + 5 + 5 = 15**

a. Define hardness. Briefly discuss the different hardness measurement techniques. State the purposes of Micro-indentation at low load over Macro indentation.

b. What precautionary steps must we follow for measuring the hardness using the Vickers hardness testing machine?

c. Show through a sketch that to produce a geometrically similar indentation in a Brinell test (d/D) must remain constant.

[Turn over

3. **5+5+5 = 15**

a. What is proof stress? How is estimated? How is it different from yield stress? Find the relation between Engineering stress and True stress.

b. Explain the necking phenomenon in a tensile test sample in light of plastic instability.

c. Write down the "constitutive equation" correlating strain, strain rate, and temperature. How would you experimentally determine the individual term of the "constitutive equation" that relates to the tensile flow stress of a material? Discuss.

4. **5+5+5 = 15**

a. Schematically draw the impact energy absorption capacity vs. temperature curve of low-C steel and define different impact transition temperatures (ITTs) on that curve.

b. Draw the load vs. displacement or time diagrams under impact loading conditions and discuss how the shape of the graph changes to the testing temperature.

c. Discuss the following factors affecting the impact transition temperature of steel (i) grain size & (ii) Chemical composition.

5. **4+4+4+3 = 15**

a. Differentiate between high and low cycle fatigue.

b. Discuss the effect of Mean stress on S-N curve of a material.

c. What is the role of surface residual stress on the fatigue performance of a material?

d. Briefly describe the important features observed in the fatigue fracture surface.

6. **6+6+3 = 15**

a. Illustrate an idealized shape of a Creep curve under a constant load test. What will be the nature of the curve under a constant stress state?

b. Give a brief description of the chief deformation mechanisms operative during creep.

c. Define creep strength and creep life of a material.

7. Write a short note on (Any four): (4 × 5 = 20)

a. Knoop micro-hardness testing

b. Determination of crack arrest temperature (CAT)

c. Goodman diagram

d. Magnetic particle testing

e. X-ray radiography testing