一、 **What are the characterizations of three main class of engineering materials？(10%)**

二、 **Compare the percentage ionic character in the semiconducting compounds (a). HgTe (5%) (b) InSb (5%)？ X_{Hg} = 1.5 ; X_{Te} = 2.0 ; X_{In} = 1.5 and X_{Sb} = 1.8.**

三、 **An x-ray diffractometer recorder chart for an element that has either the BCC or the FCC crystal structure showed diffraction peaks at the following 2θ angles: 38.60°; 55.71°; 69.70°; 82.55°; 95.00°; and 107.67°, wavelength λ of the incoming radiation was 0.15405 nm (a) Determine the crystal structure of the element (3%)？(b) Determine the reflecting (h k l) plane in the cubic crystal (2%)？(c). Determine the lattice constant of the element (5%)？**

四、 **Calculate the theoretical volume change accompanying a polymorphic transformation in a pure metal from the FCC to BCC crystal structure. Assume hard-sphere model. (10%)**

五、 **What are the crystalline imperfections or defects in the crystals of the metals？ What are the influence of these imperfections on the engineering properties of the metals？ (10%)**

六、 **Consider the impurity diffusion of gallium into a silicon wafer. If gallium is diffused into a silicon wafer with no previous gallium in it at a temperature of 1,100℃ for 2 hour, if the surface concentration is 10^{20} atoms/m^3, (a) what is the concentration of gallium at the depth of $3.17x10^{-6}$m (8%)？ (b) What type of semiconductor this wafer is (2%)？ $D_{1100℃}$= $7.0x10^{-17}$ m^2/s**

z	erf z	z	erf z	z	erf z	z	erf z
0	0	0.40	0.4284	0.85	0.7707	1.6	0.9763
0.025	0.0282	0.45	0.4755	0.90	0.7970	1.7	0.9838
0.05	0.0564	0.50	0.5205	0.95	0.8209	1.8	0.9891
0.10	0.1125	0.55	0.5633	1.0	0.8427	1.9	0.9928
0.15	0.1680	0.60	0.6039	1.1	0.8802	2.0	0.9953
0.20	0.2227	0.65	0.6420	1.2	0.9103	2.2	0.9981
0.25	0.2763	0.70	0.6778	1.3	0.9340	2.4	0.9993
0.30	0.3286	0.75	0.7112	1.4	0.9523	2.6	0.9998
0.35	0.3794	0.80	0.7421	1.5	0.9661	2.8	0.9999

七、 **Compare (a). the engineering stress (2%) and strain (2%) with (b). the true stress (3%) and strain (3%) for the tensile test of a low carbon steel that has the following test values. Load applied to the specimen= 20,000 lb_f . Initial specimen diameter=**

0.500 in, diameter of specimen under 20,000 lb_f load= 0.400 in.

八、 **Determine the critical crack length (mm) for an internal crack in a thick 2024-T6 alloy plate has a fracture toughness K_{IC} = 23.5 $MPam^{1/2}$ and is under a stress of 300MPa？ Assume $Y = \pi^{1/2}$。(10%)**

九、 **A borosilicate glass between 600℃ (annealing point) and 800℃ (softening point) has viscosities of $10^{12.5}$ P and $10^{7.4}$ P, respectively. Calculate the activation energy for this borosilicate glass？ (10%)**

十、 **Calculate the modulus of elasticity for the following composite material stressed under (a) isostrain conditions (5%)(b) isostress conditions (5%)？ Glass fiber-reinforced-epoxy resin: V_f = 70%; E_f =1.05×10^7 psi; E_m = 4.5×10^5 psi.**