Total No. of Questions : 8]

SEAT No. :

P1935

[Total No. of Pages : 3

[4922]-1001

M.Sc.

PHYSICS

PHY UT-501 : Classical Mechanics

(2013 Pattern) (Credit System) (4 Credits) (Semester-I)

Time : 3 Hours] *[Max. Marks : 50*

Instructions to the candidates:

1) ***Answer any five questions out of eight questions.***
2) ***Draw neat diagrams wherever necessary.***
3) ***Figures to the right indicate full marks.***
4) ***Use of electronic calculator is allowed.***

Q1) a) What is velocity dependent potential? Where is it applicable? Obtain Lagrangian for a charged particle moving in electromagnetic field. **[4]**

b) Apply variational principle to find equation of motion of one dimensional simple harmonic oscillator. **[3]**

c) Show that the transformation

$$q = \sqrt{2p}\sin Q$$

$p = \sqrt{2p}\cos Q$ is canonical. **[3]**

Q2) a) Using Euler-Lagrange's equation determine the path which requires least time to travel from a point at higher level to a point at lower level in a plane under uniform gravitational field. **[4]**

b) Explain how two body problem is reduced into equivalent one body problem. **[3]**

c) Obtain Hamiltonian and Hamilton's equations of motion for ideal spring-mass system. **[3]**

P.T.O.

Q3) a) Define Poission bracket, hence prove the relation

$$\frac{d}{dt}[F,G]=\left[\frac{dF}{dt},G\right]+\left[F,\frac{dG}{dt}\right].$$ **[4]**

b) Draw phase space diagram for a stone thrown straight vertically upwards in the field of uniform gravity. **[3]**

c) The Lagrangian of a system is

$$L=\frac{1}{2}m(\dot{r}^2+r^2\dot{\theta}^2)-v(r)$$

Identify the cyclic coordinate and obtain corresponding conservation law. **[3]**

Q4) a) Prove that, $[L_x, P_y] = P_z$. **[4]**

b) Show that generating function, $F=\sum QiPi$ generates identity transformation. **[3]**

c) In how much time will the plane of oscillation of Focault's pendulum turn through 90° at 30° latitude? **[3]**

Q5) a) A cylinder of radius '*a*' and mass '*m*' rolls down an inclined plane making an angle θ with the horrizontal. Setup Lagrangian and find equation of motion. **[4]**

b) Using variational principle show that shortest distance between two points in a plane is straight line. **[3]**

c) Write coriolis force for **[3]**

i) River flow on the surface of the earth.

ii) Formation of cyclones.

Q6) a) Using Poisson Brackets, show that transformation

$$Q = \left(e^{-2q} - p^2\right)^{1/2}$$

$$P = \cos^{-1}(pe^q)$$

is canonical. **[4]**

b) What are inertial frames of reference? How two inertial frames S and S′ are related by Galilean transformation? **[3]**

c) Explain geosynchronous and geostationary orbits. State the uses of artificial satellites. **[3]**

Q7) a) What are constraints? Write the types and equation of constraints for the following. **[5]**

i) Simple pendulum of variable length.

ii) Particle moving on or outside the surface of sphere.

b) Prove that under canonical transformation (q, p) to (Q, P) Poisson bracket remains invarient. **[5]**

Q8) a) Show that for relativistic free particle, Hamiltonian is given by

$$H(r, p) = \sqrt{p^2c^2 + m_0^2c^4} + V(r)$$ **[5]**

b) A particle describes circular orbit given by $r = 2a \cos \theta$, under the influence of an attractive central force directed towards a point on the circle. Show that force varies as the inverse of fifth power of distance. **[5]**

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Total No. of Questions : 8]

SEAT No. :

P1936

[Total No. of Pages : 3

[4922]-1002

M.Sc.

PHYSICS

PHY UT-502 : Electronics

(Semester-I) (2013 Pattern 4-Credits)

Time : 3 Hours] *[Max. Marks : 50*

Instructions to the candidates:

1) ***Solve any five questions out of the eight questions.***
2) ***Neat diagrams must be drawn wherever necessary.***
3) ***Figures to the right indicates full marks.***
4) ***Use of calculator is allowed.***

Q1) a) Derive the expression T = 1.1RC for monostable multivibrator using Ic 555. **[4]**

b) Define shift register. State its types and applications. **[3]**

c) State atleast three features of 78XX voltage regulator. **[3]**

Q2) a) List the output voltage option for positive and negative fixed voltage series regulators. Define load and line regulation. **[4]**

b) Discuss the advantages and disadvantages of binary type and R-2R type converter. **[3]**

c) What output voltage would produced by a D/A converter whose output range is 0 to 10V and whose input binary number is **[3]**

i) 10 (for a 2-bit DAC)

ii) 0110 (for a 4-bit DAC)

iii) 10111100 (for 0 8-bit DAC)

P.T.O.

Q3) a) Explain the operation of Astable multivibrator using OP Amp. **[4]**

b) What is PLL? Define its **[3]**

i) Capture range.

ii) Lock range frequency.

c) Draw block diagram of Ic 566 VCO and explain its operation. **[3]**

Q4) a) Explain successive approximation A/D type converter. **[4]**

b) Place on the truth table and map the function

$$Y = \bar{A}\bar{B}C+\bar{A}B\bar{C}+A\bar{B}\bar{C}+ABC \cdot$$ **[3]**

c) Give block diagram of Ic 723 regulator and explain its operation. **[3]**

Q5) a) Give block diagram of Ic 7490 decade counter. Also draw waveforms for Q_A, Q_B, Q_C, Q_D. Assuming that the clock is applied to input A of Ic 7490. **[4]**

b) What is the principle of SMPS discuss its advantages. **[3]**

c) What is up down counter? State its applications. **[3]**

Q6) a) Define foldback current limiting? Draw the circuit diagram for foldback power supply using Ic 723 and explain its operation. **[4]**

b) Determine the number of Flip-flops that would be required to build the following counters. **[3]**

i) Mod 6 ii) Mod 19

iii) Mod 31

c) Draw a block diagram of DC-DC convertor. Explain its operation. **[3]**

Q7) a) Design an adjustable voltage regulator from the Ic 7805 to get an output voltage of 7.5V. **[5]**

b) Design VCO using Ic 566 to generate a waveform with frequency 10 kHz.

