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SEAT No._____ No. of Printed Pages : 02

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SARDAR PATEL UNIVERSITY

M. Sc. (Physics) (IVth Semester) Examination

Day: Thursday, Date: 02/11/2017, Time: 10:00 a.m. to 01:00 p.m.

Course No. PS04CPHY01 (Nuclear and Particle Physics)

CBCS (choice based credit system)

Important Note: Signs have their usual meaning.

Q.1: Eight multiple choice questions (MCQ) carry one mark each.

Q.2: Short answer questions carrying two marks each (attempt any seven out of nine).

Q.3 to Q.6: Long answer questions carrying 12 marks each.

Total Marks: 70

Q1 (i) The total angular momentum of the ground state of the deuteron is;
(a) 1^+ (b) 2^- (c) 0^+ (d) 3^+

(ii) The magic nuclei having zero electric quadrupole moment has _____ shape.
(a) ellipsoidal (b) spherical
(c) cylindrical (d) toroidal

(iii) The three β - decay process are _____ transitions.
(a) Isobaric (b) Isotopic (c) Isomeric (d) Isotonic

(iv) The leptonic number for positron and anti-neutrino is _____.
(a) 1 (b) -1 (c) 0 (d) 2

(v) An electron colliding with the atomic nucleus experiences Coulomb scattering leading to change in its _____ acceleration and emit electromagnetic radiation known as Bremsstrahlung radiations.
(a) radial (b) linear (c) circular (d) rotational

(vi) The Synchrotron radiation power varies as _____ of radius of the particle motion.
(a) 1 (b) -2 (c) 0 (d) 2

(vii) The gauge bosons responsible for the strong interaction are known as.
(a) gluons (b) gravitons (c) neutrinos (d) mesons

(viii) The total energy released per burning of one hydrogen nucleus in the PPI cycle is about
(a) 931 MeV (b) 6.55 MeV (c) 26 MeV (d) 8.5 MeV

Q2 (i) Explain Nordhiem rule.

(ii) Explain experimental properties of the deuteron.

(iii) Discuss Geiger Nuttal law.

(iv) Derive an expression for the energy loss of neutrons in matter.

(v) What is compound nucleus? Write a nuclear reaction where in compound nucleus is formed.

(vi) Describe classification of nuclear reactors.

(vii) Explain why fusion of light nuclei and fission of heavy nuclei releases energy?

(viii) What are breeder reactors? Describe in short its working.

(ix) Explain briefly the idea of grand unification theory.

Q3	(a)	Using necessary equation derive magnetic moment of deuteron.	6
	(b)	Discuss various exchange forces in nuclear interaction.	6
		OR	
	(b)	In the collective nuclear model discuss in brief the rotational motion of the nucleus.	6
Q4	(a)	Deriving the equation of disintegration energy of α - particles and discuss reason of emission of the particles.	6
	(b)	Explain the Fermi theory of β - decay by deriving and discussing the equation of transition probability.	6
		OR	
	(b)	Discuss by deriving equation for the energy loss of heavy charged particle interacting in matter.	6
Q5	(a)	Write the main components of a nuclear reactor and discuss each of them in short.	6
	(b)	Discuss nucleosynthesis in stars.	6
		OR	
	(b)	Discuss the medical diagnostic and therapeutic applications of nuclear physics.	6
Q6	(a)	What are the different conservation laws obeyed by the fundamental particles? With the help of these conservation laws verify whether the following decay/ reaction are allowed or forbidden 1) $P \rightarrow \pi^+\pi^-\pi^+$ 2) $\pi^- + n \rightarrow \Lambda^\circ + K^-$	6
	(b)	Discuss Gell-Mann's SU(3) Quark Model for hadrons. Explain its successes and failures.	6
		OR	
	(b)	Discuss the antiproton detection experiment.	6

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SARDAR PATEL UNIVERSITY

Vallabh Vidyanagar

M. Sc. (Physics) 4th Semester Examination

Monday, 6th November, 2017

Time: 10:00 am to 01:00 pm

Subject: PS04CPHY02 [Theoretical Solid State Physics]

Total Marks: 70

Note: (1) Figures to the right indicate marks.
(2) Symbols have their traditional meaning.

Q:1 **Attempt all of the following Multiple choice type questions. [01 mark each]** [08]

(1) The energy corresponding to a free electron is given by

(a) $h^2k^2/8\pi^2m$ (c) $h^2k/8\pi^2m$

(b) $hk^2/8\pi^2m$ (d) $h^2k^2/4\pi^2m$

(2) A plasma oscillation in a metal is a _____excitation of the conduction electrons.

