(c) Monel metal is an alloy of —— and ——.

(d) Cermets are

(i) metals for high temperature use with ceramic like properties

(ii) ceramics with metallic strength and lustre

(iii) coated tool materials

(iv) metal-ceramic composites

(e) Nanocomposite materials are highly preferable in design considerations for their

(i) vibration resistance

(ii) high resistance to crack propagation

(iii) impact resistance

(iv) high resilience

(f) The steel products which are required to be shock resistant should have

(i) high toughness

(ii) low hardness

(iii) high yield stress

(iv) low percentage of carbon

Code : 021305

2012

MATERIAL SCIENCE

Time : 3 hours *Full Marks* : 70

Instructions :

(i) *The marks are indicated in the right-hand margin.*

(ii) *There are* ***NINE*** *questions in this paper.*

(iii) *Attempt* ***FIVE*** *questions in all.*

(iv) *Question No.* ***1*** *is compulsory.*

1. Answer any *seven* sub-questions (Select correct answer/Fill in the blanks) : 2×7=14

(a) The cupola is used to make

(i) pig iron

(ii) steel

(iii) wrought iron

(iv) cast iron

(b) Iron has the unique characteristic of being

(i) paramagnetic

(ii) dielectric

(iii) ferromagnetic

(iv) ferroelectric

9. Write short notes on the following : 14

(a) Whiskers

(b) Glass fibre-reinforced polymer composite

(c) Tempered martensite

(d) Hume-Rothery rule

★ ★ ★

(g) Which of the following structures has maximum hardness?

(i) Cementite

(ii) Austenite

(iii) Pearlite

(iv) Martensite

(h) An iron-carbon binary alloy has 0·5% carbon by weight. What is this alloy called?

(i) Eutectoid

(ii) Eutectic

(iii) Hypoeutectoid

(iv) Hypereutectoid

(i) As per Gibbs' phase rule, if the number of components is equal to 2, then the number of phases will be

(i) ≤ 5

(ii) ≤ 4

(iii) ≤ 3

(iv) ≤ 2

(j) Tempering temperature of most of the materials is of the order of

(i) 100 °C to 150 °C

(ii) 200 °C to 300 °C

(iii) 350 °C to 400 °C

(iv) 400 °C to 500 °C

Code : 021305

B.Tech. 3rd/Semester Exam., 2013

MATERIAL SCIENCE

Time : 3 hours *Full Marks* : 70

Instructions :

(i) The marks are indicated in the right-hand margin.

*(ii) There are **NINE** questions in this paper.*

*(iii) Attempt **FIVE** questions in all.*

*(iv) Question No. **1** is compulsory.*

1. Choose the correct answer (any *seven*) : 2×7=14

(a) Which is closest to the purest form of iron?

(i) Cast iron

(ii) Wrought iron

(iii) Grey iron

(iv) Mild steel

(b) The process of isothermal transformation to form bainite in steel, is known as

(i) austempering

(ii) austeniting

(iii) barkerising

(iv) polymerization

(c) Which of the following is not a permanent magnetic material?

(i) Chromium steel

(ii) Silicon iron

(iii) Cobalt steel

(iv) Alnico

(d) Which one of the following materials is viscoelastic in nature?

(i) Nylon

(ii) Glass

(iii) Rubber

(iv) Graphite

(e) If the structure of a sample consists of pearlite, cementite and free carbon, the sample may be

(i) cast iron

(ii) alloy steel

(iii) dead mild steel

(iv) eutectoid steel

(f) Pearlite is obtained when steel is

(i) quenched in oil

(ii) cooled in still air

(iii) slowly cooled in furnace

(iv) quenched in water

(g) A material having different properties in different directions, is known as

(i) isotropic

(ii) amorphous

(iii) austenitic

(iv) anisotropic

(h) Temperating of hardened steel is done to increase its

(i) ductility

(ii) grain size

(iii) surface condition

(iv) carbon content

(i) The fatigue strength of materials increases

(i) with temperature

(ii) by providing scratches on the surface

(iii) by providing notches

(iv) by under-stressing the material

(j) The capacity of a metal to exhibit considerable elastic recovery upon release, is known as

(i) toughness

(ii) resilience

(iii) hardness

(iv) stiffness

2. (a) Give the classification of ceramic materials, organic materials, electrical materials and magnetic materials with their properties and applications. 8

(b) Write short notes on : 6

(i) Nanomaterials

(ii) Biomaterials

(iii) Optical fibre

3. (a) What is a 'phase diagram'? How is it classified? What useful information does it provide? 6

(b) State Gibbs' phase rule. What is the minimum and maximum number of phases which could exist in a pure metal? 4

(c) Discuss the Hume-Rothery rules for alloy formation. 4

4. Draw the iron-carbon phase diagram and discuss briefly the structure and properties of steel having 0·83% and 0·40% carbon when cooled from 1000 °C to room temperature. 14

5. (a) Draw a TTT diagram of eutectoid steel. Discuss all the transformation with the rate of cooling. 8

(b) Why continuous cooling of plain carbon steel does not show bainite in its microstructure? 6

