IP32A

USN | | | | | | | | | | |

NEW SCHEME

Third Semester B.E. Degree Examination, Dec. 06 / Jan. 07
ME / IP / IM / MA / AU
Material Science and Metallurgy

Time: 3 hrs.] [Max. Marks:100

Note : *Answer any TWO full questions from Part A, TWO full questions from Part B and ONE from Part C.*

Part - A

1 a. Draw the unit cells of BCC and FCC and establish their Atomic Packing Factor (APF) and Co-ordination Number (CN). **(06 Marks)**

b. What do you mean by imperfections in crystals? Explain briefly the different types of crystal imperfections. **(08 Marks)**

c. Distinguish clearly between edge dislocation and screw dislocation with neat sketch. **(06 Marks)**

2 a. State and explain Fick's 1st and 2nd laws of diffusion. Also explain the factors affecting diffusion co-efficient. **(08 Marks)**

b. Draw the stress versus strain diagram (schematic) of mild steel and describe how the following properties can be obtained from it.
   i) Modulus of elasticity
   ii) Yield strength
   iii) Ultimate Tensile Strength UTS **(08 Marks)**

c. Distinguish clearly between (any two) :
   i) Conventional stress and True stress
   ii) Conventional strain and True strain
   iii) Slip and Twinning in single crystals. **(04 Marks)**

3 a. Derive an expression for the Critical Resolved Shear Stress (CRSS) for slip. **(06 Marks)**

b. Define creep deformation. Explain the different stages of creep with a neat sketch. Also explain the characteristics of creep in these three stages. **(08 Marks)**

c. Explain briefly any two :
   i) Types of fatigue loading with examples
   ii) Brittle fracture and ductile fracture
   iii) Stress relaxation. **(06 Marks)**

Part - B

4 a. Derive an expression for the critical size of the nucleus for homogeneous nucleation and explain the process of grain growth. **(08 Marks)**

b. What is a solid solution? Explain with neat sketches the substitutional and the interstitial solid solutions. **(06 Marks)**

c. State and explain Hume Rothery rules that govern the formation of solid solutions. **(06 Marks)**

Contd.... 2

c. Draw the Fe-Fe_3C phase diagram and label all the phase fields. 10

5. a. Distinguish, with suitable examples, substitutional and interstitial solid solutions. 06

b. Considering the example of an isomorphism system, describe the construction of phase diagrams. 06

c. What is the purpose of tempering the hardened steel ? Explain the changes that occur in hardened steel on tempering. 08

6. a. Lead (Pb) melts at 323°c and Tin (Sn) melts at 232°c. Addition of Sn to Pb lowers the melting point of Pb and addition of Pb to Sn also lowers the melting point of Sn. At 180°c, liquid of composition 61.9%Sn,alpha (α) phase of composition 19.2% Sn and beta (β) phase of composition 96.2%Sn. are in thermal equilibrium. The solubilities of Pb in Sn and Sn in Pb at room temperature are negligible. 08

(i) Draw the Pb – Sn phase diagram.

(ii) Identify the reaction occurring at 180°c.

(iii) Calculate the amount of Phases in an alloy of composition 40% Sn at 179°c.

b. Discuss the Solidification sequence of a hypoeutectic cast iron as it is cooled from liquid state to room temperature. 06

c. Define hardenability. Describe the Jominy end quench test of determining hardenability of steels. 06

Part C

7. a. Compare Grey cast iron with malleable cast iron with reference to their composition, structure, properties and uses. 08

b. What are the advantages and limitations of composites as compared to metals and polymers? 06

c. Write a note on AISI classification of Steels. 06

8. a. What are the role of 06
(i) Matrix
(ii) Reinforcement
(iii) Interface in composites?

b. Give an account of non-heat treatable Aluminum alloys. How are these alloys strengthened? 08

c. Discuss the composition and uses of α-brasses and bronzes. 06

MODEL QUESTION PAPER II

Sub : -MATERIALS SCIENCE AND METALLURGY(ME/IP/IM/MA/AU)
Sub Code : - IP - 32A
Time : - 3 hours. Max Marks -100

Note: - 1) Answer TWO questions from Part-A, TWO questions from Part-B and ONE question from Part-C.

Part A

1.	a.	Tantalum at 20°c is BCC and has an atomic radius of 0.143nm. Calculate its lattice parameter.	03
	b.	Define atomic packing factor. Determine the atomic packing factor of an ideally packed HCP unit cell.	07
	c.	Draw the stress-strain diagram (schematic) of mild steel and describe how the following properties can be obtained from the curve. (i) Elastic modulus (ii) Yield strength (iii) UTS (iv) Ductility (v) Toughness.	10
2.	a.	State Fick's first law of diffusion and explain.	03
	b.	Draw a crystal lattice containing an edge dislocation and show the burgers vector.	03
	c.	Discuss the factors affecting fatigue strength in metals.	08
	d.	The Critical stress intensity factor (K_{Ic}) of a Material used for a component is 26 M Pa $\sqrt{m}$. What is the applied stress that will cause fracture if the component contains an internal crack of length 1.72 mm? Assume the geometric constant y = 1.	06
3.	a.	Calculate the resolved shear stress on (111) [OTI] slip system of a unit cell in an FCC crystal if a stress of 13.7 MPa is applied in [001] direction of the unit cell?	06
	b.	Draw a typical creep curve and explain the stages of creep.	08
	c.	How is fatigue strength of non-ferrous materials determined?	06

Part B

4.	a.	State Gibb's phase rule and explain the terms.	04
	b.	Calculate the critical radius of a homogeneous nucleus that forms when pure liquid of Copper Solidifies. Assume an under cooling of 0.2Tm. Data : Melting point of Copper =1083°c Heat of fusion of Copper =1826 J/cm^3 Surface energy of Copper =177x10^{-7} J/cm^2	06

8. a. What are the advantages and limitations of composites as compared to polymers and ceramics? 06

b. What is meant by "modification" of AL-Si alloys? Why is it done? 06

c. Discuss the composition, properties and uses of α – brasses and Leaded Bronzes. 08

MODEL QUESTION PAPER 1

Sub Code : - MATERIALS SCIENCE AND METALLURGY (ME/IP/IM/MA/AU)
Sub : - IP - 32A
Time : -3 hours. Max Marks: -100

Note: - Answer TWO questions from Part-A, TWO questions from Part-B and ONE question from Part–C.