(a) collective transverse (c) transverse

(b) collective longitudinal (d) longitudinal

(3) Near the forbidden band the curvature of E versus k becomes

(a) negative (c) zero

(b) constant (d) positive

(4) The distance from the centre to boundary of the first Brillouin zone is

(a) $2\pi/a$ (c) π/a

(b) $\pi/2a$ (d) 2π

(5) The classical Debyr-Huckel screening length is proportional to

(a) $\left(N_0e^2/T\right)^{-1/2}$ (c) $\left(N_0e^2/T\right)^{1/2}$

(b) $\left(N_0e^2/T\right)^{2}$ (d) $\left(N_0e^2/T\right)$

(6) Change in 1/H through a single period of oscillation $\Delta(1/H)$ is proportional to

(a) $1/A_e$ (c) A_e

(b) $1/(A_e*hc)$ (d) hc/A_e

(7) For a superconducting material, transition temperature Tc varies with the average isotopic mass M as,

(a) $T_C \propto M^{-1}$ (c) $T_C \propto M^{-1/2}$

(b) $T_C \propto M^{-2}$ (d) $T_C \propto M^{1/2}$

(8) The width of energy gap in a superconductor at 0°K is nearly

(a) $300k_BT_C$ (c) $3T_C$

(b) k_BT_C (d) $3.5k_BT_C$

Q:2 **Answer any 7 of the following 9 questions briefly. [02 marks each]** [14]

1 Explain Umklapp scattering.
2 Explain electrostatic screening.
3 How is a reciprocal lattice obtained from direct lattice?
4 Using suitable schematic diagrams explain briefly the zone schemes.
5 Explain briefly the dHvA effect.
6 What anomalous skin effect ?
7 Explain the origin of energy gap in superconductors.
8 Explain with the help of a suitable diagram the term 'coherence length'.
9 Give in brief the experimental survey of superconductivity.

Q:3 (a) State and prove Bloch theorem. [6]

(b) Derive an expression for the band effective mass of an electron and interpret the concept of hole. [6]

OR

(b) Write a note on Kronig Penny model. [6]

Q:4 (a) Explain the formation of energy bands. Describe the empty lattice method. [6]

(b) What is orthogonalized plane wave? Obtain an expression for OPW form factor. [6]

OR

(b) Describe the APW method of band structure calculation. [6]

Q:5 (a) What is Fermi surface? Describe the Harrison's method of constructing Fermi surface. [6]

(b) Name various methods for the experimental mapping of Fermi surface and discuss cyclotron resonance in detail. [6]

OR

(b) Obtain an expression for the Lindhard screening function. Also determine its limiting values for $q \to 0$ and $q \to \infty$. [6]

Q:6 (a) Explain Josephson effects and derive expression for current density across superconductor-insulator-superconductor junction. [6]

(b) Explain the formation of Cooper pair. Enumerate the important features of BCS theory of superconductivity. [6]

OR

(b) Define Superconductivity. Explain in detail how superconductors are classified into class-I and class-II superconductors. [6]

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SARDAR PATEL UNIVERSITY
M. Sc. (Physics) 4th Semester Examination
Wednesday, 8th November 2017
Time: 10:00 AM to 01:00 PM
Paper Code: PS04EPHY01
Course Title: Applied Crystallography and Bio-Physics
Max Marks: 70

NB: i All symbols have their usual meaning.
ii Figure at the right side of the question indicates full marks.

Que: 1 Write correct answer for each of the following MCQs. [08]

1 The intensity of each peak in XRD pattern is different due to ___.

a) Applied voltage b) Applied current
c) Specimen d) None of the above

2 Four circle diffractometer is used for

a) Powder specimen b) Single crystal
c) For any crystalline material d) amorphous

3 The name of the technique where crystal is fixed and film is flat.

a) Laue b) Rotation
c) Weissenberg d) precession

4 Flat Metal screen is used in ___ technique to record the XRD pattern.

a) Rotation b) Weissenberg
c) precession d) single crystal diffractometer

5 X ray diffraction from a f.c.c. structure, does not reflects the plane

a) (100) b) (111)
c) (220) d) (311)

6 When two cysteine molecules combine together, which type of bonding is formed

a) hydrogen b) disulphide
c) peptide d) ionic

7 In ESR, when external magnetic field is normal to the hemeplane and parallel to the internal field then Lande's factor is equal to ___.

a) 6 b) 8
c) 4 d) 2

8 Haemoglobin molecule possess how many heme groups.

a) 4 b) 3
c) 2 d) 1

Que2 Write answers of <u>any seven</u> questions in brief. [14]

1 Why the white radiation is must for Laue method?
2 What is the role of metal screen in Weissenberg method?
3 Define integrated intensity and gives its unit.
4 What is Wilson's plot?