6. (a) What effect does a change in heating or cooling rate have upon the transformation temperature in steel? 6

(b) Calculate the thickness of micro-constituents present in pearlite if density of ferrite and cementite is 7·76 gm/cc and 7·66 gm/cc respectively. 4

(c) A steel contains 40% ferrite and 60% pearlite at room temperature. Determine the amount of total ferrite and cementite present in the alloy. 4

7. (a) What are the various types of annealing? Where are they used? 6

(b) What is the major difference in the purpose of annealing and normalizing? 4

(c) "Hardening of steel is always followed by tempering." Is it true or false? If true, give reasons. 4

8. (a) What are the different types of composite materials available? Give their suitable examples with applications. 6

(b) What are the most important rules for designing composite parts? 4

(c) Write the applications of cemented carbide composite. 4

9. Distinguish the following : 14

(a) Plain carbon steel and Alloy steel

(b) White cast iron and Malleable cast iron

(c) Grey cast iron and Spheroidal grey iron

(d) Euterics and Eutectoids

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Code : 021305

B.Tech 3rd Semester Exam., 2015

MATERIAL SCIENCE

Time : 3 hours *Full Marks* : 70

Instructions :

(i) The marks are indicated in the right-hand margin.

*(ii) There are **NINE** questions in this paper.*

*(iii) Attempt **FIVE** questions in all.*

*(iv) Question No. **1** is compulsory.*

1. Choose the correct answer (any *seven*) : 2×7=14

(a) Which of the following materials is the hardest?

(i) Alumina

(ii) High-carbon steel

(iii) Cast iron

(iv) Diamond

(b) The phase boundary between α and (α + β) regions is called

(i) liquidus

(ii) solidus

(iii) solvus

(iv) eutectic

(c) The interstitial solid solution of carbon in γ-iron is called

(i) cementite

(ii) ferrite

(iii) austentite

(iv) pearlite

(d) For a spherical particle of radius *r*, the volume to surface area ratio is

(i) $\frac{3}{r}$

(ii) $\frac{r}{3}$

(iii) $3r$

(iv) $\frac{\pi r}{3}$

(e) Which of the following refers to eutectoid reaction?

(i) $L \rightarrow \alpha + \beta$

(ii) $\alpha \rightarrow \beta + \gamma$

(iii) $\alpha + L \rightarrow \beta$

(iv) $\alpha + \beta \rightarrow \gamma$

(f) If one solid phase splits into two solid phases on heating, the reaction is

(i) eutectoid

(ii) peritectoid

(iii) eutectic

(iv) peritectic

(g) Cast iron normally contains
  (i) 1 to 1·5% C
  (ii) 2 to 4% C
  (iii) less than 1% C
  (iv) None of the above

(h) Piezo-electric materials produce electric field when subjected to
  (i) magnetic field
  (ii) optical rays
  (iii) thermal radiation
  (iv) mechanical force

(i) Examples of ferrous metals are
  (i) copper, brass, nickel
  (ii) aluminium, titanium, zinc
  (iii) cast iron, steel, alloy steel
  (iv) alumina, zirconia, silica

(j) In a single-component system, the maximum no. of phases that can co-exist in equilibrium, is
  (i) 2
  (ii) 3
  (iii) 4
  (iv) 5

2. (a) State and explain the equation for Gibbs phase rule. 7

(b) Derive the lever rule for the amount in wt. percent of each phase in two phase regions of a binary phase diagram. 7

3. (a) What is a hybrid composite? 4

(b) Write the important advantages of hybrid composites over normal fiber composites. 4

(c) Find an expression for the modulus of elasticity for a hybrid composite in which all fibers of both types are oriented in the same direction. 6

4. (a) Explain with reason why glass fiber reinforced composites are utilized extensively. 7

(b) Explain the limitations of glass fiber reinforced composites. 7

5. Compare gray and malleable cast iron with respect to—
  (a) composition and heat treatment;
  (b) microstructure;
  (c) mechanical characteristics. 6+4+4

6. (a) What is the distinction between cement and concrete? 4

(b) Write some important limitations that restrict the use of concrete as a structural material. 4

(c) Explain the techniques that are utilized to strengthen concrete by reinforcement. 6

7. (a) Classify different types of materials with their properties and application. 8

(b) Write short notes on the following : 6

(i) Biomaterial

(ii) Optical fiber

(iii) Nanomaterials

8. (a) Draw the lead-tin phase diagram. 4

(b) What are the compositions of phases? 4

(c) Calculate the relative amount of each phase present in terms of mass fraction. 6

9. Write notes on the following : 14

(a) Bainite

(b) White cast iron

(c) Martensite

(d) Hume-Rothery Rules

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Code : 021305

B.Tech 3rd Semester Exam., 2017

MATERIAL SCIENCE

Time : 3 hours *Full Marks* : 70

Instructions :

(i) The marks are indicated in the right-hand margin.

*(ii) There are **NINE** questions in this paper.*

*(iii) Attempt **FIVE** questions in all.*

*(iv) Question No. **1** is compulsory.*

1. Choose the correct answer (any *seven*) : 2×7=14

(a) Which of the following is strong and ductile materials?