Part A

a. Aluminium crystallizes in FCC structure with a lattice parameter of 0.405nm. Calculate the atomic radius of aluminium. 03

b. Discuss the factors affecting self-diffusion in metals. 06

c. Draw, on the same plot, schematic stress – strain curves of mild steel, grey cast iron and copper. 03

d. Explain the mechanisms of fatigue crack growth in ductile materials. 08

a. Define atomic packing factor. Determine the atomic packing factor of FCC unit cell. 07

b. A low carbon steel rod is subjected to a tensile load of 7,000 kg. Assuming no volume change during extension, determine engineering stress, engineering strain, true stress and true strain. The initial diameter of rod is 13mm and the specimen under the load is 12mm. 08

c. What are the affects of
(i) Stress , (ii)Temperature on creep curve? 05

a. Sketch the unit cell of HCP lattice. Estimate the affective number of atoms per unit cell in HCP. 04

b. Compare edge dislocation with screw dislocations. 08

c. A 0.2%C steel component is to be carburized at 920^0c. Calculate the time required to increase the carbon content to 0.4% at 0.5mm below the surface. Assume that the carbon content at the surface is 0.9%. 08
Given : $D920^0 c = 1.28x10^{-11}$ m^2/s
Error functions values:

Z	erf (Z)
0.75	0.7172
0.80	0.7421

Part B

Draw the structure of a typical cast ingot and identify various regions. 05

. A binary alloy of composition 40%B. 60%A contains two phases namely liquid and solid at a particular temperature. The Composition of solid phase is 23% and that of liquid phase is 68%B. Estimate the amount of solid and liquid phases in the alloy. 04

. What is an invariant reaction? Write down the following invariant reactions: 04

(i) Eutectic
(ii) Peritectic
(iii) Eutectoid

1. Discuss the solidification sequence of a 0.6%c steel as it is cooled from liquid state to room temperature. 07

a. Four specimens A.B.C and D of an eutectoid steel are autenitized at 780^0c for sufficiently long period. The specimens are cooled to room temperature as mentioned below: 08

(i) Specimens a is quickly transferred to a salt bath maintained at 300^0c. After 2 hrs the specimen was removed and cooled to room temperature.
(ii) Specimen B is cooled in still air.
(iii) Specimen C is quickly transferred to a container containing water at room temperature.
(iv) Specimen D is cooled within the furnace itself.

Compare the structure and properties of these four specimens.

b. Distinguish between TTT and CCT diagrams. Which is of practical use ? Justify. 08

c. State theme Rothery rules governing solid solubility. 04

a. Distinguish substitutional and interstitial solid solutions. Give examples. 04

b. Define Autenite, Ferrite, Cementite and Pearlite. 04

c. Draw a typical Age-hardening curve and indicate 04
i. Optimum aging
ii. Under aging
iii. Over aging

d. Estimate the amount of procutectoid ferrite, eutectoid ferrite, pearlite and cementite in 0.5% steel at room temperature. 08

Part C

a. Compare white cast iron with S.G iron with respect to their composition, microstructure, properties and uses. 08

b. What are the main types of synthetic fibres used to produce FRPs? 04

c. Explain in detail the BIS classification of steels. 08

MODEL QUESTION PAPER - 1

115/c

(50)

No... 1

NEW SCHEME

USN | | | | | | | | | |

Third Semester B.E. Degree Examination, January/February 2004

Common to ME/IP/IM/MA/AU

Material Science & Metallurgy

Time: 3 hrs.] [Max.Marks : 100

Note: *Answer TWO questions from PART A, two from PART B and ONE question from PART C.*

PART A

1. (a) Nickel has FCC crystal structure with a lattice parameter of 0.352nm. What is the value of atomic radius in nanometers? (4 Marks)

   (b) Draw stress - strain curve for mild steel and describe how to find each of the properties.
   i) Yield strength
   ii) Ductility
   iii) Toughness
   iv) Ultimate tensile strength
   v) Fracture stress (10 Marks)

   (c) Describe and illustrate the edge and screw dislocations. How do they cause plastic deformation? (6 Marks)

2. (a) The surface of a steel gear made of 1020 steel (0.2% C) is to be gas carburised at 927^0C. Calculate the time required to increase the carbon content to 0.4% at 1mm below the surface if the carbon potential at surface is 1.2wt%.

