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B.TECH
PCMT4201

3rd Semester Regular / Back Examination 2015-16
INTRODUCTION TO PHYSICAL METALLURGY
BRANCH(S): MM,MME
Time: 3 Hours
Max Marks: 70
Q.CODE: T629

Answer Question No.1 which is compulsory and any five from the rest.
The figures in the right hand margin indicate marks.

Q1 **Answer the following questions:** **(2 x 10)**

a) How do the ferrite and austenite stabilizers affect the eutectoid temperature in steels?

b) Theoretical density of an FCC metals with atomic radius and atomic weight of 0.144 nm and 197(g/mol) respectively is approximately(in kg/m3)?

c) Find out interlamellar spacing for (320) of an FCC crystal structure with atomic radius of 0.128 nm.

d) What is cold shortness in steels? What causes cold shortness?

e) Write the no of slip system of FCC ,BCC & HCP .Is FCC is more ductile than BCC ?justify your answer.

f) Calculate the linear density of atoms along [111] in Cu.

g) Why are high speed steels subjected to subzero treatment?

h) Why metals have good electrical and thermal conductivity

i) Explain why there is an increase in density on melting of ice.

j) Calculate the spacing of edge dislocations in a simple tilt boundary if the angle of tilt is 2° and burgers vector, b = 0.25 nm.

Q2 **a)** Estimate the (i) magnitude of critical radius, r*, (ii) critical free energy of nucleation, Δf^* and (iii) the number of atoms in the critical embryo of solid silver in super cooled liquid silver at 735 °C. For silver ΔH (fusion) = 12 kJ/mole. T_m = 960.8 °C. Density of solid silver, ρ = 10.6 g/cm^3. The interfacial surface free energy between solid and liquid silver, $\gamma_{s/L}$ = 126 x 10^{-7} J/cm^2. Atomic weight of silver = 107.87
Avogadro's number = 6.023 x 10^{23} mol^{-1}. **(5)**

b) Melting point of an element A is 1500 °C while that of element B is 1800 °C. The α solid solution containing 30 wt.% B, the β solid solution containing 80 wt.% B and the liquid containing 50 wt.% B are in equilibrium at 1200 °C. At room temperature, the maximum solubility of B in the α phase is 20 wt.% and the maximum solubility of A in the β phase is 10 wt.%. **(5)**
(a) Sketch the phase diagram and label different regions.

(b) What are the weight fractions of phases present in the A-70wt. %B alloy
(i) at a temperature just above 1200 °C
(ii) at a temperature just below 1200 °C
(iii) at room temperature

Q3 **a)** Why is the T-T-T curve C shaped? Explain. Draw the T-T-T curve of eutectoid steel and state the simplest heat treatment necessary to obtain the following micro constituents. **(5)**
(i) Pearlite, (ii) Bainite, (iii) Pearlite + Martensite, (iv) Martensite

b) Give the typical composition, microstructure and the method of production of malleable cast irons. What are the major applications of such cast irons? **(5)**

Q4 **a)** What is critical resolved shear stress and on what factors does it depend? What is Schimd's Law? Derive the resolved shear stress as a function of the axial stress in a single crystal. **(5)**

b) If the axis of a face centered cubic crystal lies along [321] and it is loaded in tension to a stress of 20 MPa, what will be the resolved shear stress on the $(11\bar{1})$ slip plane and parallel to the [101] slip direction. **(5)**

Q5 **a)** Draw the iron-iron carbide diagram and label the phase fields, important temperatures and compositions. Write the invariant reactions occurring in the above system. How is the iron-carbon (graphite) equilibrium diagram different from the above diagram? **(5)**

b) A piece of copper has a measured density of 8910 kg / $m^{3.}$ The lattice parameter of fcc copper is 0.36153 nm and its atomic mass is 0.06351 kg / mol. Calculate the percentage of vacancies in the pure copper. Avogadro's number is 6.02×10^{23} mol^{-1}. **(5)**

Q6 **a)** Explain the malleabilizing treatment given to produce malleable cast irons. What is the structure, special characteristics and applications of such cast irons? **(5)**

b) A binary phase diagram of components P & Q displays an eutectoid reaction with terminal solid solutions of α on the P rich side and β on the Q rich side. At the eutectoid temperature, the solubilities of Q in α & in β are 5 and 90 wt% respectively. The densities of α & β phases are 9.5 and 2.49 gm/cm^3 respectively **(5)**

i) At the eutectoid point the alloy has α & β in the weight ratio 1:1.the eutectoid point occurs at composition?

ii) At eutectoid temperature the ratio of α & β phases in the specimen observed under microscope are?

Q7 **a)** Define kink and jog. Describe its mechanism of formation with suitable diagram. **(5)**

b) Find out the elastic strain energy per unit length of dislocation line in Cu. Given shear modulus=45GPa , lattice parameter=$3.61A^0$ **(5)**

Q8 Write short notes on (any two) **(5 x 2)**

a) Cold working Vs Hot working
b) Yield point phenomena
c) Slip Vs Twin
d) Dual Phase Steel