SEAT No._____ No. of Printed Pages : 03

[120]

SARDAR PATEL UNIVERSITY
Vallabh Vidyanagar
M. Sc. (Physics) 3rd Semester Examination
Monday, 10th April, 2017
Time: 02:00 pm to 05:00 pm
Subject: PS03CPHY01 [Quantum Mechanics-II]

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) For Pauli matrices $\sigma_-^2 =$ _____. Take $\hbar = 1$.

(a) 0
(b) $-i\sigma_+$
(c) $i\sigma$.
(d) -1

(2) In the matrix representation of angular momentum $j = ½$, $J_- =$ _____. Take $\hbar = 1$.

(a) $\begin{pmatrix} 0 & 1 \\ 1 & 0 \end{pmatrix}$
(b) $\begin{pmatrix} 0 & -i \\ i & 1 \end{pmatrix}$
(c) $\begin{pmatrix} 1 & 0 \\ 0 & 1 \end{pmatrix}$
(d) $\begin{pmatrix} 0 & 0 \\ 1 & 0 \end{pmatrix}$

(3) Transitions in the lowest order can take place only between pairs of states (f,i) for which

(a) $H = 0$
(b) $H'^0_{fi} = \infty$
(c) $H'^0_{fi} = 0$
(d) $H'^0_{fi} \neq 0$

(4) $a^1_f(t)$ provides a good approximation to the $a_f(t)$ if the total probability for transitions from i to all states $f \neq i$ is

(a) $\sum' \left|a^1_f(t)\right|^2 \ll 1$
(b) $\sum' \left|a^1_f(t)\right|^2 \gg 1$
(c) $\sum' \left|a^1_f(t)\right|^2 = 1$
(d) $\sum' \left|a^1_f(t)\right|^2 = 0$

(5) $V(t_1,t_2)V(t_2,t_3) =$

(a) $V(t_3,t_1)$
(b) 1
(c) $V(t_1,t_3)$
(d) 0

(6) The Pauli spin matrix $\sigma_y =$

(a) $\begin{pmatrix} 0 & -i \\ i & 0 \end{pmatrix}$
(c) $\begin{pmatrix} 1 & 0 \\ 0 & -1 \end{pmatrix}$

(b) $\begin{pmatrix} 0 & 1 \\ 1 & 0 \end{pmatrix}$ (d) $\begin{pmatrix} 0 & i \\ i & 0 \end{pmatrix}$

(7) In Natural units ($\hbar = c = 1$), dimensional formula for electric charge is _____.

(a) $M^0L^0T^0$ (c) $M^1L^0T^{-1}$

(b) $M^1L^1T^0$ (d) $M^1L^0T^0$

(8) The Klein-Gordon field is an example of spin s = _____ field.

(a) 5/2 (c) 0

(b) 1 (d) 3/2

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

1 Explain spin vectors for spin ½ system.

2 For a system of identical particles, show that the Eigen value of exchange operator must be ± 1.

3 Explain in brief propagator.

4 What is constant perturbation? Draw a schematic diagram to show the transition probability as a function of energy.

5 What is dipole approximation?

6 Give interpretation of Klein-Gorden equation.

7 What is the need for Schroedinger's relativistiv equation?

8 For S.H.O., write lowering ($\hat{a}$) and ($\hat{a}^\dagger$) operators in terms of position and linear momentum operators. Prove that $\left[\hat{a}^\dagger, \hat{a}\right] = -1$.

9 Define field. Write its coordinate.

Q:3 (a) For an atomic system in the presence of external magnetic field, obtain the expression of non-relativistic Hamiltonian including spin. Interpret your result when spin-orbit interaction is neglected. [6]

(b) Derive eigenvalue spectrum for J^2 and j_z and show that $\left[\left(J_x + J_y + J_z\right), J^2\right] = 0$ [6]

OR

(b) Explain in brief (i) Clebsch-Gorden co-efficients. (ii) Phase convention. [6]

Q:4 (a) Obtain the general solution of time-dependent Schrödinger equation. [6]

(b) Considering time dependent first order perturbation theory explain the elastic scattering of a particle by a potential. [6]

OR

(b) Write a note on transitions in the second order. [6]

