COLLEGE OF ENGINEERING, PUNE
END SEMESTER EXAMINATION
M. Tech (Metallurgy): IS -501-11
Electronic and Magnetic Materials

Year: 2011-12 **Semester I**

Duration: 3 Hrs **Max.Marks: 50**

Instructions

1 Draw the neat figures to support your answers.

2 Use of non programmable calculator is permitted.

Q.1 a Define drift velocity of electrons on the basis of classical free electron theory and derive the relation between drift velocity and applied field. 6

b State the mixture rules to estimate electrical resistivity of materials. 4

Q.2 a The electrical resistivity of a semiconductor is 3×10^3 ohm m at 27^0C. Its conductivity is 2.67 per ohm per m at 250 ^{0}C. Estimate the energy gap and identify the material ($k = 8.620 \times 10^{-5}$ eV/ K) 6

b Write a note on Josephson effect and Tunneling. 4

Q.3 a Cite the differences between hard and soft magnetic materials in terms of both hysteresis behavior and typical applications. 6

b Explain why aluminum used in long distance transmission lines cannot be strengthened by solid solutions. 4

Q.4 a Would you expect the physical dimensions of a crystal - $BaTiO_3$ to change when it is subjected to an electrical field? Why or why not? 6

b State the significance of Fermi Energy level 4

Q.5 a A parallel plate capacitor has an area of 8×10^{-4} m^2 and a plate separation of 2×10^{-3} m across which a potential of 10 V is applied. If a dielectric material having constant $7(\varepsilon_r = 7)$ is positioned within the plates. Calculate the followings: 6

1) Capacitance, 2) Charge stored on each plate

2) Dielectric displacement, 4) Polarization.

Assume $\varepsilon_0 = 8.85 \times 10^{-12}$ F/ m

b How anti reflection coating on solar cell can be designed and selected? 4

COLLEGE OF ENGINEERING, PUNE – 5

(An Autonomous Institute of Government of Maharashtra)

End Semester Examination

PY-513 & PM-513: Concepts in Materials Science

Programme: **M.Tech. (Physical Metallurgy & Process Metallurgy)**
Duration: **180 Minutes**
Max. Marks: **100**
Weightage: **50%**

Year: **2011-12**
Date: **27 November 2011**

***Instructions*:**

1. *All questions are compulsory.*
2. *Draw neat figures wherever necessary.*
3. *Figures to the right indicate full marks.*
4. *Assume suitable data if required.*

Q.1: **(a)** What are the possible factors that deside the formation of *substitutional solid solution* ? (6)

(b) Calculate the atomic density (number of atoms per unit area) on (111) planes of copper (FCC crystal structure) with the lattice parameter of 3.61 Å. (7)

(c) Find the Millar indices of a plan that makes intercepts on a, b and c axes equal to 3 Å, 4 Å and 3 Å in a tetragonal crystal with c/a ratio of 1.5. (7)

Q.2: **(a)** Consider a tensile testing specimen of mild-steel which was subjected to the following two situations: During performing the tensile testing, load is released after some plastic deformation (just above the yield-point), and then tensile testing of the same specimen was carried out again after some days. Draw the schematic engineering stress-strain curves on the *same plot (graph)* for these two situations. (6)

(b) How will you decide the edge and screw dislocations are positive or negative ? (4)

(c) The yield strength of a polycrystalline material increases from 120 MPa to 220 MPa, on decreasing the grain diameter from 0.04 mm to 0.01 mm. Find the yield stress for a grain size of ASTM 9. (10)

Q.3: **(a)** Using the phase diagram for Ag-Pt below (see *Figure-1*), write down all transformation reactions (indicated by points and numbers), and corresponding type of reaction that occurs on cooling. (8)

