



Uva Wellassa University, Sri Lanka
End Semester Examination - September 2012
SCT 342-2 Structural Properties of Materials



Time: Two (02) hours

Total 05 Questions

Answer four (04) questions only

- 01). i. Very briefly explain the term *mechanical properties of materials*.
- ii. What are the three principal ways of applying loads?
- iii. With the help of a rough sketch, briefly explain the term *nonlinear elastic behaviour*.
- iv. Define the term *Poisson's ratio*. What are the maximum value and the theoretical value of Poisson's ratio for an isotropic material.
- v. A metal rod having a circular cross section is deformed elastically by applying a tensile load along its long axis. If the original diameter of the nickel rod is 10.0 mm, determine the magnitude of the load required to produce a 0.025 mm change in diameter. Poisson's ratio and modulus of elasticity of nickel are 0.27 and 198 GPa, respectively.
(25 Marks)
- 02). i. Explain the term *plastic deformation* from an atomic perspective.
- ii. Make schematic representation of the typical *Engineering Stress-Strain behavior* to fracture for a metal and label the followings on it;
- a. Proportional limit (P)
 - b. Elastic and plastic regions
 - c. Maximum (the point corresponding to the tensile strength)
 - d. Region of the neck formation
 - e. Fracture point (F)
- iii. With the help of a rough sketch, explain how to derive the *yield strength* from a stress-strain curve by using the *strain offset* method.
- iv. Define the term *ductility*.
- v. A cylindrical copper specimen having an original diameter of 22.8×10^{-3} m and length of 1.28 m is pulled in tension until fracture occurs. The diameter at the point of fracture is 16.6×10^{-3} m and the fractured gauge length is 1.52 m. Calculate the ductility in terms of percent elongation (%EL) and percent reduction in area (%RA).
(25 Marks)

- 03). i. With the help of a rough sketch, briefly explain the difference between *Engineering stress-strain behavior* and *True stress-strain behavior*.
- ii. Write down the related expressions for *True stress* and *True strain*.
- iii. Define the term *creep*? List the main stages of creep.
- iv. What is the most important parameter for determining creep behavior in *long-life* applications. Similarly, what is the respective important parameter for *short-life* applications?
- v. A creep test was conducted for a refractory ceramic under a constant stress level at two different temperatures. The steady-state creep rates were $1.77 \times 10^{-6} \text{ s}^{-1}$ and $3.21 \times 10^{-5} \text{ s}^{-1}$ at $1000 \text{ }^{\circ}\text{C}$ and $1200 \text{ }^{\circ}\text{C}$, respectively. Calculate the activation energy for creep of this refractory ceramic. The universal gas constant is $8.31 \text{ J mol}^{-1} \text{ K}^{-1}$.
- (25 Marks)
- 04). i. Briefly explain why the ductile fracture is preferred over the brittle fracture in most of the material .
- ii. List the three main types of information, which can be gathered from the fractography studies.
- iii. Briefly distinguish between the *transgranular fracture* and *inter granular fracture*.
- iv. Explain the reason for experimental fracture strength of a brittle material to be much lower than its estimated theoretical cohesive strength.
- v. What is the magnitude of the maximum stress that exists at the tip of an internal crack having radius of curvature of $3.25 \times 10^{-4} \text{ mm}$ and a crack length of $7.5 \times 10^{-2} \text{ mm}$ when a tensile stress of 200 MPa is applied? What is the stress concentration factor?
- (25 Marks)
- 05). i. List the four *main causes* responsible for failure of a material component.
- ii. What is *fatigue failure*? Explain the three distinct stages of fatigue failure.
- iii. With the help of a rough sketch of a S-N curve, explain the terms *fatigue strength* and *fatigue life*.
- iv. Make schematic representation to show the stage -I and stage-II of crack propagation through a polycrystalline material.
- v. List three measures that can be taken to increase the fatigue resistance of a material through improving the quality of its surface.
- (25 Marks)