Q:5 (a) Obtain the plane wave solution of the Dirac equation. [6]

(b) Write a note on the interaction picture of time evolution. [6]

OR

(b) Starting with Dirac's relativistic Hamiltonian $H = c\vec{\alpha} \cdot \vec{p} + \beta mc^2$ derive the Dirac equation. [6]

Q:6 (a) Establish classical field equations using concept of Lagrangian field density. What is meant by Dirac field. [6]

(b) Explain canonical quantization required in field theory. Distinguish between first and second quantization. [6]

OR

(b) Assuming following form for Lagrangian density, viz; $\mathcal{L} = i\hbar\psi^* \dot{\psi} - \frac{\hbar^2}{2m}(\nabla\psi^*)(\nabla\psi) - V(\vec{r};t)\psi\psi^*$, and using Hamiltonian form for field equation derive time dependent Schrödinger equation. [6]

SEAT No._____

[1041]

SARDAR PATEL UNIVERSITY

M. Sc. (Physics), 3rd Semester Examination

15th April 2017, Saturday

Time: 02:00 pm TO 05:00 pm

Subject: Crystallography and Materials Science, Paper No. PS03EPHY01

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 each.

Max Marks: 70

Que 1 Select the correct answer for each of the following MCQs. **[08]**

1 1) Rf SQUID contains how many junctions in superconducting ring ?

a) one b) two
c) three d) four

2 The combination of the electron and its strain field is known as

a) polariton b) polaron
c) photon d) phonon

3 In piezo electricity

a) electrical energy is converted into mechanical energy
b) mechanical energy is converted into electric energy
c) mechanical energy is converted into thermal energy
d) electrical energy is converted into thermal energy

4 Optical fiber works on the principle of

a) total internal reflection b) diffraction
c) interference d) reflection

5 Every reciprocal lattice vector is

a) Parallel to a lattice plane b) Perpendicular to lattice plane
c) Inclined to an angle of 45 with the plane d) None of this

6 Bragg's law in vector form is

a) $2K.G = 0$ b) $2k.G + G2 = 0$
c) $2K.G - G^2 = 0$ d) $2K.G + G = k^2$

7 Spherical projection ,the plane of projection is

a) Passing through the center of the circle b) Touching the circle
c) On both side of the circle d) The surface of the circle

8 The ferroelectric materials show polarization at $T<T_c$

a) In the presence of electric field b) In absence of electric field
c) It does not required any external d) none of the above

Que 2 **Write answers of any seven questions.** **[14]**

1. What is Bragg's law? Explain each term of it.
2. Reciprocal lattice vector is orthogonal to lattice plane- Prove.
3. Body centered cell can have only even number of 'N' present in its diffraction whereas base centered cell have no reflections - Explain.
4. Discuss characteristics of $BaTiO_3$ crystal.
5. Differentiate between piezoelectric and ferroelectric crystals.
6. What is magneto resistance ? Explain in short GMR effect observed in materials.
7. State LST relation. High lights its uses in inelastic neutron scattering.
8. What are polymers? Define branched polymer, cross link polymer, thermosetting and thermoplastic polymer.
9. Explain switching process in amorphous semiconductors.

Que 3 **[a]** i) Derive Laue equations for diffraction. **[06]**
ii) What are spherical and stereographic projections?

[b] Mention the differences in direct lattice and reciprocal lattice. Establish the general relationship between interplanar spacing and reciprocal lattice parameters. Hence use the equation to obtain the relation for cubic, tetragonal and orthorhombic system. **[06]**

OR

[b] Discuss the experimental technique to record electron diffraction from a polycrystalline specimen. How do you calculate the lattice parameters from it? **[06]**

Que 4 **[a]** Obtain Thomson's equation for scattering of X-Rays by electron and interpret the result. **[06]**

[b] Derive the necessary equation for structure factor from an NaCl crystal and hence state the type of reflections will remain absent. Mention the differences if the crystal is replaced by KCl. **[06]**

OR

[b] Give the classification of ferroelectric materials. **[06]**

Que 5 **[a]** Explain in detail the electron-electron interaction mechanism with suitable diagrams. **[06]**

[b] What is polariton? Derive the necessary expression relating the dielectric constant with longitudinal and transverse optical phonon frequency. **[06]**