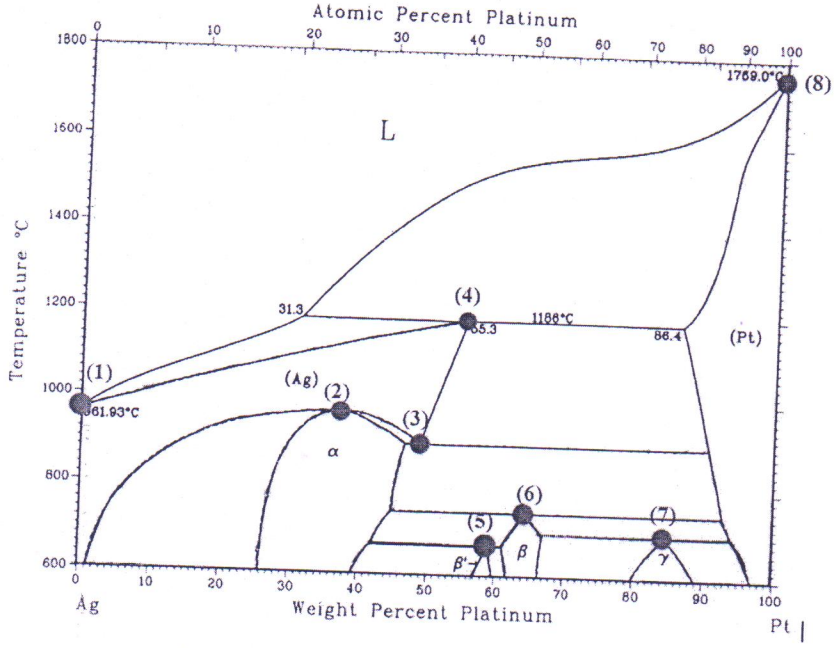

Figure-1

(b) Calculate the percentage of phases present in Ag – 60% Pt alloy at about 1190 °C and 880 °C. (6)

(c) Explain the fundamental mistakes in the phase diagrams drawn below (see *Figure-2*). Correct the mistakes and redraw the modified version of these phase diagrams. (6)

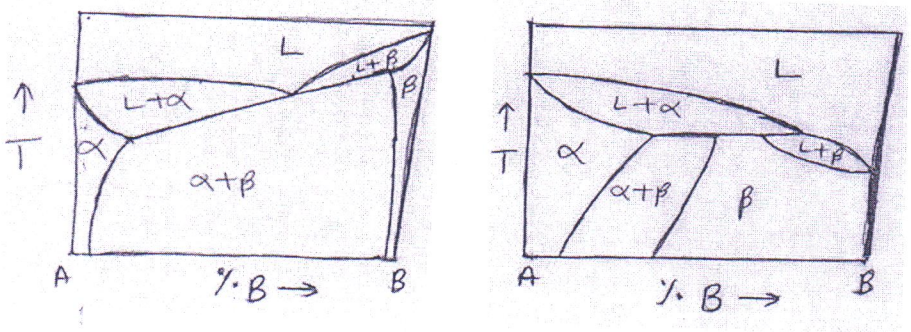

Figure-2

Q.4: **(a)** Calculate the percentage of phases present in 0.2% C and 1.2% C steels at about 730 °C. (7)

(b) Draw schematically the microstructures of 0.2 % C and 1.2 %C steels obtained after equilibrium cooling (i.e. cooled from liquid state at very slow cooling-rate). (7)

(c) Give the classification of alloying additions in steels. (6)

Q.5: **(a)** Consider 0.8% C steel. Draw the schematic heat-treatment cycles along with TTT diagram for annealing, normalizing, quenching, tempering and austempering. (Appropriate labeling is must) (8)

(b) Write a short note on age-hardening treatment. (6)

(c) State the simplest heat treatment, along with cooling curve and TTT diagram, necessary to convert 0.8 % C steel from one structure to another: (i) Martensite to pearlite, (ii) Pearlite to bainite, and (iii) Bainite to martensite. (6)

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COLLEGE OF ENGINEERING, PUNE

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END-SEM EXAMINATION

Nanomaterials and Nanotechnology (Subject Code: DE 1 TH)

Programme: F.Y. M. Tech. / Final year B. Tech. Year: 2011 – 2012

Time Duration: 3 Hours Max. Marks: 50

Instructions

1. Answer all questions.
3. Neat diagrams must be drawn wherever necessary
4. Sharing/exchange of calculators is not allowed.

