Uva Wellassa University of Sri Lanka
Faculty of Science and Technology
Department of Science and Technology
300 level 2nd Semester Examination – Jan. / Feb. 2016
SCT 342-2 Structural Properties of Materials

Uva Wellassa University

Instructions to candidates
Duration: 02 hours
Number of questions: 04
Answer all questions
Mark allocation: 80

1. a. Define engineering stress and engineering strain. (04 marks)

   b. Draw the stress-strain diagram for steel. You should clearly label the important regions and points of the plot. (05 marks)

   c. A tensile stress, 250 MPa, is applied on a rectangular bar. What will be the magnitude of the shear stress on planes oriented 45° with respect to the axis of the bar? (05 marks)

   d. Describe briefly the important characteristic features of elastic and plastic regions in stress-strain diagram of a metal. (06 marks)

2. a. What is the atomic scale picture of the elastic deformation? How does this change under plastic deformation? (04 marks)

   b. The net bonding energy between two adjacent ions, E_N, is a function of the interatomic distance (r) and can be represented as follows:

$$E_N = -\frac{A}{r} + \frac{B}{r^n}$$

   where A, B, and n are constants for the particular ionic system. This equation is also valid for the bonding energy between adjacent ions in solid materials. The modulus of elasticity E is directly proportional to the slope of the interionic force-separation curve at the equilibrium interionic seperation (r_0) and is given by:

$$E\ \alpha \left(\frac{dF}{dr}\right)$$

   Derive an expression for the dependence the modulus of elasticity on the A, B, and n parameters. (05 marks)

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c. Consider a cylindrical speciman of a metal alloy that has a diameter of 5 mm. A tensile force of 2000 N produces an elastic reduction in diameter of 3.2×10^{-4} mm. Calculate the modulus of elasticity for this alloy, given that Poission's ratio is 0.40.

(04 marks)

d. A cylindrical rod which is 380 mm long, having a diameter of 10 mm, is to be subjected to a tensile load. If the rod is to experience neither plastic deformation nor an elongation of more than 0.9 mm when the applied load is 24.5 kN, which of the four metals or alloys listed below are possible candidates? Justify your answer(s).

(07 marks)

Material	Modulus of Elasticity (GPa)	Yield Strength (MPa)	Tensile Strength (MPa)
Aluminium alloy	70	255	420
Brass alloy	100	345	420
Copper	110	250	290
Steel	207	450	550

3.

a. Briefly describe the following terms using the mathematical expressions where appropriate.

i. Ductility
ii. Resilience
iii. Toughness

(09 marks)

b. Obtain the expressions for the true stress and strain using engineering stress and engineering strain.

(05 marks)

c. A bar which is 10 cm long is first elongated by drawing to 15 cm, and then drawing to 20 cm.

i. Calculate the engineering strains for the above two steps, and compare the sum of these with the engineering strain calculated for the overall deformation.

(03 marks)

ii. Repeat the calculation with true strains.

(03 marks)

4.

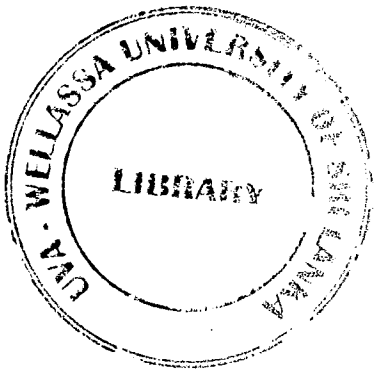
a. What is meant by "elastic strain recovery"? (04 marks)

b. Calculate the strain-hardening exponent (n) for an alloy in which a true stress of 625 MPa produces a true strain of 0.3. (Assume a value of 1075 MPa for the constant K)

(04 marks)

c. Name three (03) hardness tests that are performed in mechanical testing of materials. (03 marks)

d. Describe in detail how deformation and failure of engineering materials influence our day today life. (09 marks)



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