Uva Wellassa University

Uva Wellassa University, Sri Lanka
Faculty of Science and Technology
Science and Technology Degree program
2nd Semester Examination – September/October 2013
SCT 342-2 Structural Properties of Materials

Number of questions: Five (05)
Answer Four (04) questions only
Time allocation: Two (02) hours
Total marks allocated: 100

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1. a. Define the terms *engineering stress* and *engineering strain.*

   b. State the expression governing the relationship between the *engineering stress* and the *engineering strain* under *elastic deformation.*

   c. Make a rough sketch to show how to derive the *modulus of the elasticity* from a *force-separation curve* (the variation of *Force* versus *Interatomic separation*), for a material having strongly bonded atoms.

   d. For a cylindrical metal rod, the stress at which plastic deformation begins, is 299.7×10^6 Pa, and the modulus of elasticity is 87.9×10^9 Pa. What is the maximum load that may be applied to the rod with a cross-sectional area of 87.5×10^{-6} m without plastic deformation? If the original rod length is 43.2×10^{-2} m, what is the maximum length to which the rod may be stretched without causing plastic deformation?

   e. How can the macroscopic *elastic strain* be explained from an atomic perspective?

(25 Marks)

2. a. Define the term toughness. What is the SI unit for toughness?

   b. Differentiate the *plastic deformation* from *elastic deformation.*

   c. Make a rough sketch to show the difference between the typical *Engineering Stress-Strain behavior* and the *True stress-strain behavior* for a ductile material. Extend these plots till the facture point and label all the important points.

d. Give the quantitative ductility expressions for present elongation (%EL) and present reduction of area (%RA).

e. A tensile tested copper rod, having a circular cross section, fractured at an engineering fracture strength of 347.5 MPa. During this process, the original 5.25 mm diameter of the rod decreased to the final fractured diameter of 2.15 mm. Compute the *ductility* in %RA and the *true stress* at fracture.

(25 Marks)

3. a. List three main distinctive patterns, which can be observed from a brittle fracture surface.

b. How would you explain the features of *spherical dimples* and *parabolic-shaped dimples* found in a factographic study done with high resolution SEM.

c. State the expression showing the relationship between the *maximum stress at the crack tip* with the *applied stress* and the *geometrical factors* of an internal crack.

d. Compute the stress concentration factor at the tip of a surface crack having a crack length of 17.5 mm and a radius of curvature of 0.27 mm.

e. Make a rough sketch of the *Impact energy* versus *Temperature* plot to show the *ductile to brittle transition* behavior of a material.

(25 Marks)

4. a. List the two *main solutions* for failure of an engineering material.

b. Explain why the fatigue failure, even in ductile materials, is regarded as sudden and catastrophic.

c. Briefly explain the mechanism of the fatigue testing apparatus using for rotating-bending tests.

d. Distinguish between the *low cycle fatigue* and *high cycle fatigue.*

e. Make a rough sketch of S-N curve to explain the term *fatigue limit* (endurance limit).

(25 Marks)

5. a. Define the term *hardness.*

b. Name three main quantitative hardness testing methods.

c. With the help of a schematic representation, explain the main stages of *creep.*

d. A creep test was conducted for a ceramic under a constant applied stress level at two different temperature levels of 1000 and 1200 ^{0}C. The steady-state creep rates were 6.7 x 10^{-5} s^{-1} and 9.4 x 10^{-3} s^{-1} at 1000 and 1200 ^{0}C, respectively. If the gas constant is 8.31 J $mol^{-1}K^{-1}$, calculate the activation energy for creep.

e. Name four different mechanisms that are responsible for creep.

(25 Marks)

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