APL 753: Properties and Selection of Engineering Materials

Minor I Exam - Question paper

Date: 29-Aug-2016   Time Duration: **1 h** (2:30 pm to 3:30 pm)   Total Marks: **40**

Question 1
[2 + 2 + 2 = 6]

List out the six major classes of engineering materials with one example in each. In that, give the approximate range of Young's modulus for three main material classes. Explain briefly how the nature of the bonding in these main material classes account for the relative magnitude of the elastic properties.

Question 2
[3 + 2 = 5]

(a) Draw $(1\bar{2}2)$ and (102) planes in a single unit cell specifying the choice of axes and the origin.

(b) Draw the direction common to both the planes and give its Miller indices.

Question 3
[5 + 2 = 7]

(a) Draw HCP unit cell structure showing one 6-fold symmetry along its c-axis, and outline one tetrahedral (TH) and one Octahedral (OH) void. Mention the effective number of TH and OH voids in that HCP unit cell structure.

(b) Consider a FCC unit cell and calculate the size of an interstitial atom that can fit into its TH void without displacing surrounding atoms.

Question 4
[4 + 3 = 7]

With sketches mention the main strengthening mechanisms by which metals are hardened. Identify which mechanisms account for the following increases in yield stress:

    a. Pure annealed aluminium: 25 MPa; cold rolled Al-Mn-Mg alloy: 200 MPa

    b. Pure annealed copper: 35 MPa; cast 60-40 Brass (60% Cu, 40% Zn): 105 MPa

    c. Pure annealed iron: 140 MPa; quenched & tempered medium carbon steel: 550 MPa.

Question 5
[3 + 2 = 5]

A Zinc single crystal is oriented so that the normal to its slip plane (basal plane) makes an angle of 60° with the tensile axis. The three slip directions make angles of 38°, 45° and 84° with respect to this axis. If the plastic deformation first commences at an applied tensile stress of 5.84 MN/m², find which of the three slip directions has initiated slip and at what value of the critical resolved shear stress?