Uva Wellassa University, Sri Lanka

End Semester Examination – January 2010

CHE 481-1 Phase Transformations

Time: One (01) hour

Total three (03) Questions
Answer two (02) questions only

01) Two 'mythological metals' fantasium (Fa) and hilarium (Hi) have melting points of 1250°C and 800°C respectively. They are completely soluble as liquids but only partially soluble as solids, forming two solid solutions α and β. These solid solutions form a eutectic at 620°C containing 62% Hi and 38% Fa. The following table shows the maximum solid solubilities of each metal in the other, under equilibrium conditions over a range of temperatures:

Temperature (°C)	0	100	200	300	400	500	600	620
Max solubility of Hi in Fa (α) (% wt)	5.0	6.5	8.3	10.4	13.0	16.4	22.3	24.0
Max solubility of Fa in Hi (β) (% wt)	1.0	1.4	1.8	2.4	3.3	4.6	6.4	7.0

i. Draw the phase diagram for the system and label all phase fields. (10 marks)

ii. Describe step by step the solidification and cooling under equilibrium conditions from 1000°C to 0°C of an alloy containing 70% Fa/ 30% Hi. Sketch the expected structures at each stage. (10 marks)

iii. Calculate the proportions of phases in this 70% Fa/ 30% Hi alloy at temperature of (a) 800°C (b) 400°C (10 marks)

iv. Describe step by step the solidification and cooling under equilibrium conditions from 1150°C to 0°C of an alloy containing 85% Fa/ 15% Hi. Sketch structures at each stage. (10 marks)

v. Sketch the structure which would most probably be obtained if the 85% Fa/ 15% Hi alloy was cooled slowly to 700°C and then quenched in cold water. (10 marks)

02) Using the isothermal transformation diagram (Fig Q2) for an iron–carbon alloy of eutectoid composition, specify the nature of the final microstructure (in terms of microconstituents present and approximate percentages of each) of a small specimen that has been subjected to time–temperature treatments given below. In each case assume that the specimen begins at 760°C and that it has been held at this temperature long enough to have achieved a complete and homogeneous austenitic structure.

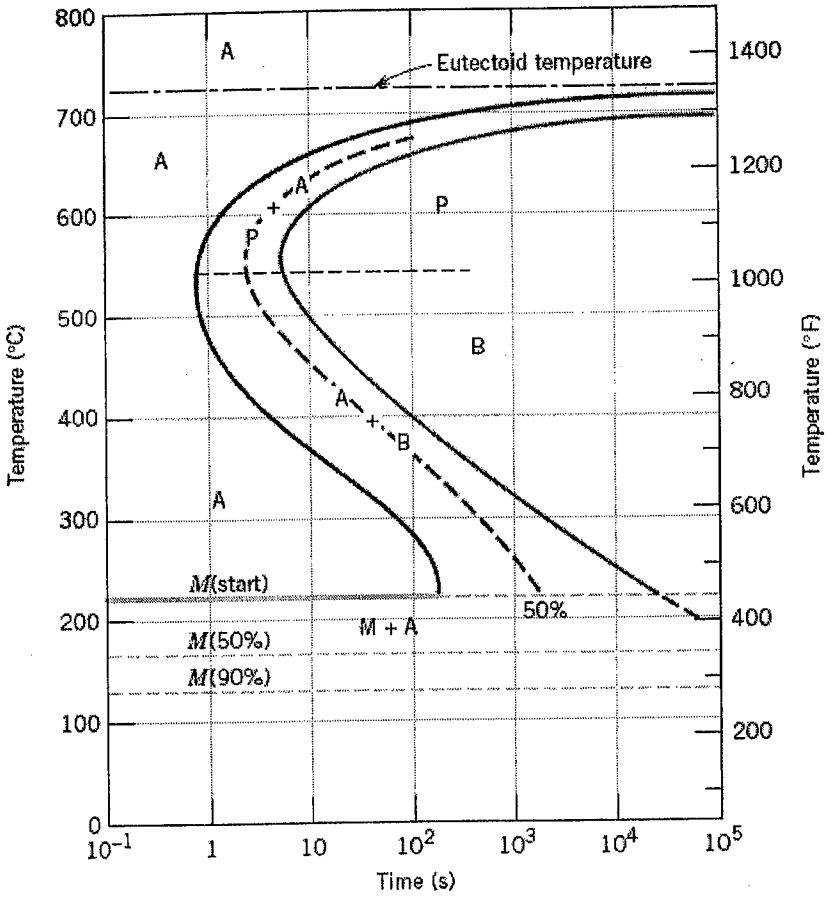

Fig Q2

i. Cool rapidly to 350°C, hold for 10^3 s, then quench to room temperature.

(06 marks)

ii. Rapidly cool to 625°C, hold for 10 s, then quench to room temperature.

(06 marks)

iii. Rapidly cool to 600°C, hold for 4 s, rapidly cool to 450°C, hold for 10 s, and then quench to room temperature.

(06 marks)

iv. Reheat the specimen in part (c) to 700°C for 20 h.

(06 marks)

v. Rapidly cool to 300°C, hold for 20 s, then quench to room temperature in water. Reheat to 425°C for 10^3 s and slowly cool to room temperature.

(06 marks)

vi. Cool rapidly to 665°C, hold for 10^3 s, then quench to room temperature.

(06 marks)

vii Rapidly cool to 575°C, hold for 20 s, rapidly cool to 350°C, hold for 100 s, and then quench to room temperature.

(07 marks)

viii. Rapidly cool to 350°C, hold for 150 s, then quench to room temperature.

(07 marks)

03) Two solids A and B show partial solid solubility. The melting points of A and B are 600°C and 700°C, respectively. The cooling curves of the metals prepared from mixtures of A and B in various ratioes, show the following features.

Composition (mol % of A)	Breaks at	Halt at
10	660°C and 580°C	-
20	610°C, 440°C and 200°C	-
40	490°C	350°C
60	-	350°C
70	430°C	350°C
90	550°C, 430°C and 250°C	-
95	570°C, 500°C and 130°C	-

i. Sketch the cooling curves for above mixtures.

(25 marks)

ii. Construct the phase diagram for the A/B system using the above data and label the diagam completely.

(15 marks)

iii. Explain the behaviour observed, when a mixture of 70 mol% A is cooled.

(10 marks)