   (Diffusion co-efficient $D_{927^0C} = 1.28 \times 10^{-11} \frac{m^2}{sec}$ erf(0.9) = 0.8) (4 Marks)

   (b) Determine the critical crack length for a through thickness crack in a thick material of $K_{IC} = 24.2Mpa\sqrt{m}$, which is under a stress of 350MPa. Assume size factor, $y = 1$ (4 Marks)

   (c) Describe the basic structural changes which take place when a homogenous ductile material is caused to fail by fatigue under cyclic stress. (6 Marks)

   (d) Draw a typical creep curve for a metal under constant load and at relatively medium temperatures and explain stages of creep. (6 Marks)

3. (a) Describe the fatigue test. (4 Marks)

   (b) Discuss
   i) Temperature effect on creep curve
   ii) Non propagating cracks
   iii) Cup and cone fracture in mild steel
   iv) Recrystallisation
   v) Effect of grain size on strength (10 Marks)

   (c) A 12.5 mm dia Aluminium alloy test bar is subjected to a load of 2tons. If the dia of the bar is 12.4mm at this load, calculate engineering strain, engineering stress, true stress and true strain. Assume no change in volume. (6 Marks)

Contd.... 2

PART B

4. (a) State Hume - Rothery rules for solid solution. (4 Marks)

   (b) State Gibbs phase rule and explain the term invariant reaction with an example. (5 Marks)

   (c) Write equations for the following invariant reactions with sketches.
   Eutectic, Eutectoid, Peritectic and Peritectoid (5 Marks)

   (d) Write short notes on
   i) Coring
   ii) Critical radius of nuclei
   iii) Columnar grains. (6 Marks)

5. (a) If a thin sample of 0.2%C steel is slow cooled from austenitic region and held at 700^0C until transformation is complete, what will be its microstructure? Discuss proportions of proeuctectoid ferrite, eutectoid ferrite, cementite and pearlite. (8 Marks)

   (b) Describe Jominy hardenability tests and its practical application. (8 Marks)

   (c) What are CCT curves and mention its uses. (4 Marks)

6. (a) Describe decomposition structures that can be developed when a supersaturated solid solution of an $Al - 4\%Cu$ alloy is aged. (4 Marks)

   (b) Describe austempering, induction hardening and carburising heat treatment processes. (6 Marks)

   (c) Discuss the role of Chromium, Nickel and Boron in steels. (6 Marks)

   (d) What is the engineering purpose of tempering the hardened steel? (4 Marks)

PART C

7. (a) How are ductile irons manufactured? (8 Marks)

   (b) How are Aluminium - silicon alloys modified? (6 Marks)

   (c) Briefly discuss BIS classification of steels. (6 Marks)

8. (a) What properties of carbon fibres are important for reinforced plastics and how carbon fibres are produced. (5 Marks)

   (b) Calculate the tensile modulus of elasticity of a unidirectional carbon-fibre reinforced composite material which contains 62% by volume of carbon fibres in iso-strain and iso-stress condition.

   $E_{carbon\ fibre}$ $3.86 \times 10^4 kgf/mm^2$
   E_{epoxy} $4.28 \times 10^2 kgf/mm^2$

   (5 Marks)

   (c) How are malleable cast irons produced in industry? Discuss the structural changes and mention the applications. (5 Marks)

   (d) What are the basic temper designation of wrought aluminium alloys? (5 Marks)

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(48)

115/c

No... 1

NEW SCHEME

IP32A

USN

Third Semester B.E. Degree Examination, July/August 2004

Common to ME/IP/IM/MA/AU

Material Science & Metallurgy

Time: 3 hrs.] [Max.Marks : 100

Note: *Answer TWO questions from PART A, two from PART B and ONE question from PART C.*

PART - A

1. (a) Draw neat sketches of B.C.C and F.C.C unit cells and from fundamentals calculate their atomic packing factors. (10 Marks)

   (b) With neat sketches differentiate between edge and screw dislocations. (5 Marks)

   (c) Calculate the diffraction rate of carbon in iron at 700^0C assuming the constants $A = 4.9 \times 10^{-5} m^2/s$ and $E = 153.2 kJ/mol$. (5 Marks)

2. (a) With the help of a neat schematic conventional stress-strain diagram for mild-steel under uniaxial static tension explain clearly the behaviour of the material till fracture. (10 Marks)

   (b) Define

   i) Elastic strength ii) Stiffness iii) Resilience iv) Toughness & v) Ductility (5 Marks)

   (c) Why is brittle fracture dangerous ? (2 Marks)

   (d) Explain strain hardening briefly. (3 Marks)

3. (a) Draw a typical three stage creep curve and explain clearly the phenomenon and major mechanisms that are operative in each stage. (10 Marks)

   (b) How would you conduct a test to assess the fatigue life of a material? Explain briefly. (5 Marks)

   (c) What is S-N diagram ? How is it drawn ? How is it useful to convert from fatigue life to fatigue strength. (5 Marks)

PART - B

4. (a) Explain briefly the Hume-Rothery rules of substitutional solid solutions. (5 Marks)

   (b) Two metals A and B of melting points 1000^0C and 800^0 C respectively have unlimited mutual liquid solubillities. The solid solubility of B in A is a maximum of 20% at the eutectic temperature of 500^0C, which reduces to 10% at 0^0C. The solid solubility of A in B is a maximum of 10% at the eutectic temperature which reduces to 5% at 0^0C. No solid state reactions other than those due to solubility changes occur in the series. The eutectic composition is 70% B. Assume solidus, liquidus & solvus lines to be straight.

   i) Draw the phase diagram of the series. (5 Marks)

   ii) Describe the mode of solidification, solid state reactions and room temperature microstructure of an alloy containing 40% B. (10 Marks)

Contd.... 2

5. (a) Draw a neat schematic iron-iron carbide equilibrium diagram. (5 Marks)

   (b) Describe using the above diagram the mode of solidifaction, solid state reactions and room temperature micro-structure of a very slowly cooled steel of carbon content 1.2%. (5 Marks)

   (c) State and explain Gibb's phase rule and its aplicability to metallic systems. (5 Marks)

   (d) Explain how equiaxed and columnar grains are formed during solidification, for example in an ingot mould. (5 Marks)

6. (a) Draw a schematic T.T.T diagram for a plain carbon eutectoid steel, label all regions and super impose on it the cooling curves for,
   i) Full annealing ii) Normalising iii) Austempering iv) Mastempering and v) Quench hardening and explain the structure and properties of the materials got out of the above five processes. (10 Marks)