			Marks
Q. 1		Explain a flow chart for the fabrication of carbon nanotube (CNT) filled polymer matrix nanocomposites (PNCs). Discuss the improvement in mechanical and electrical properties of PNCs? Also explain the percolation threshold phenomena of CNT filled PNCs.	10
Q. 2	A	Write in brief about principle of any three characterization techniques used in nanotechnology. Calculate the line breadth of the nanomaterials which shows intense diffraction peak at 40° and crystallize size of about 50 nm.	5
	B	Discuss in details (with graph) the effect of grain size on melting temperature, coercitivity and hardness of the nanomaterials.	5
Q. 3		Answer **<u>any five</u>** from the following questions;	15
	A	Calculate surface area and number of atoms present in an atomic thick 2-dimensional film with length and breadth of 1μm each? (assume diameter of atom = 0.1 nm)	
	B	Illustrate in a neat diagram, number of iron atoms in bulk and on the surface as a function of increasing particle size.	
	C	Explain in brief the important steps involved in a nano-lithography.	
	D	What are the merits and demerits of PVD method of synthesis of nanomaterial?	
	E	What do you mean by BET? What is the specific surface area of a material? Why does discrepancy arise between the experimental specific surface area and the calculated specific surface area?	
	F	Explain size dependence sensing behaviour of nanomaterials.	
Q. 4		Write short notes on ***<u>any five</u>*** from the following topics; (A) Nano-Dry, (B) Diamond nanoemitter, (C) HiPCO Process, (D) Nanotechnology for cosmetics, and (E) Composition and application of nanofluids (F) Sample preparation methods for TEM analysis (G) Preparation and properties of CNT filled metal matrix nanocomposites	15

COLLEGE OF ENGINEERING, PUNE
END SEMESTER EXAMINATION
M. Tech (Physical / Process Metallurgy)
Mechanical Behaviour of Materials: (PM 505)

Year: 2011-12 **Semester I**

Duration: 3 Hrs **Max.Marks: 50**

Instructions

1 Draw the neat figures to support your answers.

2 Use of non programmable calculator is permitted.

Q.1 a Explain Yielding criteria for ductile metals. 6

b A steel bolt having 10 mm radius is subjected to a static mean force of 19.2 KN. What is the maximum value of reversed direct fatigue load which the bolt can withstand assuming fatigue limit under zero mean stress condition is 287 MPa. Use Soderberg equation and assume yield strength of steel is 364 Mpa. 4

Q.2 a What will be the limiting design stress in both cases for a steel possessing a tensile yield stress of 550 Mpa and a fracture toughness of 40 MPa $m^{1/2}$, using factor of safety 1.5, if no plastic deformation is permitted and maximum tolerated crack is a) 3 mm and b) 5 mm in length. 6

b State the rules of slip in case of single crystal. 4

Q.3 a Explain alloy design principles with reference to the development of creep resistant materials with suitable examples. 6

b Why higher stress is necessary to initiate plastic flow in polycrystalline materials? 4

Q.4 a Write a note on any one strengthening mechanism for metallic materials in detail. 6

b Write a note on HSLA steel. 4

Q.5 a A steel link in a mechanism undergoes a fluctuating bending stress between 500 Mpa and 400 Mpa. What should be the maximum tensile strength of the steel in order that failure will not occur. Assume the endurance limit for the steel is 510 Mpa. 6

