VEER SURENDRA SAI UNIVERSITY OF TECHNOLOGY, BURLA
DEPARTMENT OF METALLURGICAL AND MATERIALS ENGINEERING
SESSION 2015 - 16 (Supplementary June ~ July 2016)

Total Pages—6

(Set-R_2)

B.Tech-6th

Phase Transformation and Heat Treatment

Full Marks : 70

Time : 3 hours

Q. No. 1 is compulsory and answer any five from the rest

The figures in the right-hand margin indicate marks

1. Answer the following in short : 2×10

   (*a*) What is B2 and LI2 ordered structures. Give one example for each.

   (*b*) Why does the melting point of grey cast iron decreases in vacuum melting. Explain this behaviour using Clausius-Clapeyron Equation ?

   (*c*) What is meant by Glissile Transformation ?

   (*d*) What is the difference between athermal and isothermal Martensite ?

(*Turn Over*)

(e) Write short notes about Habit planes of carbon steels.

(f) Discuss the role of interaction parameter (Ω) on phase formation/separation in a binary alloy.

(g) Find out the diffusion co-efficient of carbon in γ-Fe if the diffusion constant is $2 \cdot 3 \times 10^{-5}$ and the activation energy is 148 kJ/mol.

(h) Draw the free energy temperature diagram for Fe up to 1600°C showing all the allotropic forms.

(i) What is Grossman's Diameter ? Explain its significance.

(j) What is Ausforming ?

2. (a) Derive the expressions for homogeneous nucleation. Discuss the effect of super-cooling on nucleation barrier and critical radius. 5

(b) Calculate the homogeneous nucleation rate in liquid copper at under coolings of

180, 200, and 220K, using the following data :

$L = 1{\cdot}88 \times 10^9$ Jm^{-3}, $T_m = 1356$ K, $Y_{sL} = 0{\cdot}177$ Jm^{-2}, $f_0 = 10^{11}$ s^{-1}, $C_0 = 6 \times 10^{28}$ atoms m^{-3}, $k = 1{\cdot}38 \times 1$. 5

3. (*a*) Explain the construction of TTT diagram in detail. Sketch TTT diagram of hypoeutectoid, eutectoid and hypereutectoid steels. 5

(*b*) Discuss the mechanism of transformation of upper and lower bainite with neat sketch. 5

4. (*a*) What is precipitation hardening ? Explain different stages and mechanisms of precipitation hardening by coherent particles using Al-4.5 wt% Cu alloy. 6

(*b*) Discuss Bain Distortion Model of Martensitic Transformation ? 4

5. (*a*) Differentiate between hardness and hardenability. What are all the various methods for determining hardenability ? 4

(*b*) Discuss how hardenability is affected by

(*i*) Austenite Grain Size

(*ii*) Carbon Content

(*iii*) Presence of Alloying elements. 6

6. (*a*) Write short notes on the following defects and their remedies : 5

(*i*) Inclusions

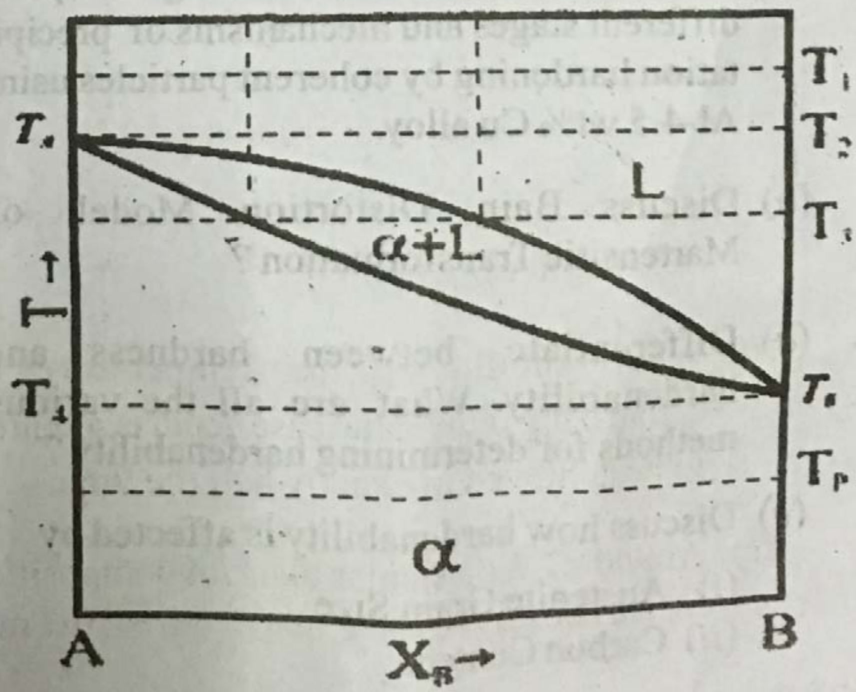
(*ii*) Oxidation and Decarburization

(*iii*) Overheating and Burning of Steel

(*iv*) Quench Cracks

(*v*) Distortion and Warping.

(*b*) Draw the G-X diagrams at the temperatures shown in Figure (T_1, T_2, T_3, T_4 and T_p) 5



7. Discuss the following in detail : 10

(*i*) Malleabilization of white cast iron

(*ii*) Nodularization of SG iron

(*iii*) Austempering.

8. A thick steel slab with 0·2 wt% carbon concentration is exposed to a carburizing atmosphere at 900° C. Carbon concentration at the surface of the slab is kept constant at 1·3 wt%. Case depth is considered as the depth from the surface at which carbon concentration drops to 0·6 wt%. The diffusion coefficient for carbon in iron at this temperature is $1 \cdot 6 \times 10^{-11}$ m²/s. Assume that the steel piece is semi-infinite. 10

(*a*) Calculate the time required for achieving a case depth of 0·5 mm.

(*b*) What should be the temperature of carburizing if the same case depth is required to be achieved in exactly half the time.

(*c*) At 900° C, a particular plane of composition C_x was observed to be at a depth of 0·7 mm at the end of carburizing cycle. What should be the position of the plane C_4' after double the carburizing time at 900°C ?

Table 6.1 Tabulation of Error Function Values

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