   (b) Define hardenability. Explain with a neat sketch the Joming - end - quench test and discuss the effect of alloying elements on the hardenability of steels. (10 Marks)

PART - C

7. (a) Give the various classifications of Grey-cast iron. (2 Marks)

   (b) Give the typical composition and uses of hypo-eutectic grey - cast irons. (8 Marks)

   (c) Give the typical composition and ues of the following alloys:
   i) Yellow brass
   ii) Standard brass
   iii) Admiralty gun metal
   iv) Phosphor Bronze (10 Marks)

8. (a) What is a composite ? (2 Marks)

   (b) Classify composite materials. (3 Marks)

   (c) Why and how are composites superior to conventional materials. (5 Marks)

   (d) Explain fundamentals of production of FRP's. (10 Marks)

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M-3

P-8

NEW SCHEME

IP32A

USN

Third Semester B.E. Degree Examination, January/February 2005

Common to ME/IP/IM/MA/AU

Material Science & Metallurgy

Time: 3 hrs.] [Max.Marks : 100

Note: *Answer TWO questions from PART A, two from PART B and ONE question from PART C.*

PART A

1. (a) Define atomic packing factor (APF). Calculate APF for BCC system. (3 Marks)

   (b) Copper has an FCC structure and an atom radius of 0.1278 mm. Calculate its density. Given $At.wt.\ of\ Cu = 63.54$. Avogadro number = 0.602×10^{24} (5 Marks)

   (c) Draw a schematic stress strain curve for mild steel and explain the determination of various mechanical properties from the curve. (12 Marks)

2. (a) Define creep. Draw a typical creep curve and indicate the stages of creep. Which stage is of practical significance? Justify your answer. (8 Marks)

   (b) State and explain Fick's first law of diffusion. (6 Marks)

   (c) Calculate the diffusivity of copper in Aluminium at 1000^0C.
   Given : $D_0 = 1.5 \times 10^{-5}\ m^2/s\ Q = 126\ kJ\ mol^{-1}\ R = 8.314\ Jk^{-1}mol^{-1}$. (6 Marks)

3. (a) How is fatigue strength of materials determined? (8 Marks)

   (b) Explain the mechanism of fatigue crack growth in ductile materials. (8 Marks)

   (c) Differentiate between ductile and brittle fractures. (4 Marks)

PART B

4. (a) Draw $Fe - Fe_3C$ phase diagram and identify the phase fields. (10 Marks)

   (b) State Gibbs phase rule and explain each term. (6 Marks)

   (c) Calculate the amount of pro-eutectoid ferrite, eutectoid ferrite and cementite in 0.4% carbon steel at room temperature. (4 Marks)

5. (a) Explain the concept of critical radius for nucleation during solidification. (8 Marks)

   (b) What is a solid solution? With suitable examples explain the different types of solid solutions. (8 Marks)

   (c) A binary alloy of M and N contains 56% solid phase and 44% of liquid phase. The composition of solid phase and liquid phase are 28% N and 70% N respectively. What is the overall composition of the alloy? (4 Marks)

Contd.... 2

6. (a) Explain annealing and normalizing. (4 Marks)

(b) What is tempering ? Why is it done? (3 Marks)

(c) What is the purpose of surface hardening treatment? What type of steels can be surface hardened and how? (10 Marks)

(d) What is age-hardening? What are its requirement? (3 Marks)

PART C

7. (a) What is a composite material? What are its constituents and why are these present? How do you classify composites? What are the advantages and limitations? (12 Marks)

(b) Write a note on Al-Si alloys. (6 Marks)

8. (a) Distinguish between α and $(\alpha+\beta)$ brasses with respect to composition, properties and applications. (6 Marks)

(b) Give the composition, structure and uses of

i) S.G. Iron

ii) Malleable cast iron

iii) Grey cast iron (3×3 Marks)

(c) Write a note on FRPs. (5 Marks)

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NEW SCHEME

Third Semester B.E. Degree Examination, July 2006
ME / IP / IM / MA / AU
Materials Science and Metallurgy

Time: 3 hrs.] [Max. Marks:100

Note: 1. ***Answer any TWO questions from Part A and TWO questions from Part B and ONE question from Part C.***

PART A

1 a. The unit cell of Chromium is cubic and contains 2 atoms. Determine the dimension of the chromium unit cell. [Given: Atomic weight of C_v =52 and density of Cr =7.19 Mgm^{-3}] **(05 Marks)**

b. Define atomic packing factor (APF). Determine APF of *Al* for FCC unit cell. **(05 Marks)**

c. Discuss the role of dislocations in metallic materials. List the differences between edge and screw dislocations. **(10 Marks)**

2 a. Define 'ductile' and 'brittle' fracture with examples. **(05 Marks)**

b. Draw a schematic stress-strain curve for mild steel and explain the mechanical properties in terms of the curve. **(10 Marks)**

c. A copper rod of initial diameter 2 mm fractures at a load of 110 kg. Its ductility is 75 percent reduction in area. Calculate the true stress at fracture. **(05 Marks)**

3 a. Define 'Creep'. Draw a typical creep curve and indicate the stages of creep. Which stage is generally important and why? **(08 Marks)**

b. How is fatique strength of materials determined? **(06 Marks)**

c. There is 0.19 atom pet copper at the surface of some aluminium and 0.18 atom pet copper, 1.2 mm underneath the surface. What will be the flux of copper atoms be from the surface inward at 500°C? [Aluminium is FCC and a = 0.4049 nm. Diffusivity of *Cu* in *Al* = 4 x 10^{-14} m^2/s at 500°C] **(06 Marks)**