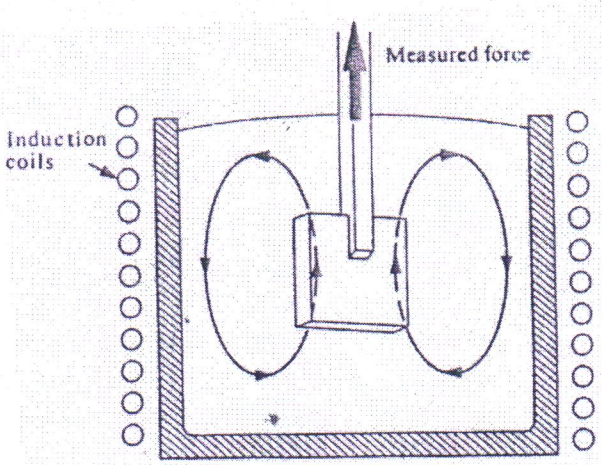
b State the importance of fracture toughness in designing of components. 4

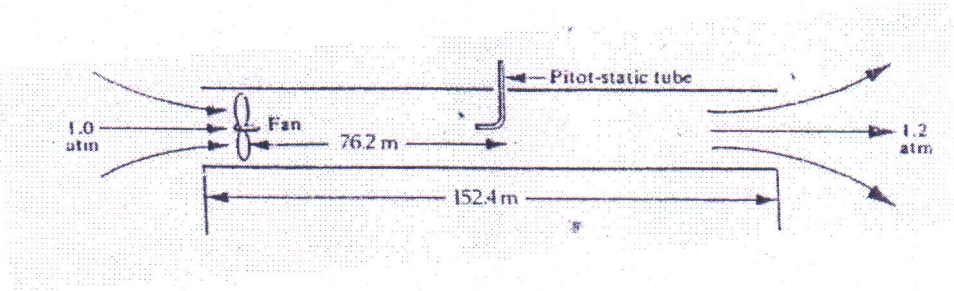
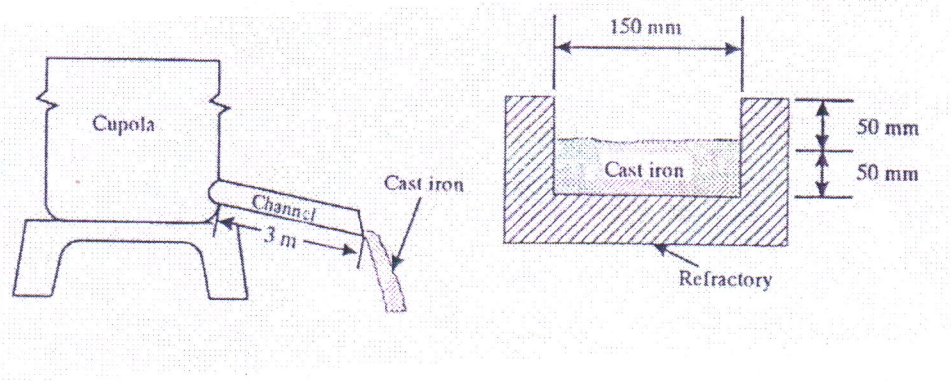
COLLEGE OF ENGIEERING PUNE
Mid Semester Exam
MT.....: Heat and Mass Transfer

