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

Total number of printed pages – 6

B. Tech.

PCMT 4201 (N) / CPMT 6201(O)

Third Semester Examination – 2010

INTRODUCTION TO PHYSICAL METALLURGY

(New and Old Course)

Full Marks – 70

Time : 3 Hours

(Students are required to give their answer any one Course according to the Syllabus)

(OLD COURSE)

*Answer Question No. **1** which is compulsory and any **five** from the rest.*

The figures in the right-hand margin indicate marks.

1. Answer the followings : 2×10

   (a) What are the differences between an alloy and a compound ?

   (b) Why do materials having FCC structure offer higher formability ?

   (c) Within a cubic crystal show the direction [332] and plane (212).

   (d) Differentiate between recovery and recrystallisation.

   (e) Explain the terms : homogeneous and heterogeneous nucleation.

   (f) Contrast the microstructure between spheroidite and tempered martensite.

   (g) Why does the fractured surface of white cast iron appear "white" ?

   (h) What is the main difference between a brass and a bronze ?

   (i) How the iron-graphite phase equilibrium diagram is different from the iron-cementite phase equilibrium diagram?

   (j) Explain why TTT diagrams can be used for isothermal treatments only.

P.T.O.

2. (a) Derive the expression for relation between atomic radius and lattice constant for BCC, and FCC lattices. 4

(b) Calculate the equilibrium number of vacancies per cubic meter for copper at 1000°C. The energy for vacancies formation is 0.9eV/atom; the density and atomic weight (at 1000°C) for copper are 8.4g/cm^3 and 63.5g /mol, respectively. 6

3. (a) Explain and find an expression for resolved shear stress. What is critical resolved shear stress ? 5

(b) A stress of 85MPa is applied in the [001] direction, on an BCC single crystal. Calculate the resolved shear stress for the $(011)[1\bar{1}1]$ slip system. 5

4. (a) What are the Hume-Rothery rules for the solid solubility ? 3

(b) Explain the eutectic reaction. Draw binary eutectic phase diagram of any two component system and show salient points on it. 7

5. (a) Draw Iron-carbon equilibrium diagram and label the phase fields. Discuss in brief the different reactions that take place in this system. 6

(b) From the iron-iron carbide phase diagram, for a 0.2%C steel, name the phases and their fractions at equilibrium at the following temperatures: 4

(i) just above eutectoid temperatures

(ii) just below eutectoid temperature

6. (a) What is a T-T-T diagram? With respect to this diagram sketch and label the time temperature paths to produce the following microstures : 6

(i) 100% fine pearlite

(ii) 100% martensite

(b) With the help of TTT diagram describe the full-annealing heat treatment for plain-carbon steel. What types of microstructures are produced by full-annealing a hypoeutectoid steel? 4

7. (a) Differentiate between the hardenability and the hardness of a steel. Describe the Jominy hardenability test. 6

(b) What are alloy steels? Explain the composition, properties and applications of following stainless steels: 4

(i) Austenitic

(ii) martensitic.

8. (a) Describe the composition, properties and application of the following Cu-Zn brasses: 5

(i) cartridge brass

(ii) muntz metal.

(b) What are the aluminium bronzes and phosphor bronzes ? Write down their compositions and applications. 5

(NEW COURSE)

*Answer Question No. **1** which is compulsory and any **five** from the rest.*

The figures in the right-hand margin indicate marks.

1. Answer the followings: 2×10

   (a) Calculate the packing density of a FCC structure.

   (b) Give the steps for determining the Miller indices of crystallographic directions.

   (c) At 727°C γ-iron (FCC) can dissolve carbon up to 0.77% where as α-iron(BCC) is able to dissolve only up to 0.025% - Why?

   (d) Why are metals good conductors of heat and electricity?

   (e) Sketch 110 plane and direction in the unit cell of a cubic crystal.

   (f) What is critical cooling rate?

   (g) Show that true stress-strain curve is above and left to the engineering stress-strain curve.

   (h) Derive the relationship between true stress & engineering stress.

   (i) Determine the maximum number of phases that can coexist in equilibrium in a three-component system (metallic).

   (j) Determine whether the following dislocation dissociation reaction is feasible

   $$a/2[0\bar{1}1] = a/6[1\bar{2}1] + a/6[\bar{1}12]$$

2. (a) Find out the tensile stress applied along the $[1\bar{1}0]$ axis of a silver crystal to cause slip on the $(1\bar{1}1)[011]$ system. The critical resolved shear stress is 6 MPa. 4

(b) Draw the Iron-cementite phase diagram. Label the important phase fields, temperatures and compositions. Give the important invariant rections occurring in the system. 2+2+2

3. (a) What is twinning ? What is the difference between slip and twinning ? 4

(b) What are the different types of point defects ? And how do they influence the properties of solids. 3+3

4. (a) Name the various stages of annealing a cold worked material. 2

(b) What are the structural changes and changes in property that occur during the various stages of annealing? 5

(c) Differentiate between annealing and normalising. 3

5. (a) What is hardenability ? Describe the Jominy end quench method of determining hardenability of steels. 4

(b) What is homogenous nucleation ? What is critical free energy of nucleation and critical radius of nuclei in homogeneous nucleation ? And how are these affected by varying the temperature of transformation ? 6

6. Write Short-notes on : 2×5

(a) Solid solution

(b) Muntz Metal

(c) Sensitization

(d) High Speed Steel

(e) Ductile Iron

7. (a) What is tempering ? Why is tempering done? Explain briefly the micro structural and property changes that take place in a steel during various stages of tempering. 6

(b) What is super cooling ? Explain its role in phase transformation. 4

8. (a) What is yield point phenomenon ? Describe with a neat sketch of load-elongation curve of low-carbon steel. Show how strain ageing occurs with suitable diagram. 3+2

(b) What is the driving force for grain growth ? State and explain Hall-Petch relationship. 3

(c) What is Zener pinning effect ? 2