(i) Polymers

(ii) Ceramics

(iii) Metals

(iv) Semiconductors

(b) Which of the following statements is false?

(i) Line defects are thermodynamically stable

(ii) Dislocation can end inside a crystal without forming loop

(iii) ABC ABC ABC ... is stacking sequence for HCP crystal

(iv) All of the above

(Turn Over)

(c) Time-dependent permanent deformation is called

(i) plastic deformation

(ii) elastic deformation

(iii) creep

(iv) Anelastic deformation

(d) The most influencing factor of diffusivity is

(i) diffusing species

(ii) temperature

(iii) lattice structure

(iv) presence of defects

(e) Which of the following is not a Hume-Ruthery condition?

(i) Crystal structure of each element of solid solution must be the same

(ii) Size of atoms of each two elements must not differ by more than 15%

(iii) Elements should form compounds with each other

(iv) Elements should have the same valence

(f) Phase formed of diffusionless reaction is

(i) pearlite

(ii) lower bainite

(iii) upper bainite

(iv) martensite

(g) Eutectoid product in Fe-C system is called

(i) pearlite

(ii) bainite

(iii) ledeburite

(iv) spheroidite

(h) Failure due to excessive deformation is controlled by

(i) material properties

(ii) design and dimensions

(iii) Both (i) and (ii)

(iv) None of the above

(i) Most often machine components are failed by

(i) buckling

(ii) creep

(iii) fatigue

(iv) All of the above

(Turn Over)

(j) Last constituent to fail in fiber reinforced composites is

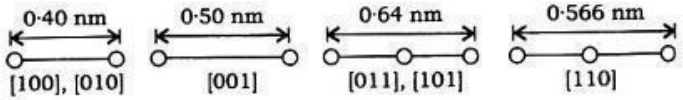
(i) matrix

(ii) fiber

(iii) Both fails at same time

(iv) Can't define

2. (a) The accompanying figure shows the atomic packing schemes for several different crystallographic directions for a hypothetical metal. For each direction, the circles represent only the atoms contained within a unit cell, the circles are reduced from their actual size. Draw the unit cell and identify the crystal structure : 7



(b) Show that a line of dislocation contains edge, screw or mixed dislocations. 7

3. (a) For aluminium (atomic radius 0·1431 nm), compute the inter-planer spacing for (110) set of planes. 7

(b) Calculate the atomic packing fraction for diamond cubic crystal and find its density (atomic radius $r = 0 \cdot 77$ Å). 7

(Continued)

4. Construct and label different regions of Ag-Cu phase diagram using the following data :

Melting point of Ag = 960 °C

Melting point of Cu = 1085 °C

At eutectic point = 780 °C, eutectic composition = 28 wt% Cu, maximum solubility of Ag in Cu = 8 wt%, maximum solubility of Cu in Ag = 6 wt%

At room temperature, maximum solubility of Ag in Cu = 3 wt% and maximum solubility of Cu in Ag = 2 wt%

Assume the liquids, solidus and solvus line are straight. Calculate the amount of proeutectic phase in 60 wt% Cu alloy at 779 °C and draw the change in micro-structures when cooled slowly from liquid state to room temperature. 6+2+6=14

5. Construct isothermal transformation diagram for eutectoid steel, determine and draw the final microstructure of a small specimen that has been subjected to the following time-temperature treatment. In each case, assume that the specimen begins at 800 °C, and that it has been held

at this temperature long enough to have achieved a complete and homogeneous austenite structure : 6+(2×4)=14

(a) Rapidly cool to 250 °C, hold for 10^5 s, then quench to room temperature

(b) Rapidly cool to 400 °C, hold for 10 s, then quench to room temperature

(c) Rapidly cool to 700 °C, hold for 10^5 s, then quench to room temperature

(d) Rapidly cool to 650 °C, hold at this temperature for 6 s, rapidly cool to 400 °C, hold for 10 s, then quench to room temperature

6. For a polymer-matrix fiber-reinforced composite—

(a) list three functions of the matrix phase; 6

(b) compare the desired mechanical characteristics of matrix and fiber phases; 4

(c) cite two reasons why there must be a strong bond between fiber and matrix at their interface. 4

7. A continuous and aligned glass fiber-reinforced composite consists of 30 vol% of glass fibers having a modulus of elasticity of 69 GPa and 70 vol% of a polyester resin that, when hardened, displays a modulus of 3·4 GPa.

(a) Compute the modulus of elasticity of this composite in the longitudinal direction. 2

(b) If the cross-sectional area is 250 mm^2 and a stress of 40 MPa is applied in this longitudinal direction, compute the magnitude of the load carried by each of the fiber and matrix phases. 6

(c) Determine the strain that is sustained by each phase when the stress in part *(b)* is applied. 6

8. (a) What is cast iron? How does it differ from pig iron? 5

(b) Compare ductile (nodular) cast iron with other cast iron on the basis of mechanical properties, composition and microstructure. 9

(Turn Over)

9. Write short notes on the following : 14

(a) Composite and alloys

(b) Annealing and normalizing

(c) Cross-slip and jog

(d) Frank-Read source

★★★