PART B

4 a. What is critical radius for nucleation in solidification? How is it affected by under cooling? **(05 Marks)**

b. Describe different types of solid solutions. **(05 Marks)**

c. Give a schematic phase diagram for Fe-Fe_3C system. Label phase fields and write down the various reactions involved in Fe-Fe_3C system. **(10 Marks)**

5 a. Describe the construction of phase diagrams by thermal analysis. **(08 Marks)**

b. Draw a binary eutectic phase diagram between two components which are partially soluble in each other in the solid state. Label all the phase fields. **(06 Marks)**

c. A binary alloy A-50%B contains at a particular temperature two solid phases α and β. The compositions α and β are 5% B and 95% B respectively. Calculate the amount of α and β in the alloy. **(06 Marks)**

Contd.....2

6 a. Explain the concept harden ability. **(05 Marks)**
b. Discuss "Carburizing" and "induction hardening". **(10 Marks)**
c. Write a note on *Al-Cu* alloys. **(05 Marks)**

PART C

7 a. What is a composite material? How is it classified? What are the essential ingredients of a composite material? What is the role of each of them? **(10 Marks)**
b. Compare MMCs with PMCs. **(05 Marks)**
c. Discuss the application of *Al-SiC* composites. **(05 Marks)**

8 a. Give the composition and uses of various types of cast irons. **(08 Marks)**
b. What are brasses and bronzes? Give an account of composition and application of α-brasses. **(08 Marks)**
c. What are the main types of synthetic fibres used in FRPs? **(04 Marks)**

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IP32A

USN | | | | | | | | | | |

NEW SCHEME

Third Semester B.E. Degree Examination, Dec. 06 / Jan. 07
ME / IP / IM / MA / AU
Material Science and Metallurgy

Time: 3 hrs.] [Max. Marks:100

Note : *Answer any TWO full questions from Part A, TWO full questions from Part B and ONE from Part C.*

Part - A

1 a. Draw the unit cells of BCC and FCC and establish their Atomic Packing Factor (APF) and Co-ordination Number (CN). **(06 Marks)**

b. What do you mean by imperfections in crystals? Explain briefly the different types of crystal imperfections. **(08 Marks)**

c. Distinguish clearly between edge dislocation and screw dislocation with neat sketch. **(06 Marks)**

2 a. State and explain Fick's 1st and 2nd laws of diffusion. Also explain the factors affecting diffusion co-efficient. **(08 Marks)**

b. Draw the stress versus strain diagram (schematic) of mild steel and describe how the following properties can be obtained from it.
   i) Modulus of elasticity
   ii) Yield strength
   iii) Ultimate Tensile Strength UTS **(08 Marks)**

c. Distinguish clearly between (any two) :
   i) Conventional stress and True stress
   ii) Conventional strain and True strain
   iii) Slip and Twinning in single crystals. **(04 Marks)**

3 a. Derive an expression for the Critical Resolved Shear Stress (CRSS) for slip. **(06 Marks)**

b. Define creep deformation. Explain the different stages of creep with a neat sketch. Also explain the characteristics of creep in these three stages. **(08 Marks)**

c. Explain briefly any two :
   i) Types of fatigue loading with examples
   ii) Brittle fracture and ductile fracture
   iii) Stress relaxation. **(06 Marks)**

Part - B

4 a. Derive an expression for the critical size of the nucleus for homogeneous nucleation and explain the process of grain growth. **(08 Marks)**

b. What is a solid solution? Explain with neat sketches the substitutional and the interstitial solid solutions. **(06 Marks)**

c. State and explain Hume Rothery rules that govern the formation of solid solutions. **(06 Marks)**

Contd.... 2

5 a. State the Gibb's phase rule and explain the various terms. **(04Marks)**

b. Melting points of Cu and Ag are 1083^0C and 961^0C respectively. They form an eutectic at 72% Ag at 780^0C. Maximum solid solubility of Ag in Cu is 8% at 780^0C, which decreases to 1.5% at room temperature. Maximum solid solubility of Cu in Ag is 9% at 780^0C which decreases to 1.0% at room temperature.

i) Draw phase diagram for Cu – Ag system. Identify all the phases and describe the solidification of 70% Cu and 30% Ag alloy.

ii) Find the temperature at which an alloy with 20% Cu starts and ends solidification.

iii) Percentage weight and composition of liquid and solid phase in 20% Ag and 80% Cu at 900^0C. **(10 Marks)**

c. Explain the different types of reactions in phase transformations. **(06 Marks)**

6 a. Draw Fe – Fe_3C (Iron-Iron carbide) phase diagram and mark on it all salient temperatures composition and phases on it. Elaborate the invariant reactions involved in it. **(12 Marks)**

b. What is TTT-diagram? How is it different from phase diagram? Describe the various transformed products of Austenite on cooling. **(08 Marks)**

Part - C

7 a. What are the salient features of cast iron? Discuss briefly the classification of cast iron based on their microstructure. **(06 Marks)**

b. Distinguish clearly between plain carbon steels and alloy steels. **(06 Marks)**

c. Discuss the following with reference to their composition, properties and applications :

i) Structural steels

ii) Tool and Die steels

iii) Al – Cu and Al – Si alloys

iv) Brasses and Bronzes **(08 Marks)**

8 a. From fundamentals, distinguish clearly between alloys and composite materials. **(06 Marks)**

b. Discuss briefly advantages and applications of :

i) Metal Matrix Composites (MMCs)

ii) Fibre Reinforced Plastics (FRPs) **(06 Marks)**

c. Explain briefly on the different methods of production of metal matrix composite materials. **(08 Marks)**

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06ME32A

Third Semester B.E. Degree Examination, Dec. 07 / Jan. 08
Material Science and Metallurgy