(P.T.O)

5 What is the role of gnomonic projection in Laue method?
6 Radiation produces damage to biological molecules -Explain with example.
7 State the factors affecting crystallization of biological macromolecule.
8 State and explain Pullman's criterion for carcinogenic activity.
9 Which three measurable parameters are commonly used for obtaining image of tissues in MRI?

Que3 [A] What are different types of Laue techniques? Discuss the technique highlighting the basic principle for recording diffraction pattern in such a set up. [06]

Que3 [B] Give the sketch of Debye-Scherrer powder method and explain in detail its working. Why do you get doublet in such a photograph? [06]

OR

Que 3 [B] Derive the necessary formula for determining the particle size of polycrystalline specimen under non-ideal condition. Also interpret the result. [06]

Que 4 [A] List the factors modifying the diffracted intensity. Discuss in detail multiplicity factor and polarization factor. [06]

Que 4 [B] Discuss the graphical method to index a cubic XRD pattern from a polycrystalline specimen. [06]

OR

Que 4 [B] Sketch a four circle single crystal diffractometer and discuss its working. Define primary and secondary extinctions. [06]

Que 5 [A] Discuss primary, secondary and tertiary structure of protein. [06]

Que 5 [B] Discuss two different methods of protein crystallization at laboratory in detail. [06]

OR

Que 5 [B] How Raman spectroscopy differs from IR spectroscopy? Explain the use of Raman spectroscopy to study proteins and nucleic acids. [06]

Que 6 [A] State the basic principle of Infrared spectroscopy and discuss how proteins can be studied with the help of this technique. [06]

Que 6 [B] Discuss delocalization in biomolecules specifically considering example of benzene molecule and explain various parameters. What is the role of tight binding model to it. [06]

OR

Que 6 [B] Write the full form of NMR. Discuss the basic principle and its application in bio-physics. [06]

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M.Sc. (Physics)(IVth Semester) Examination
Date : 10 / 11 /2017, Day : Friday , Time : 10:00a.m to 1:00p.m.
Subject : Crystal growth and imperfections in Solids, Paper No. PS04EPHY02
CBCS(choice based credit system)

Important Note : Q.1 : Multiple choice questions (MCQ) carries one mark each.
Q.2 : Short questions carries two marks each (attempt any seven out of nine)
Q.3 to Q.6 : Long questions carries 12 marks .

Total Marks : 70

Choose the appropriate options from the following in Q.1

Q.1 (8)

i) Which rule tells whether or not a dislocation reaction will occur ?
(a) Frenkel (b) Schottky (c) Frank (d) Burger's

ii) _____ technique is known as high temperature solution growth.
(a) Bridgman (b) Czochralski (c)Verneuil flame fusion (d) flux growth

iii) An atom located at a position that is not a normal lattice site is known as
(a) Frenkel defect (b) Schottky defect (c) dislocation (d) tilt defect

iv) -------- is a negative ion vacancy with one excess electron bound at the vacancy
(a)F-center (b) M-center (c) V-Center (d) K-center

v) When structures are subjected to dynamic and fluctuating stresses it is termed as
(a) Creep (b) Fatigue (c) Fracture (d) dislocation

vi) Self diffusion occurs by which mechanism
(a)vacancy (b) interstitial (c) ring (d) impurity

vii) Which is two dimensional imperfection ?
(a) line (b) surface (c) point (d) void

viii) The number of independent variable for the layer type phase equilibrium diagram above the melting point of Pb and Al is _____ .
(a) 0 (b) 1 (c) 2 (d) 3

Q.2 *Answer any seven questions out of nine in Q.2* (14)

i) Obtain the expression for strain energy of an edge dislocation.

ii) What is creep ? Draw a plot of creep strain as function of time.

iii) Draw the diagrams showing like and unlike dislocations on the same plane, unlike dislocations separated by few atomic spacing, combination of dislocations.

iv) Explain why in Brigmann technique grown seed crystal is not used ?

v) Define slip planes and slip directions.

vi) Draw the cooling curve of pure and binary system.and calculate number of degree of freedom for each case.

vii) What is diffusion ? State Fick's first law of diffusion.

viii) Determine the fraction of atoms in a given solid with the energy equal to 1.5 eV at room temperature (300K) and at 1500K where Boltzmann's constant $k = 8.614 \times 10^{-5}$ eV/K.

ix) Explain Kirkendall effect.

(6)

Q.3(a) Sketch and discuss in detail phase equilibrium diagram of two component system that are mutually soluble in liquid state and partially soluble in solid state.

