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 ^{0}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 1.2×10^{-5} $^0C^{-1}$.

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 facture* 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 3.25×10^{-7} m and a crack length of 7.5×10^{-5} m when a tensile stress of 2.0×10^{8} 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 ^{0}C at two different stress levels of 5.5×10^7 Pa and 6.9×10^7 Pa. The steady-state creep rates were 6.94×10^{-7} s^{-1} and 6.67×10^{-6} s^{-1}, respectively. The activation energy for creep of this alloy is 1.4×10^5 J mol^{-1} and the gas constant is 8.31 J mol^{-1} K^{-1}. Compute the steady-state creep rate at 250 ^{0}C for a stress level of 4.8×10^7 Pa.

(25 Marks)