OR

[b] Fractional quantum Hall effect differs from normal Hall effect- Discuss this in detail with schematic figures. **[06]**

Que 6 **[a]** What are liquid crystals ? Explain the effect of magnetic field on liquid crystals. **[06]**

[b] Give the classification of different amorphous semiconductors and discuss the band structure and electronic conduction mechanism in it. **[06]**

OR

[b] Explain different techniques to prepare magnetic fluid in the laboratory. **[06]**

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SARDAR PATEL UNIVERSITY
M.Sc. (Physics) (III[rd] –Semester) Examination
Day & Date : Tuesday & 18/04/2017
Time: 02.00 p.m. to 05.00 p.m.
Subject: MAGNETIC AND OPTICAL PROPERTIES IN CONDENSED MATTER
Paper No. : PS03EPHY02

Instruction:
(a) Figure to the right indicate marks. Total Marks : 70

Q.1 Write answer of all questions by showing your choice against the question number. [8]

(1)Excitation may be achieved by bombardment with electrons is called _____ luminescence.
(a) photo (b) electro (c) chemi (d) cathodo

(2) Zinc orthosilicate activated with _____ then it can be used as oscilloscope screen.
(a) manganese (b) divalent manganese
(c) trivalent manganese (d) tetravalent manganese

(3) The maximum overlap of absorption and emission line, the recoil energy should be nearly equal to _____ eV.
(a) 6 (b) 0.6 (c) 0.06 (d) 0.006

(4) If we are using a loosely bound solid in Mossbauer experiment, then gamma ray has _____ .
(a) natural broadening (b) Doppler broadening
(c) both natural and thermal (d) none of the above

(5) Dielectric constant of Mica is varies in between:
(a) 5.5 and 7.5 (b) 5 and 7 (c) 5 and 7.5 (d) 5.5 and 7

(6) Polarizability has the SI units of _____.
(a) $C \cdot m \cdot V^2$ (b) $C \cdot m^2 \cdot V$ (c) $C \cdot m^2 \cdot V^{-1}$ (d) $C \cdot m^2 \cdot V.K$

(7) The Neel temperature T_N is associated with _____.
(a) paramagnetism (b) ferromagnetism
(c) antiferromagnetism (d) ferrimagnetism

(8) Coercivity is the field that reduces the magnetic induction to _____ .
(a) saturation (b) maximum
(c) minimum (d) zero

Q.2 Attempt any Seven of the followings: [14]

(i)How radiationless transition is possible in luminescent material?

(ii) Obtain the equation for luminescence efficiency depends on the concentration of the activator atoms.

(iii) Describe natural line width in Mossbauer spectroscopy in brief.

(iv) What is Doppler broadening? Obtain the expression to calculate this broadening.

(v) Explain P.B. Moon's experiment for attempt to observe resonance fluorescence.

(vi) Why transformer oil has to be used in transformer and it must be check in regular interval of time?

(vii) In optical absorption process, explain in brief exciton absorption.

(viii) Describe "Knight shift" for NMR.

(ix) Explain thermal excitation of magnon in brief.

Q.3(a) Compare the absorption and emission spectra of pure and thallium doped KCl crystal. Explain the role of thallium in KCl crystal using necessary diagram in detail and also mention its requirements. [6]

Q.3(b) With help of suitable diagram discuss the sulphide phosphors in detail. [6]

OR

Q.3(b) Describe applications of the luminescent material. Give reasons for waste of energy in case of primary ionization. [6]

Q.4(a) Why Mossbauer experiment must be performed at low temperature? Obtain an expression of Debye - Waller factor and also show its temperature dependence. [6]

Q.4(b) (i)Describe R.W.Wood experiment to observe resonant absorption using necess diagram. [6]

(ii) List applications of Mossbauer effect.