Time: 3 hrs. Max. Marks:100

Note : ***Answer any FIVE full questions.***

1 a. Sketch the unit cell of a HCP crystal structure and calculate the number of atoms per unit cell and derive an expression for the density of atomic packing. **(10 Marks)**

b. List the mechanisms of diffusion in solids and explain with sketches any two of them. **(10 Marks)**

2 a. A copper rod of initial diameter 2 mm fractures at a load of 110 kg. Its ductility is 75% reduction in area. Calculate the true stress at fracture. **(06 Marks)**

b. Differentiate between slip and twinning deformations in materials. **(06 Marks)**

c. Define hardness and explain in detail the Brinell hardness testing. **(08 Marks)**

3 a. Explain with sketch the ductile to brittle transition in materials. **(05 Marks)**

b. Explain with sketch the different stages of creep deformation. **(10 Marks)**

c. Explain the process of stress relaxation. **(05 Marks)**

4 a. What is a 'Solid solution'? List the Hume Rothery rules for the formation of substitutional solid solution. **(06 Marks)**

b. Give typical examples for eutectic and eutectoid reactions mentioning for each the temperature and composition at which it occurs. **(04 Marks)**

c. Two metals A and B have their melting points at 900^0 C and 800^0 C respectively. The alloy pair forms a eutectic at 600^0 C of composition 60% B. They have unlimited liquid solubilities. The Solid solubility of A in B is 10% and that of B in A is 5% at eutectic temperature and remains constant till 0^0 C. Draw and label all the fields. Find the liquid and solid phase percentages in an alloy of 20% B at 650^0 C. **(10 Marks)**

5 a. Draw a neat sketch of iron-carbon equilibrium diagram and show all the phase fields, temperature, compositions on it. Explain the solidification mode of a hyper eutectoid steel of 3% C as it cools from liquid phase **(10 Marks)**

b. Explain the steps to construct TTT diagram. Draw a labeled sketch of a TTT diagram for an eutectoid steel. **(10 Marks)**

6 a. Define the process of heat treatment and classify the various heat treatment processes. **(10 Marks)**

b. Explain Normalizing heat treatment process with a sketch. **(05 Marks)**

c. Define hardenability of a material and list the factors affecting hardenability in steels. **(05 Marks)**

7 a. Classify the different types of steels and explain the effect of alloying elements on steel. **(10 Marks)**

b. Explain modification of Al–Si alloy. **(05 Marks)**

c. List the alloying elements and applications of Magnesium based alloys. **(05 Marks)**

8 a. Explain the general methods of corrosion prevention. **(10 Marks)**

b. Write short notes on any two :
   i) Intergranular corrosion
   ii) Stress corrosion cracking
   iii) Cavitation damage. **(10 Marks)**

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06ME32A

Third Semester B.E. Degree Examination, Dec.08/Jan.09
Material Science and Metallurgy

Time: 3 hrs. Max. Marks:100

Note: ***Answer any FIVE full questions, selecting at least TWO questions from each part.***

PART – A

1 a. Define space lattice. Find out basic atoms and packing factors or packing densities for B.C.C. and F.C.C. Draw concerned figures. **(08 Marks)**

b. Explain crystal imperfections with figures. **(08 Marks)**

c. State Fick's laws of diffusion. **(04 Marks)**

2 a. Define Engg. Stress and strain and true stress and strain. Find out the relationship between True stress and Engg. Stress. **(08 Marks)**

b. Define hardness. Draw the figure of Brinell Hardness Testing machine and label the parts. **(05 Marks)**

c. Explain Slip and Twinning with figures. **(07 Marks)**

3 a. Explain types of fractures with figures. **(06 Marks)**

b. Explain creep curve. **(08 Marks)**

c. Explain factors affecting fatigue life. **(06 Marks)**

4 a. Define solid solutions and explain different types of solid solutions with figures. **(08 Marks)**

b. State Gibb's Phase rule and define the terms used. Discuss its importance. **(06 Marks)**

c. Explain the construction of phase diagram with figure. **(06 Marks)**

PART – B

5 a. Draw Fe-C equilibrium diagram and label it. Show the invariant points on it. Write the reactions occurring at these points indicating the temperature and composition of each phase. **(08 Marks)**

b. Explain the construction of TTT diagram with figure and label it. **(08 Marks)**

c. Define Martensite, Cementite, Austenite and Ferrite. **(04 Marks)**

6 a. Define Hardenability. Explain Jominy end quench tests with related figures. **(10 Marks)**

b. Explain Austempering and Martempering with figures. **(10 Marks)**

7 a. Explain different types of cast irons with microstructures. **(08 Marks)**

b. Write short note on Al-alloy. **(04 Marks)**

c. Define Brasses. Explain season cracking of brass and how to eliminate it. **(04 Marks)**

d. Define Bronze. Explain Tin bronze's antifriction properties. **(04 Marks)**

8 a. Write a note on passivation. **(06 Marks)**

b. Explain the alloying method for corrosion protection. **(07 Marks)**

c. Explain cathodic protection with figures. **(07 Marks)**

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06ME32A

Third Semester B.E. Degree Examination, June-July 2009
Material Science & Metallurgy

Time: 3 hrs. Max. Marks:100

Note: ***Answer any FIVE full questions, selecting at least TWO questions from each part.***

PART – A

1 a. What is a crystal imperfection? Give the list of crystal imperfections. **(06 Marks)**

b. Define atomic packing factor. Calculate the atomic packing factor for FCC. **(06 Marks)**

c. Copper has FCC structure and an atomic radius of 1.278 $\mathring{A}$. Calculate its density. Given mol. wt. = 63.54 g/mol. **(08 Marks)**

2 a. Define i) Resilliance ii) Tensile strength iii) Hardness iv) Ductility **(08 Marks)**

b. With the help of stress-strain curves show for the Engg stress-strain and True stress-strain. Explain briefly. **(06 Marks)**

c. Explain the Brinell hardness & Rockwell Hardness with sketches & equations. **(06 Marks)**

