Name : .....

Roll No. : .....

Invigilator's Signature : .....

CS/B.TECH (CT)/SEM-7/CT-701/2011-12

2011

PHYSICAL CERAMICS

Time Allotted : 3 Hours *Full Marks* : 70

The figures in the margin indicate full marks.

Candidates are required to give their answers in their own words as far as practicable.

GROUP – A
(Multiple Choice Type Questions)

1. Choose the correct alternatives for the following : 10 × 1 = 10

i) Atomic packing factor is

a) distance between adjacent atoms

b) projected area fraction of atoms on a plane

c) volume fraction of atom in cell

d) none of these.

ii) Schottky-defect in ceramic material is

a) interstitial impurity

b) cation-anion vacancy pair

c) vacancy-interstitial pair of cations

d) substitutional impurity.

iii) The unit for diffusion D, is

a) $m^2 \ \sec^1$ b) $m^2 \ \sec^{-1}$

c) $m^{-2} \ \sec^{-1}$ d) $m^{-2} \ \sec^1$.

iv) For Band Structure calculation in solids, which mathematical function is used ?

a) Kronig-Penney function

b) Block function

c) Fermi-Dirac function

d) Motto Transaction function.

v) In E (k) vs k curve, at the edge of the First Brillouin Zone the electrons are

a) reflected

b) scattered by the atoms

c) propagated inside the crystal

d) none of these.

vi) Last constituent to fail in fibre reinforced composites is

a) matrix

b) fibre

c) both fail at the same time

d) Can not be specifically determined.

vii) In solid state sintering, densification takes place through

a) surface diffusion

b) evaporation-condensation

c) volume diffusion

d) none of these.

viii) When Mg^{2+} ions go into solid solution in Al_2O_3 crystal structure, the lattice undergoes.

a) Expansion

b) Contraction

c) Lattice remains as it was

d) none of these.

ix) Example of antiferromagnetic material is

a) salts of transition elements

b) rare earth elements

c) transition metals

d) ferrites.

x) Example of diamagnetic materials is

a) Alkali metals b) Transition metals

c) Rare earth elements d) Superconductors.

GROUP – B

(Short Answer Type Questions)

Answer any *three* of the following. 3 × 5 = 15

2. Briefly discuss mass transport mechanism during liquid state sintering.

3. Discuss briefly why value of driving force is more in reaction sintering than that in solid state sintering.

4. Discuss 'Femi energy' and 'density of states' of electron.

5. Discuss with sketches dielectric polarization mechanisms.

6. Discuss the effect of temperature on intrinsic and extrinsic semiconductors.

7. Write on charge density in extrinsic semiconductors.

GROUP – C

(Long Answer Type Questions)

Answer any *three* of the following. 3 × 15 = 45

8. Why sintering is called thermally activated process ? What type of mass transport mechanism is operative during solid state sintering ? Discuss in brief any one of which are operative in ceramic materials. Discuss the role of sintering aids in alumina sintering. 3 + 3 + 5 + 4

9. a) State the types of energies that determine the structure of ferromagnetic domains. Which two energies determine the domain wall width ? Schematically show the relationship among them indicating equilibrium wall width. 2 + 2 + 3

b) Write some specific applications of solft ferrites and hard ferrites with examples of them. 3

c) i) Calculate the numerical value for Bohr Magnetron μ_B in $A.m^2$.

ii) Calculate the theoretical saturation magnetization M in amperes per metre and the saturation induction B_S in teslas for the ferrite $FeO.Fe_2O_3$. Neglect the $\mu_0 H$ term for the B_S calculation. The lattice constant of $FeO.Fe_2O_3$ unit cell is 0·839 nm.

(Given, $\mu_0 = 4\pi \infty 10^{-7}$ T.m/A) 5

10. a) Assuming one-*D* periodic potential field, discuss the solution to Schrö dinger's wave equation using 'Bloch function' and 'Kronig-Penney' model with necessary sketches and show how energy bands result from it with forbidden regions. 8

b) What are Brillouin zones ? State the condition for Bragg reflection from *a* two *D* square lattice with a sketch. 4

c) Calculate the energy of a free electron in the energy level immediately above/after the lowest energy level confined in a cubical box of side 0·1 nm.

(Given : $h = 6{\cdot}62 \infty 10^{-34}$ Js

$m = 9{\cdot}1 \infty 10^{-31}$ kg

$l = 0{\cdot}1 \infty 10^{-9}$ m) 3

11. a) What causes the electrical resistivity of a metal to increase as its temperature increases ? Schematically show the variation of electrical resistivity of a metal with absolute temperature. 2 + 2

b) Establish a quantitative expression for conductivity of a semiconductor defining all relevant terms used in it. 6

c) i) For intrinsic silicon, the *n* temp. electrical conductivity is $4 \infty 10^{-4} (\Omega . m)^{-1}$; the electron and hole mobilities are respectively 0·14 and 0·048 m^2/V.s. Compute the electron and hole concentration at room temperature.

ii) Phosphorus is added to the above high purity silicon to give a concentration of 10^{23} m^{-3} of charge carriers at room temperature. Is the material *n*-type or *p*-type and why ? Calculate the room temperature conductivity of this material assuming that electron and hole mobilities are the same as for the intrinsic material. 5

12. a) State the main factors contributing to opacity of a two-phase system. 3

b) Discuss important characteristics of materials used in optical engineering applications and state how to achieve them in practice. 3

c) Define dispersion of Hight. Show the typical dispersion curve of an optical material. What is known as 'Abbe number' ? 4

d) Discuss with a sketch the stress-optical effect in glass. 5

13. Write short explanatory notes on any *three* of the following :

3×5

i) Boundary reflectance and surface gloss

ii) Translucency of porcelain

iii) Direct and super-exchange interaction

iv) Fick's first and second laws of diffusion

v) Paramagnetism and Pauli paramagnetism

vi) Intrinsic and extrinsic semiconductors.