OR

Q.4(b) What is Mossbauer effect? Draw schematic diagram of Mossbauer effect and describe its construction and working in detail. Also mention its requirements. [6]

Q.5(a) Distinguish between polar and non-polar solids with an example. Explain complex dielectric constant of non-polar solids. [6]

Q.5(b) What is photoconductivity? Derive the expression for the photoconductivity depends on the intensity of illumination using necessary diagram. [6]

OR

Q.5(b) What is polarizability? Explain different types of polarizability. Discuss frequency dependence of polarizability. [6]

Q.6(a) What is resonance? Derive Bloch equations in case of nuclear magnetic resonance. [6]

Q.6(b) Write a short note on magnetic interaction leading to hyperfine splitting. [6]

OR

Q.6(b) What are magnons? Derive and discuss the dispersion relation of Magnons. [6]

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SARDAR PATEL UNIVERSITY
M.Sc. (PHYSICS) (IIIrd Semester) Examination
Tuesday, 18th April, 2017 2:00 pm to 5:00 pm
Course No.: PS03EPHY04
MICROPROCESSORS: PROGRAMMING, INTERFACING AND APPLICATIONS

Note: All questions are compulsory.

Total Marks:70

Q.1 Multiple Choice Questions. **(8)**

(i) LDA instruction uses ____ machine cycles for its execution.
(a) 1 **(b)** 2 **(c)** 3 **(d)** 4

(ii) An Op-Code used for microprocessor programming is a
(a) 8-bit Data **(b)** 16-bit Address **(c)** Instruction code **(d)** 16-bit Data

(iii) Asynchronous data transfer scheme can be implemented by _____ approach
(a) Hardware **(b)** Software **(c)** both a and b **(d)** DMA

(iv) An I/O port has
(a) Address bus **(b)** buffers **(c)** data bus **(d)** all of the above

(v) Clock frequency of ADC-0800 can be _____
(a) 100 kHz **(b)** 3MHz **(c)** 900 kHz **(d)** 2 kHz

(vi) In the output stage of a Sample and Hold circuit which of the following is used to obtain low droop rate and low noise?
(a) MOSFET, **(b)** MESFET, **(c)** Bi-FET, **(d)** CCD.

(vii) Seven segment display FND 503 is _____type display unit.
(a) Common Cathod **(b)** Common Anode
(c) Common Collector **(d)** None

(viii) The most suitable temperature sensor for microprocessor based temperature measurement and control system is
(a) Thermocouple **(b)** semiconductor diode **(c)** pyrometer **(d)** none.

Q.2 Short Answer Questions. (Attempt any seven) **(14)**

(a) Explain the instructions STA and LXI.

(b) Explain the instruction RIM.

(c) Write the meaning of each of the bits of control word for IC-8255.

(d) Which is the fastest data transfer technique in case of INTEL-8085 microprocessor? Why?

(e) What are the functions of Programmable counter/interval timer IC INTEL-8252?

(f) Explain how microprocessor receives an EOC signal once the A to D conversion is initiated.

(g) What are full scale and zero adjustments in ADC-0800? How are they implemented?

P.T.O.

(h) Explain in brief how frequency of a sine wave can be measured using microprocessor.

(i) Discuss how electrical quantities e.g. current, voltage and resistance are measured using a microprocessor.

Q.3(a) Sketch and explain the block diagram of INTEL-8085 microprocessor. (6)

(b) With the help of timing diagram explain the fetch and execute cycle. (6)

OR

(b) Give classification of instructions used for MPU-8085 programming. With suitable examples explain two byte and three byte instructions in detail. (6)

Q.4(a) Write an assembly language program for addition of two 8-bit numbers having 16-bits sum. (6)

(b) Describe interrupts of INTEL-8085. (6)

OR

(b) Discuss operating modes of IC 8255. (6)

Q.5(a) Discuss in detail about (6)

(i) Clock for ADC

(ii) Analog multiplexer.

(b) Explain in detail the application of S/H circuit LF 398 in a data acquisition system. (6)

OR

(b) Explain the operating principle of DAC and show how ADC can be realized using an DAC. (6)

Q.6(a) Discuss with the help of a suitable example how subroutine is used to create a desired time delay. (6)

(b) Explain how alpha numeric characters are displayed using interfacing diagram of display driver IC, seven segment LED display and microprocessor. (6)

OR

(b) Enlist different microprocessor compatible temperature sensors with their temperature range and discuss temperature monitoring system with the help of interfacing to 8085 MPU using any one of them along with a suitable assembly level programme. (6)

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