Registration No: | | | | | | | | | | |

Total Number of Pages:02 **B.Tech**

PME3I001

3sd Semester Regular / Back Examination 2017-18

Introduction To Physical Metallurgy & Engineering Materials

BRANCH: MECH

Time: 3 Hours

Max Marks: 100

Q.CODE: B1123

Answer Question No.1 and 2 which are compulsory and any four from the rest.

The figures in the right hand margin indicate marks.

Q1 **Answer the following questions: *multiple type or dash fill up type*** **(2 x 10)**

a) FCC crystals have more packing density than BCC crystal yet why solubility of carbon in FCC form of iron is higher than in its BBC form?

b) What is the effect of temperature on concentration of vacancy?

c) What are the major differences between an edge & screw dislocation?

d) Apply phase rule to the two phase field of a binary isomorphous diagram. What conclusion can be drawn?

e) It is often thought that that species having lower activation energy diffuses faster than the one having higher activation energy. Is this always true?

f) Why the eutectic structure does not exhibit coring?

g) What is constitutional super-cooling? When does this take place?

h) What is a Composite?

i) Difference between Metals and Ceramics?

j) Rank the following samples in order of increasing self diffusion coefficients (a) Aluminium single crystal, (b) Polycrystalline aluminium whose average grain size is 5micron (c) Polycrystalline Aluminium whose average grain size is 10micron.

Q2 **Answer the following questions: *Short answer type*** **(2 x 10)**

a) Compare between deformation mechanisms of slip and twinning

b) A metal under goes an allotropic transformation at room temperature at high pressure and at lower temperature at atmospheric pressure. Is the volume change associated with this transformation positive or negative?

c) Show the packing efficiency of BCC is 68%

d) Define crystal, lattice and motif

e) Why is grain boundary irregular?

f) If the lattice parameter of alpha iron 286 pm what is the atomic radius?

g) Draw the phase diagram of pure Fe (from room temp ownwards)

h) What is the effect of plastic deformation on lattice parameter?

i) When does a polycrystalline material have same yield strength along all possible direction?

j) For an ASTM grain size of 4, approximately how man grains would be there per square inch in a micrograph taken at a magnification of 100X?

Q3 **a)** Explain critical resolved shear stress and derive Schmid's law **(10)**
If aluminium deforms at an axial tension of 6.9 MPa in direction [010] on (111) [110] slip system. What is its critical resolved shear stress?

b) Calculate the equilibrium number of vacancies per cubic meter of copper at 1000^0C. The energy for vacancy formation is 0.9 eV/atom. The atomic weight and density at 1000^0C for Cu is 63.5 g/mol and 8.40 g/cc respectively. Boltzmann constant k = 8.62×10^{-5} **(5)**

Q4 **a)** Derive an expression for critical nucleus size as a function of temperature and show with the help of a schematic graph its variation with temperature. Assuming that a stable nucleus should have at least 100 atoms which correspond to around 1nm radius mark the region of homogeneous nucleation. **(10)**

b) Estimate the size of critical nucleus of tin when it is super cooled by 20ºC. Assume nucleation to be homogeneous. The enthalpy change for solidification of tin is 0.42 GJ/m^3 . The liquid / solid interfacial energy is 0.055 J/m^2 . The melting point of tin is 232° C. **(5)**

Q5 **a)** Draw the phase diagram for a binary alloy system having following features. Melting point of the two metals (A & B) are widely different. These are partially soluble in each other. There is one three phase reaction isotherm at a temperature higher than the melting point of B but lower than that of A. Write down the equation representing the 3 phase reaction. What is it commonly known as? **(10)**

b) Two alloys belonging to a binary system have the following microstructures. One having 25% B consists of 50% α & 50% eutectic and the other having 0.75%B has 50% β & 50% eutectic. Microstructrural examination shows that eutectic is made of 50% α & 50% β. Estimate the composition of α, β & eutectic. **(5)**

Q6 **a)** Explain the Precipitation hardening mechanism for Al-4%Cu alloy. Also mention crystallographic aspects. **(10)**

b) Nickel, Aluminium & Copper have face cantered cubic structure yet Ni is soluble in copper whereas Al has only a limited solubility. Explain why it is so? **(5)**

Q7 **a)** Explain Fick's first and second laws of diffusion. Derive the necessary expressions **(10)**

b) What is the burgers vector of a dislocation? How is the burgers circuit used to define the burgers vector? **(5)**

Q8 **a)** Draw properly the T-T-T diagram of eutectoid plain carbon steel. Sate its utility and limitations. Define critical cooling rate and actual cooling rate. **(10)**

b) State the Hume-Rothery rules that favorable for substitutional solid solution **(5)**

Q9 Two metals, X [Melting point = 1300 ^{0}C] and Y [Melting point = 1000 ^{0}C], are partially miscible. They form two solid solutions α and β. Under equilibrium conditions, maximum conditions, maximum solubility values are given in the following table **(15)**

Temperature (^{0}C)	0	200	400	600	800	900	950
Max. solubility of Y in X [wt.%]	3	10	20	32	50	40	35
Max. solubility of X in Y [wt.%]	2	2	3	5	10	5	3

A eutectic reaction occurs when the alloy contains 20 wt. % of X production both α and β phases.

a) Based on the given information, construct an appropriate equilibrium phase diagram and label each phase.

b) An alloy containing 60 wt % of X is slowly cooled under equilibrium cooling conditions to room temperature from temperature just above the melting point of X. Discuss the phase transformation which will take place and calculate the percentage of α at 200 ^{0}C

c) Outline the heat treatment you would recommend for the above alloy to obtain a very fine dispersion of β phase.