3 a. With the help of neat sketches explain the different stages of ductile cup & cone fracture. **(06 Marks)**

b. What is fatigue? What are the factors affecting the fatigue life? **(08 Marks)**

c. What is Griffith's theory of brittle fracture? Explain and give the equation for critical stress for crack propagation. **(06 Marks)**

4 a. What are Hume-Rothery's rules? **(05 Marks)**

b. Explain two types of phase diagrams & their interpretation. **(10 Marks)**

c. Differentiate between substitutional and interstitial solid solutions. **(05 Marks)**

PART – B

5 a. Draw neatly Iron-Carbon diagram and label all the parts. **(08 Marks)**

b. With the help of above diagram, explain cooling of steel with 0.6% carbon showing the microstructure at different stages. **(08 Marks)**

c. Draw TTT diagram for plain carbon eutectoid steels. Label the details. **(04 Marks)**

6 a. Define Hardenability. Explain with neat sketches how you find it by Jomeny-end Quench test. **(08 Marks)**

b. Explain any two types of case hardening, with sketches. **(06 Marks)**

c. Distinguish between Normalising and Annealing. **(06 Marks)**

7 a. Give the composition and uses of various cast-irons. **(06 Marks)**

b. Give the list of various copper alloys. Write a short note on copper alloys. **(08 Marks)**

c. What are the various effects of alloying elements on steels? **(06 Marks)**

8 a. What is corrosion? Explain any four methods of preventing corrosion. **(10 Marks)**

b. Write short notes on any TWO:
   i) Single metal galvanic cell corrosion.
   ii) Corrosion mechanism.
   iii) Passivation. **(10 Marks)**

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06ME32A

Third Semester B.E. Degree Examination, Dec.09/Jan.10
Materials Science and Metallurgy

Time: 3 hrs. Max. Marks:100

Note: ***Answer any FIVE full questions, selecting atleast TWO questions from each part..***

PART-A

1 a. Sketch any three types of Bravais lattices. **(06 Marks)**

b. Determine the relationship between atomic radius and lattice parameters in cubic systems [simple cubic, BCC and FCC]. **(06 Marks)**

c. Illustrate the steady-state diffusion. **(08 Marks)**

2 a. From the tensile stress-strain behaviour for the brass specimen shown in Fig. Q2(a), determine the following :

i) The modulus of elasticity

ii) The yield strength at a strain offset of 0.002.

iii) The maximum load that can be sustained by a cylindrical specimen having an original diameter of 12.7 mm.

iv) The change in length of specimen originally 250 mm long which is subjected to a tensile stress of 350 MPa. **(12 Marks)**

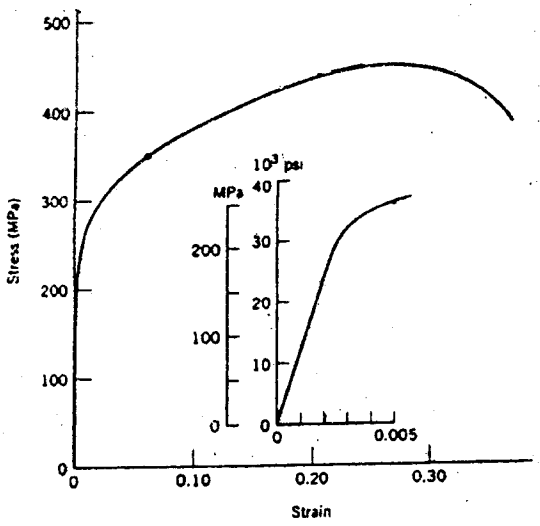

Fig. Q2(a)

b. When a 3000 kg load is applied to a 10 mm diameter ball in a Brinell test of a steel, an indentation of 3.1 mm is produced. Estimate the tensile strength of the steel. **(04 Marks)**

c. A piece of copper originally 300 mm long is pulled in tension with a stress of 270 MPa. If the deformation is entirely elastic, what will be the resultant elongation? ($E = 100 \times 10^3$ MPa) **(04 Marks)**

3 a. Illustrate the stages in the cup and cone facture **(08 Marks)**

b. What is fatigue? Draw the SN curves for i) a material that displays a fatigue limit ii) a material that does not display a fatigue limit. **(08 Marks)**

c. Explain how fatigue life can be enhanced. **(04 Marks)**

4 a. Explain unlimited suitability and limited solubility with examples (08 Marks)

b. A cooling curve is shown in Fig. Q4(b). Determine the following :

i) The pouring temperature
ii) The solidification temperature
iii) The superheat
iv) The cooling rate, just before solidification beings
v) The total solidification time
vi) The local solidification time.

(06 Marks)

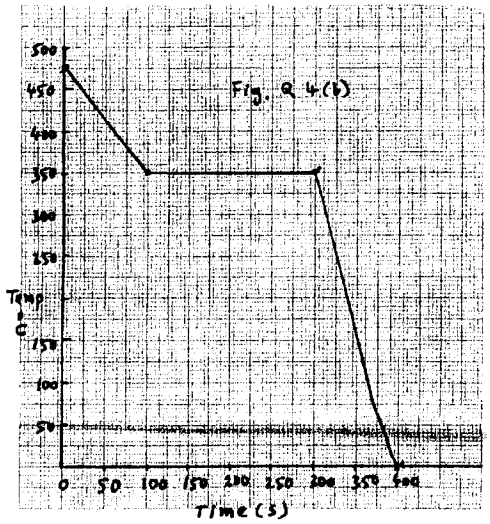

Fig. Q4(b)