Class: F.Y.M.Tech. (Process Metallurgy) **Time: 3 hours**
Marks: 50

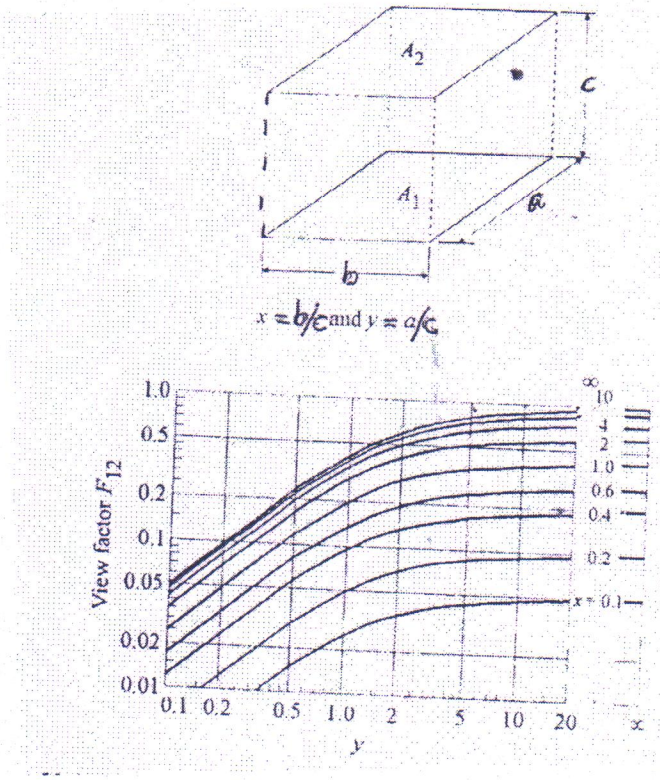
Instructions:

a) All questions are compulsory
b) Assume suitable data if necessary, draw neat figures.
c) Use of calculators is allowed.

Q1	Develop an expression for the flow of a fluid between vertical parallel plates. The plates are separated by a distance of 2 δ. Consider fully developed flow and determine- a) The velocity flow rate; b) the volume flow rate.	10
Q2	In order to study the mixing action in molten bath of aluminium contained in an induction furnace, we use a steel flag. The flag is held in a vertical position and placed in the central part of the furnace where the metal flows upward as depicted in the figure below. If the provisions are made to measure the added force exerted on the flag due to fluid motion, prepare a control chart that relates this force to the velocity of the molten aluminium in the central portion of the ~~furance~~ furnace. Assume that turbulent flow encompasses the conditions of interest. Data: Viscosity of aluminium : 1.1×10^{-3} N s/m^2 Density of aluminium: 2.5×10^3 kg/m^3. Flag dimensions : 0.3 x 0.3 x 5 mm thickness  Arrows indicate the melt's motion due to the electromagnetic forces.	10

Q3	A fan draws air at rest and sends it through a straight duct 152 m long. The diameter of the duct is 0.61 m and a pilot-static tube is installed with its impact opening along the centre line. The air enters at 300K and 1 atm and discharge at 1.2 atm. Calculate the theoretical work 9 in N m/kg) of the fan of the pitot-static tube measures a pressure difference of 25.4 mm of water. (Note: 1 atm = 1.0133 N/m^2).  	10
Q4	Consider solidification in a flat ceramic shell mold with a thickness L. There is heat loss from the outside surface to the surroundings with constant heat transfer coefficient (h= 150 W /m^2.K). Except for very early times, the temperature in the mold is at steady state. a) Derive an equation for thickness solidified versus time, b) A plate of nickel (38 mm thick) is cast in a ceramic shell mold (10 mm thick). Calculate the solidification time. Data: Nickel: Melting point 1723K; ρ= 7850 kg/m^3 ; k= 0.70 W/m.K; H_f= 2.91x10^5 J/kg.	10
Q5	Cast iron is continually tapped from the bottom of a cupola into an open refractory channel. The metal enters at 1810K and runs down the channel at a rate of 0.5 kg /s. The dimensions of the channel are shown below. Neglect the heat loss by conduction through the refractory and estimate the metal discharge temperature. Data: for molten cast iron Cp= 830 J/kg.K; ρ = 6890 kg/m^3; ε = 0.30.  	10

Data sheet:


A_2
c
A_1
a
b
$x = b/c$ and $y = a/c$
View factor F_{12}
1.0
0.5
0.2
0.1
0.05
0.02
0.01
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y
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4
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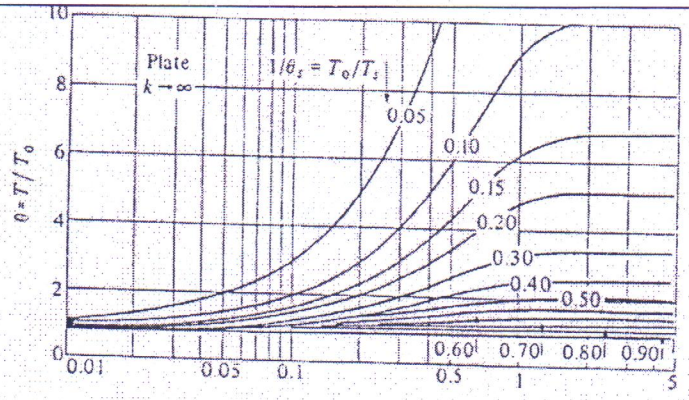
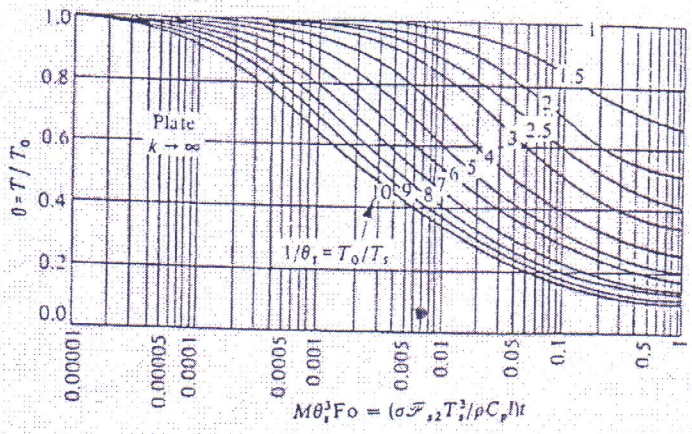


(a) Heating, $\theta_s = T_s / T_o > 1$



(b) Cooling, $\theta_s = T_s / T_o < 1$

Fig. 11.28 Temperature of a plate, $0 \leq x \leq l$, with no internal thermal gradients and an insul back face, at $x = l$, after sudden exposure to (a) a radiation heat source (heating) or (b) a radia heat sink (cooling). (From P. J. Schneider, *Temperature Response Charts*, John Wiley, New Y NY, 1963, pages 147 and 148.)

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College of Engineering, Pune 5.

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End Semester Examination

M. Tech. (Metallurgical Engineering- Physical Metallurgy)

Characterization Techniques

Autumn Semester

Time 3 hours] **[Max. Marks 100**

Instructions to candidates:

1) Solve any **four** questions. Each question carries **25** marks.
2) Neat diagrams must be drawn wherever necessary.
3) Assume suitable data if necessary.
4) Use of non-programmable electronic pocket calculator is permitted.

Q.1 **(a)** Explain with suitable sketches, the interactions between the incident electron beam and the sample atoms for: **[13]**

i. A thick sample in scanning electron microscope.
ii. A thin sample in transmission electron microscope

(b) Compare the resolution and depth of focus in the TEM and SEM. What would be the resolution in a 120 KV transmission electron microscope with 25 μm numerical aperture? **[12]**

Q.2 **(a)** How it becomes possible to view dislocations in TEM. **[7]**

(b) Explain the basic arrangement of lenses and other arrangements provided in SEM to bring the electron beam to a narrow spot. **[6]**

(c) How the arrangement of lenses in TEM differs from the one provided in SEM? **[6]**

(d) Calculate the depth of field for a SEM operating at 10 mm working distance, 2,000X magnification and using 25 nm diameter electron probe. **[6]**

Q.3 **(a)** Comment on the developments in the electron sources as used in TEM/SEM. **[9]**

(b) Discuss the operating principle and type of particles used in secondary ion mass spectroscopy (SIMS) **[8]**

(c) Compare between the principles of operation of scanning tunneling microscope and atomic force microscope. **[8]**

