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

Total Number of Pages : 02 **B.Tech**
PCMT4301

5th Semester Back Examination 2018-19
PHASE TRANSFORMATION AND HEAT TREATMENT
BRANCH : METTA, MME
Time : 3 Hours
Max Marks : 70
Q.CODE : E627

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) The Clausius-Clapeyron equation is _____.

b) The hardenability of steels decreases with
(A) decrease in dislocation density
(B) increase in solutionising temperature
(C) increase in strength
(D) decrease in grain size

c) Phase rule for an isomorphous system of phase diagram is _____.

d) A 0.2 wt.% plain carbon steel sheet is heated and equilibrated in the inter-critical region followed by instant water quenching. The microstructure of the quenched steel sheet consists of
(A) fully martensite (B) proeutectoid ferrite + martensite
(C) martensite + pearlite (D) martensite + austenite

e) In a slowly cooled 0.4%C plain carbon steel, the percentage of proeutectoid ferrite is approximately
(A) 43.0 (B) 49.46 (C) 53.4 (D) 57.0

f) Identify the statement that precisely describes the principle of hot working of metals and alloys.
(A) It is mechanical deformation carried out above the temperature of recrystallisation
(B) It is mechanical deformation carried out above the room temperature
(C) It is mechanical deformation carried out above the annealing temperature
(D) It is mechanical deformation carried out just below the melting temperature

g) Calculate the ratio of the surface energy term to the volume energy term in the nucleation equation at the critical condition

h) Calculate the interfacial energy Cu having interface on (111) plane (Bond energy = 56.4 KJ/mol, a = 3.61 A^o, At. Wt = 63.55 gm/mol)

i) Draw a BCC unit cell and show the positions of an octahedral interstitial site. What should be the jump length for interstitial atoms occupying the octahedral sites in this BCC structure?

j) Estimate the carbon concentration of the steel exhibits a microstructure consisting of 40 percent pearlite and 60 percent ferrite.

Q2 **a)** What is annealing? What are its aims? Discuss the different types of annealing processes giving the temperature ranges and the aims of each type. **(5)**

b) With the help of suitable diagram, explain the process of martempering. How does it differ from austempering? What do the microstructures of **(5)**

martempered and austempered steels consists of ? what are limitations

Q3 **a)** Discuss the influence of the following elements on the structure and properties of cast iron. (A) Si (B) Mn (C) S and (D) P **(5)**

b) Explain why activation energy for the grain boundary diffusion is lower than activation energy for the lattice diffusion. **(5)**

Q4 **a)** Find out the size of the critical nucleus for homogeneous nucleation if the tiny solid formed is a cube (Take *'a'* as length of the cube edge). **(5)**

b) Explain with schematic microstructure the difference between upper bainite & lower bainite? **(5)**

Q5 **a)** Do you expect any difference in room temperature self-diffusion coefficients of Al just quenched from 600^0C to room temperature and the one slowly cooled to room temperature? Explain. **(5)**

b) The diffusivity of gallium in silicon is 8×10^{-17} m^2/s at 1100^0C and 1×10^{-14} m^2/s at 1300^0C. Determine D_0 and Q_d for diffusion of gallium in silicon and calculate diffusivity at 1200^0C. **(5)**

Q6 **a)** Calculate the hardenability (D_I) of steel composition: **(5)**
C = 0.4%, Mn = 0.7, P = 0.04, S = 0.04, Si = 0.3, Ni = 1.8, Cr = 0.8, Mo = 0.25, and ASTM grain size = 8, what could be critical diameter (D_C) in water and oil. What severity of quench would be required to fully harden the bar of 3" in diameter?

b) (A) Compare gray, malleable, nodular and white cast irons with respect to (A) composition and heat treatment, (B) microstructure, and (C) mechanical characteristics. **(5)**

Q7 **a)** What is precipitation hardening? Explain the various stages and mechanisms of precipitation hardening by coherent particles of Al-4.5wt.%Cu alloy. Sketch Gibbs free energy (G) vs. composition (X) curve for the above transformation. **(5)**

b) Explain in details the difference between TTT diagram and CCT diagram of a eutectoid steel? **(5)**

Q8 **Write short answer on any TWO :** **(5 x 2)**

a) Sub Zero treatment

b) Patenting

c) Cast Irons

d) Precipitation Hardening