

B.E Metallurgical and Material Engineering
Second Year, Second Semester Examination 2019

Subject: Mechanical Testing of Materials

Time: Three Hours

Full marks: 100

(Answer any five from the following)

- 1. Answer the following with justification:** 5 x 4 = 20
- (i) Brinell hardness is load dependent.
 - (ii) Hardness testing method used for gray cast iron.
 - (iii) Effect of specimen size on fatigue strength of a material.
 - (iv) Effect of grain size of creep strength of a material.
 - (v) Effect of residual stress on fatigue strength.
- 2. (a)** Show that the tensile strength for a material that follows power law is: $S_u = K \left(\frac{n}{e}\right)^n$
- (b)** the variation of percentage elongation X with gauge length has been found empirically to follow the relationship: $X = c \sqrt{A} / L_0 + b$, where c and b are constants. The following data were obtained for a steel plate that is 50 mm wide and 12 mm thick:
- | | | | | | | |
|------------|------|------|------|------|------|------|
| L_0 , mm | 50 | 100 | 150 | 250 | 300 | 350 |
| X | 39.4 | 30.1 | 27.1 | 24.7 | 24.0 | 23.6 |
- Find b and c , and determine the percentage elongation for a 50 by 20 mm steel plate with 250 mm gauge length.
- (c)** For a material whose flow curve is given by $\sigma = K\epsilon^n$, derive an expression for tensile yield ratio (Y.S/ UTS) in terms of n and show how S_u/S_0 can be used to determine n . 6 + 7 + 7 = 20
- 3. (a).** Discuss the nature of engineering stress-strain curve of a reasonably ductile material. 10
- (b).** Derive the relationship between strain hardening exponent and uniform strain obtained by using tensile test of a material. 10
- 4.(a).** How would you experimentally obtain the tensile strain rate sensitivity of a material?
 Discuss. 10
- (b).** What is tensile toughness? Derive its unit. 2+3 = 5
- (c).** State a method for knowing the hardness of electroplated surface of an object. Justify your answer. 5

5 (a). What is meant by Impact Transition Temperature? After mentioning the exact specimen geometry describe the process for experimental determination of Charpy Impact Transition Temperature. 3+3+4 = 10

(b) A high strength steel has a yield strength of 690 MPa and a fracture Toughness (K_{IC}) equal to 165 MPa.mt^{1/2}. Based on the level of nondestructive inspection the smallest size of the flaw that can be detected routinely is 7.6 mm. Assume that most dangerous crack geometry in the structure is a single-edge notch so that so that $K_{IC} = 1.12\sigma(\pi a)^{1/2}$. The structure is subjected to cyclic loading in which $\sigma_{max} = 310$ MPa and $\sigma_{min} = 170$ MPa. The fatigue crack growth rate for the steel is given by $\frac{da}{dN} = 2.1 \times 10^{-7} (\Delta K)^{2.25}$. Estimate the fatigue life of the structure for an increment of crack growth of 2.5 mm. 10

6 (a). The following data were obtained during tensile test of a nickel specimen

Load, kN	Diameter, mm	Load, kN	Diameter, mm
0.00	6.40	15.80	5.26
15.30	6.25	15.50	5.00
15.92	6.22	14.90	4.88
16.42	6.00	14.01	4.57
16.50	5.97	13.12	4.38
16.68	5.81	12.40	3.72

Determine the following:

- (i) True stress at maximum load; (ii) True fracture stress; (iii) True fracture strain;
 (iv) True uniform strain; (v) True necking strain; (vi) Ultimate tensile strength;
 (vii) Strain hardening exponent. 14

(b) What is mechanical equation of state? Write down the general form of constitutive equation in case of tensile testing. How would you evaluate this equation? 2+2+2 = 6

7. Write short notes on the following:

- (a) Stress Rupture Test; (b) Effect of mean stress on fatigue endurance strength; (c) Corrosion fatigue; (d) Grain size effect on creep strength. 5+5+5+5 = 20

8. (a) Draw a schematic diagram for constant load creep curve of metals and explain the nature of the curve. 6

(b) What is Universal Slope Equation? Mention its utility. 4

(c) Write a note on equicohesive temperature? 5

(d) Why true fatigue endurance behavior is not observed in all types of materials? 5