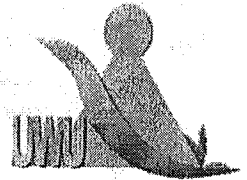
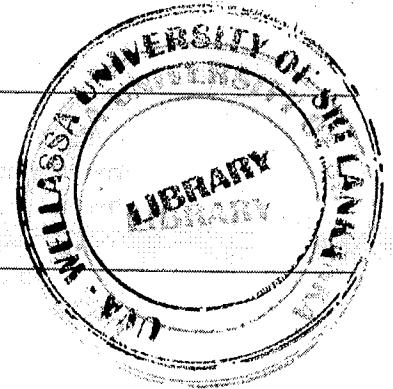


Uva Wellassa University, Sri Lanka
End Semester Examination – January 2010
SCT 342-2 Structural Properties of Materials



Time: Two (02) hours

Total 05 Questions
Answer four (04) questions only



- 01). i. Define and give an expression for *Poisson's ratio*.
- ii. A nickel 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 1.25×10^{-3} m, determine the magnitude of the load required to produce a 3×10^{-5} m change in diameter. Poisson's ratio and modulus of elasticity of nickel are 0.31 and 2.1×10^{11} Pa, respectively.
- iii. Sketch a typical *Engineering Stress-Strain behavior to fracture* for a ductile metal and label the following on it;
- (a). Proportional limit (P)
 - (b). Elastic and plastic regions
 - (c). Maximum (corresponding to the tensile strength)
 - (d). Region of the neck formation
 - (e). Fracture point (F)
- iv. How can the term *plastic deformation* be explained from an atomic perspective?
(25 Marks)
- 02) i. What does the term *elastic strain recovery* mean? Make a rough sketch of a tensile Stress-Strain diagram to show the phenomenon of *elastic strain recovery during plastic deformation*, related to strain hardening.
- ii. What is *true stress*? Give expressions for *true stress* and *true strain*.
- iii. A cylindrical specimen of steel having an original diameter of 1.5×10^{-3} m is tensile tested to fracture and found to have an engineering fracture strength of 5×10^8 Pa. If its cross-sectional diameter at fracture is 1.2×10^{-3} m, determine:
- (a) The ductility in terms of percent reduction in area.
 - (b) The true stress at fracture.
- iv. Name three different quantitative *hardness testing* methods.
(25 Marks)

- 03). i. Draw a rough sketch to show *the temperature dependence of the heat capacity at constant volume (C_v)* for a solid material. Very briefly explain why C_v rises with increasing temperature at temperatures near 0 K.
- ii. How can the term *thermal expansion* be explained from an atomic perspective?
- iii. A machine part is made from an iron rod with its axial motion restrained by rigid end supports. If the iron rod is stress free at 20 °C, what is the maximum temperature to which the rod can be heated without exceeding a compressive stress of 100 MPa. For iron, the modulus of elasticity is 207 GPa and the magnitude of the linear coefficient of thermal expansion is $1.2 \times 10^{-3} \text{ } ^\circ\text{C}^{-1}$.
- iv. Based on the formula for *Thermal Shock Resistance Parameter (TSR)*, list four measures that can be taken to increase the thermal shock resistance of a ceramic material.

(25 Marks)

- 04). i. Distinguish the main differences between *ductile fracture* and *brittle fracture*, giving special consideration to the *degree of plastic deformation before fracture* and *speed of the crack propagation*.
- ii. With the help of a rough sketch, briefly explain the main stages of a *cup-and-cone fracture*.
- iii. What is the magnitude of the maximum stress that exists at the tip of an external crack having radius of curvature of $3.25 \times 10^{-7} \text{ m}$ and a crack length of $7.5 \times 10^{-5} \text{ m}$ when a tensile stress of $2.0 \times 10^8 \text{ Pa}$ is applied? What is the stress concentration factor?
- iv. List four measures that can be taken to increase the fatigue resistance of a material through improving the quality of its surface.

(25 Marks)

- 05). i. What is *creep*?
- ii. Briefly explain the main stages of creep with the help of a schematic representation.
- iii. Very briefly discuss the effect of increasing stress and temperature on steady-state creep rate and the time to rupture.
- iv. A creep test was conducted for an alloy at 200 °C at two different stress levels of $5.5 \times 10^7 \text{ Pa}$ and $6.9 \times 10^7 \text{ Pa}$. The steady-state creep rates were $6.94 \times 10^{-7} \text{ s}^{-1}$ and $6.67 \times 10^{-6} \text{ s}^{-1}$, respectively. The activation energy for creep of this alloy is $1.4 \times 10^5 \text{ J mol}^{-1}$ and the gas constant is $8.31 \text{ J mol}^{-1} \text{ K}^{-1}$. Compute the steady-state creep rate at 250 °C for a stress level of $4.8 \times 10^7 \text{ Pa}$.

(25 Marks)