United Emirates University
Faculty of Engineering

Engineering Materials	**Mid-term Exam.**
Course No.: MECH390	**Time allowed : 1 hour**
Maximum : 20 Marks	**Date : April 30, 2001**

Answer 4 among the following 5 questions:

Question1 (5 Marks)
Indicate whether the following statement is True (T) or False (F) and correct the false one. Answer only five questions among the proposed list:

1. Non-crystalline materials are known to have a range of sizes of grain boundaries?
2. Refractories are a special class of materials known for their low melting temperature.
3. Burger vector denotes the magnitude and direction of lattice distortion associated with a dislocation.
4. When increasing the carbon content, a ferrous alloy will have a higher modulus and high ductility
5. Three distinct stages are involved in addition polymerization; these stages in order are propagation, termination and initiation.
6. Diffusion coefficient indicates the temperature at which atoms diffuse. Both temperature and distance influence diffusion coefficient.

Question 2 (5 Marks)
A common metal is known to have a cubic unit cell with an edge length of 0.421 nm. If this metal has a density of 5.70 g/cm^3 and an atomic weight of 64.0 g/mol, mention the type of unit cell and hence determine its coordination number?

Question 3 (5 Marks)
An iron – carbon alloy initially contains 0.25 wt % C and surface concentration is to be maintained at 0.85 wt % C. Calculate the carbon concentration at a position 5.5 mm if the treatment is to be conducted at 1200 ^{o}C for 55 hours. (D_o =2.3*10^{-5} m^2/s, Q_d =148 kJ / mole, R= 8.31 J/mol.K).

Question 4 (5 Marks)
Give a reason for each of the followings:

1. Titanium and aluminum alloys are widely used in aerospace applications.
2. Ductile (nodular) cast irons have higher strengths than gray cast irons.
3. Stainless steels enjoy high corrosion resistance.
4. Unalloyed copper is difficult to machine (manufacture by cutting).
5. Refractory metals such as tungsten and tantalum have high strength, large elastic moduli and high melting temperature.

Question 5 (5 Marks)
Consider a cylindrical specimen of an aluminum alloy, which the stress strain behavior is shown in the figure below. The specimen, which has a diameter of 10 mm and a length of 75 mm is pulled in tension.

1.Determine its elongation when a load of 13,500 N is applied.
2. Determine its young modulus
3. If the area under the stress-strain diagram is 52 x10^6 N.m/m^3, calculate the total energy needed by the machine to fracture the specimen.

You may use one of the following equations

$$\sigma = \mathrm{E}\,\varepsilon \quad , \qquad \varepsilon = \frac{\Delta \mathrm{l}}{\mathrm{l}_0}, \qquad \mathrm{E} = 2\mathrm{G}\,(1+\lambda), \qquad \sigma = \frac{\mathrm{F}}{\mathrm{A}}, \qquad \%\mathrm{EL} = \frac{\mathrm{l}_\mathrm{f} - l_0}{\mathrm{l}_0} \times 100$$

$$U_r = \frac{\sigma_y^2}{2E}, \qquad \rho = \frac{\mathrm{nA}}{\mathrm{V_c} N_A}, \qquad \mathrm{J} = -D\frac{dc}{dx}, \qquad \mathrm{N_v} = N \exp\left(-\frac{Q_v}{kT}\right),$$

$$\frac{C_x - C_0}{C_s - C_0} = 1 - erf\left(\frac{x}{2\sqrt{Dt}}\right),$$

$$D = D_0 e^{-\frac{Q_d}{RT}}$$