Q.3(b) Obtain the Gibb's – Thomson equation for vapour and modified Thomson's equation for melt. (6)

OR

Q.3(b) Draw schematic diagram of the crystallization apparatus, and explain in detail low temperature solution growth method of crystallization using slow cooling process. (6)

Q.4(a) Obtain the expression for concentration of Frenkel defects in equilibrium condition in an ionic crystal. (6)

Q.4(b) What is dislocation? Describe edge and screw dislocation in a crystal using appropriate diagram. (6)

OR

Q.4(b) What are stacking faults? Explain how this fault are produced in f.c.c crystal. (6)

Q.5(a) What is cross slip process ? Discuss how dislocation velocity can be measured with proper examples. (6)

Q.5(b) What to you understand by multiplication of dislocation ? Explain Frank-Read and multiple cross glide process. (6)

OR

Q.5(b) State the methods used for observations of dislocations and explain any two of them in detail. (6)

Q.6(a) Discuss what is meant by vacancy diffusion and interstitial diffusion . Using equations explain non-steady state diffusion phenomena. (6)

Q.6(b) Explain carburizing and decarburizing process in steel. (6)

OR

Q.6(b) What are cyclic stresses ? Discuss S-N curves with appropriate diagrams in detail. (6)

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SARDAR PATEL UNIVERSITY

M. Sc. (PHYSICS) IVth Semester Examination

Friday, 10th November, 2017 10:00 am to 01:00 pm

Course No.: PS04EPHY04

ADVANCED SOLID STATE ELECTRONIC DEVICES

Note: **All questions are compulsory.**

Total Marks:70

Q.1 Multiple choice questions. **(8)**

(i) Band gap shrinkage is a BJT design limitation that occurs when
(a) Base is made too thin **(b)** Base is made very lightly doped
(c) Emitter is doped heavily **(d)** Collector is made narrow

(ii) Cross doping is a serious problem in _____heterojunction devices.
(a) Si - Ge **(b)** GaAs - InP **(c)** Si - GaP **(d)** CdSe - ZnSe

(iii) For which of the following devices the carrier concentration in an active region is not controlled by doping of impurity?
(a) BJT **(b)** MESFET **(c)** MODFET **(d)** CMOS

(iv) In accumulation mode of MOS capacitor with p-type semiconductor, the hole density increases _____.
(a) within semiconductor **(b)** within oxide layer
(c) within semiconductor away from interface
(d) near semiconductor-oxide interface within semiconductor

(v) At pinch-off, the channel current is _____.
(a) infinite **(b)** zero **(c)** I_{DSat} **(d)** none of this

(vi) Which of the following is a most sensitive radiation detector?
(a) P-N photodiode **(b)** Solar cell
(c) PIN detector **(d)** Avalanche detector

(vii) For making PIN diode, in the case of night vision applications, the material used is
(a) GaP **(b)** GaAs **(c)** Hg_xCd_{1-x} **(d)** $Hg_{1-x}Cd_{1+x}$

(viii) The infrared wavelength range is _____ microns.
(a) 0.1-0.5 **(b)** 0.4-0.76 **(c)** 0.7-100 **(d)** 100-200.

Q.2 Short answer questions (Attempt any seven) **(14)**

(i) Differentiate between a MOSFET and MODFET.
(ii) Explain the preference of materials in Si based HBTs.
(iii) Write down the important issues of short channel MOSFET.
(iv) Draw the charge distribution in MOS capacitor in depletion, inversion and accumulation mode.
(v) What is a CMOS circuit? Why it consumes less power than other devices?
(vi) Explain the working of a phototransistor.
(vii) Define various characterizing parameters of a solar cell.
(viii) What is band gap tailoring? Explain.
(ix) What is external quantum efficiency?

(P.T.O)

Q.3(a) Discuss the design limitations of a BJT in detail. (6)

(b) What is the role of metal in MESFET? Discuss the structure and operation of MESFET with the help of energy band diagram and explain its V-I characteristics in detail. (6)

OR

(b) Sketch the multilayer structure of a MODFET and describe the role of each of the layers and discuss operation of MODFET in detail with the help of energy band diagram. (6)

Q.4(a) Discuss the operation of a MOS capacitor. Draw and explain its C-V characteristics. (6)

(b) Write down the key motivations used in MODFET and describe them. (6)

OR

(b) Explain different long channel issues in a MOSFET. (6)

Q.5(a) What is CCD? Sketch the structure of CCD and explain the process of charge transfer in it. (6)

(b) Discuss the absorption of light in semiconductors and explain how this property of semiconductors is used to construct radiation detectors. (6)

OR

(b) Obtain an expression for photocurrent in a P-N photo diode. (6)

Q.6(a) Discuss various important issues in the PIN device design. (6)

(b) Write a note on various LED materials. (6)

OR

(b) Draw the structures of Surface Emitting and Edge Emitting LEDs. Explain their operation and describe their merits and limitations. (6)

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