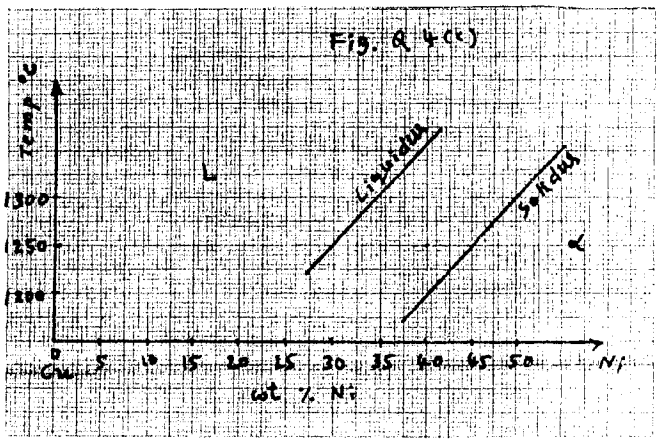

Fig. Q4(c)

c. Calculate the amounts of α and L at 1250°C and 1175°C in the Cu-40% Ni alloy shown in Fig. Q4(c). (06 Marks)

PART-B

5 a. Write the three invariant reactions in the Fe-Fe_3C phase diagram. (06 Marks)

b. What is a plain carbon steel? Discuss the transformation of eutectoid steel (0.8% C) with slow cooling. (08 Marks)

c. Illustrate the effects alloying elements on the eutectoid temperature of steels. (06 Marks)

6 a. Illustrate the variation in the microstructure of eutectoid plain-carbon steel by continuously cooling at different rates. (12 Marks)

b. Schematically illustrate the customary quenching and tempering process for a plan-carbon steel. (08 Marks)

7 a. Discuss AISI-SAE designation of steels, with examples. (05 Marks)

b. Show schematically, the microstructures of the following cast irons : gray iron, white iron, malleable iron, ductile iron and compacted graphite iron. (15 Marks)

8 a. What is corrosion? Discuss grain-grain boundary galvanic cells. (08 Marks)

b. Explain 'Two metal corrosion'. (06 Marks)

c. Explain how underground pipelines are protected using a magnesium anode. (06 Marks)

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06ME32A

Third Semester B.E. Degree Examination, May/June 2010
Materials Science and Metallurgy

Time: 3 hrs. Max. Marks:100

Note: ***Answer any FIVE full questions, selecting at least TWO questions from each part.***

PART – A

1 a. Calculate the atomic packing factor of a FCC crystal lattice. **(04 Marks)**

b. Iron has an atomic radius of 0.124 nm, BCC crystal structure and an atomic weight of 55.85 g/mol. Calculate its density. **(04 Marks)**

c. Differentiate between edge and screw dislocations, with sketches. **(08 Marks)**

d. State and explain Fick's first law of diffusion. **(04 Marks)**

2 a. Draw the stress-strain curve for the following materials :
i) Mild steel ii) Copper iii) Cast iron **(03 Marks)**

b. A cylindrical specimen of medium carbon steel, having an original diameter of 20 mm, when subjected to a tension test has a fracture strength of 450 MPa. If its final diameter at fracture is 12 mm, calculate the engineering stress, engineering strain and true stress. **(06 Marks)**

c. Differentiate between slip and twinning. **(06 Marks)**

d. Derive an expression for critical resolved shear stress for slip, with a sketch. **(05 Marks)**

3 a. Explain with a sketch, how a fatigue test is carried out. **(07 Marks)**

b. Differentiate between ductile and brittle fractures, with sketches. **(07 Marks)**

c. Discuss any two mechanisms for creep. **(06 Marks)**

4 a. Distinguish between substitutional and interstitial solid solutions. **(04 Marks)**

b. Differentiate between eutectic and peritectoid transformations, with sketches. **(06 Marks)**

c. Two metals A and B having melting points of 800°C and 1100°C respectively, form an eutectic alloy at 500°C, with an eutectic composition of 65% B and 35% A. They have unlimited liquid solubilities. The solid solubilities of B in A are 12% at 500°C and 6% at room temperature. The solid solubilities of A in B are 10% at 500°C and 5% at room temperature. Draw the complete phase diagram and label all the fields. Determine the number, type, composition and relative amounts of phases present, at room temperature, for an alloy of 30% B and 70% A. **(10 Marks)**

PART – B

5 a. Explain the solidification process of hypereutectoid steel with 1.2% C, when it is cooled from a temperature of 950°C to 600°C. Draw the microstructures and the cooling curve. **(08 Marks)**

b. Determine the percentages of pro-eutectoid ferrite, eutectoid ferrite and eutectoid cementite for 0.6% C hypoeutectoid steel at 720°C. **(06 Marks)**

c. Draw a neat TTT diagram for eutectoid steel and indicate all the phases. **(06 Marks)**

6 a. Differentiate between normalizing and annealing, with a sketch. **(06 Marks)**

b. Discuss the precipitation hardening of Al – 4 wt% Cu alloy. **(08 Marks)**

c. Explain induction hardening, with a sketch. **(06 Marks)**

7 a. Compare grey cast iron with S.G. iron, with respect to their structure, composition, properties and applications. (08 Marks)

b. Explain the composition, properties and applications of :
i) Al – Si alloys ii) Cu – Zn alloys (08 Marks)

c. Define hardenability and hardness. (04 Marks)

8 a. Write short notes on : i) Crevice corrosion ii) Stress corrosion (10 Marks)

b. Explain with a neat sketch, a galvanic cell. (10 Marks)

c. Compute the voltage at 25°C of an electrochemical cell consisting of pure Cd immersed in a 2×10^{-3} M solution of Cd^{2+} ions and pure Fe in a 0.4 M solution of Fe^{2+} ions. Also write the spontaneous reaction. The half-cell potentials for Cd and Fe are -0.403 and -0.440 respectively.

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