Q.4 **(a)** Differentiate between the followings: **[18]**

i) Wavelength dispersive spectroscopy (WDX) and Energy dispersive spectroscopy (EDX)
ii) X-ray diffraction and Electron Diffraction
iii) X-Ray Photoelectron Spectroscopy (XPS) and Auger Electron Spectroscopy (AES)

(b) How achievement of atomic level resolution becomes possible in Field Ion Microscope. **[7]**

Q.5 Write short notes on (**any three**): **[25]**

i) Electron energy loss spectrometry
ii) Low vacuum SEM
iii) Electron back scatter diffraction technique
iv) Concept of Reciprocal lattice and Ewald sphere

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COLLEGE OF ENGINEERING, PUNE

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END-SEM EXAMINATION

Phase Transformation of Materials (Subject code: PY-501)

Programme: F.Y. M. Tech. (Physical) Year: 2011 – 2012

Time Duration: 3 Hours Max. Marks: 50

Instructions

1. Answer all questions carrying equal marks.
3. Neat diagrams must be drawn wherever necessary
4. Sharing/exchange of calculators is not allowed.

		Marks
Q. 1	Draw an isothermal transformation diagram for a plain-carbon eutectoid steel and indicate the various decomposition products on it. Also explain the transformation kinetics for the formation of bainite and martensite products.	10
Q. 2	Answer any two questions from the following;	2x5
	A Discuss five differences between the bainite and pearlite.	
	B Explain (with graph) both (Vickers and Rockwell-C) hardness variation of martensite as a function of carbon content. Compared to Rockwell-C, Vickers hardness tester is preferred for hardened high-carbon steels. Why?	
	C Calculate the % volume change during transformation of an austenitic plain-carbon steel containing 1 % C to martensite (Given: lattice parameter of pure γ-Fe is 3.548 A^0).	
Q. 3	A Under a steady state condition, a plate of iron is exposed to a carburizing atmosphere on one side and a decarburizing atmosphere on the other side at 700 °C. Calculate the diffusion flux of carbon through the plate if the concentrations of carbon at positions of 5 mm and 10 mm beneath the carburizing surface are 1.2 kg/m^3 and 0.5 kg/m^3, respectively. The diffusion coefficient of carbon at this temperature is 3×10^{-11} m^2/s.	5
	B A 0.65 % C hypoeutectoid plain-carbon steel is slowly cooled from 950 °C to a temperature just slightly below 723 °C. Calculate the weight % of (a) proeutectoid ferrite, (b) eutectoid ferrite and (c) eutectoid cementite in the steel.	5
	Or	
	Why does commercial aluminium (Al) metal recrystallize at a temperature much higher than the actual preferred temperature?	5

PTO

Q. 4 Answer **any five questions** from the following; **5x4**

A A 0.8 % plain carbon steel is first slowly cooled from 850 °C to a temperature of 700 °C for 5 seconds to get product "A". Then, it is immediately quenched in a bath with temperature of 580 °C for 5 seconds to get product "B" and then finally quenched in one more bath with temperature of 50 °C for prolonged duration, where remaining retained austenite is transformed to product "C". It was considered that there was partial transformation during first and second transformation-stages. Write the name of all products (i.e. A, B and C). Will you get any retained austenite in addition to above products (Yes or No)?

B The diffusion coefficient of carbon in fcc-iron at 1000 °C is 3×10^{-11} m^2/s, while that of nickel (Ni) in fcc-iron at the same temperature is 2×10^{-16} m^2/s . Why?

C Explain long-range diffusion, short-range diffusion and diffusion-less transformations. Also write examples of each.

D Explain Burst temperature phenomena?

E With a suitable sketch show and explain the variation of retained austenite in steel with increasing carbon content. Also write the name of technique which can be used to measure retained austenite of the steel. What is the best detectable limit of this technique?

F Discuss the factors (in brief) affecting austenitic to martensite transformation.