(Given V_{cc} = 10V) **[5]**

Q8) a) In the Astable multivibrator using Ic 555, R_A = 2.2 ka R_B = 6.8 kΩ and C = 0.01 μF. **[5]**

Calculate:

i) t_{high}

ii) t_{low}

iii) free running frequency and

iv) duty cycle D.

[circuit diagram is essential].

b) Calculate the output frequency f_o, lock range f_L and capture range f_c using Ic 565 PLL, if R_T = 10 kΩ C_T = 0.01 μF and C = 10 pF. **[5]**

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Total No. of Questions : 8]

SEAT No. :

P1937

[Total No. of Pages : 3

[4922]-1003
M.Sc.
PHYSICS (Credit System)
PHY UT - 503 : Mathematical Methods in Physics
(2013 Pattern) (4 Credits) (Semester - I)

Time : 3 Hours] *[Max. Marks : 50*

Instructions to the candidates:

1) ***Answer <u>any five</u> questions out of eight questions.***
2) ***Neat diagram must be drawn wherever necessary.***
3) ***Figures to the right side indicate full marks.***
4) ***Use of calculator is allowed.***

Q1) a) Define subspace W of vector spare V. Let V be the vector space of all 2×2 matrices over R. Show that W is not a subspace of V, where W consists of all matrices with zero determinent. **[4]**

b) Find whether the following vectors in R^3 are linearly dependent or independent. **[3]**

$\{(1, -2, 1), (2, 1, -1), (7, -4, 1)\}$.

c) Let $U = \{(a, b, c) : a = b = c\}$

and $W = \{(0, b, c)\}$.

Show that $R^3 = U \oplus W$. **[3]**

Q2) a) Let D denotes the differential operator $D(f(t)) = \frac{df}{dt}$. Find the matrix representation of D in each case. **[4]**

i) $\{e^t, e^{2t}, te^{2t}\}$

ii) $\{1, t, \sin 3t, \cos 3t\}$

P.T.O.

b) Define inner product spare and norm of vector $(\|v\|)$. **[3]**

c) Consider the linear operator **[3]**

T(x, y, z) = ($2x$, $4x–y$, $2x+3y–z$).

Show that T is invertible.

Q3) a) Define adjoint of an operator T. Write the condition when it is called self - adjoint. Consider $T_v = \lambda_v$ for such self - adjoint operator and show that λ is real. **[4]**

b) State and prove Parseval's identity. **[3]**

c) The Rodrigue's formula for Laguerre polynomial is

$$L_n(x) = \frac{e^x}{n!}\frac{d^n}{dx^n}\left(x^n e^{-x}\right).$$

Find $L_0(x)$, $L_1(x)$, $L_2(x)$. **[3]**

Q4) a) Solve using Laplace transform

$x'' + 4x' + 4x = 6e^{-2t}$; $x(0) = 2$, $x'(0) = 8$. **[4]**

b) State the Dirichlet conditions that the function $f(x)$ should satisfy in order to expand in terms of Fourier series. **[3]**

c) Find the Laplace transform of **[3]**

i) L{6sin $2t$ – 5cos $2t$}

ii) L{e^{-4t} cosh $2t$}

Q5) a) Write the generating function for Bessel's function. Deduce the form of integral representation of Bessel's function. **[4]**

b) Diagonalize the matrix $\begin{pmatrix} 1 & 0 & 1 \\ 0 & 1 & 0 \\ 1 & 0 & 1 \end{pmatrix}$. Find the eigen values and eigen vectors. **[3]**

c) Find basis and dimension of subspace W of $V = M_{2\times2}$ spanned by **[3]**

$$A=\begin{pmatrix} 1 & -5 \\ -4 & 2 \end{pmatrix}, B=\begin{pmatrix} 1 & 1 \\ -1 & 5 \end{pmatrix}, C=\begin{pmatrix} 2 & -4 \\ -5 & 7 \end{pmatrix}, D=\begin{pmatrix} 1 & -7 \\ -5 & 1 \end{pmatrix}.$$

Q6) a) For Legendre function prove the orthogonality condition. **[4]**

b) Define spherical Harmonic function. Write the orthonormality integral for it. **[3]**

c) Write the expression for associated Legendre function and determine its parity. **[3]**

Q7) a) Apply Gram-Schmidt orthogonalization process to find an orthogonal basis for the subspace U of R^4 spanned by **[5]**

$v_1 = (1, 1, 1, 1)$, $v_2 = (1, 2, 4, 5)$, $v_3 = (1, -3, -4, -2)$.

b) Find if set S = {(1, 1, 1), (1, 1, 0), (1, 0, 0)} can form the basis of R^3. If yes find the co-ordinates of **[5]**

i) $v = (4, -3, 2)$

ii) (a, b, c) relative to S.

Q8) a) Write the generating function for Hermite polynomial and derive the two basic recurrence relations. **[5]**

b) Expand F(x) as a Fourier Series where **[5]**

$$F(x) = x \qquad 0 < x < \pi$$
$$= -x \qquad -\pi < x < 0$$

Total No. of Questions : 8]

SEAT No. :

P1938

[Total No. of Pages : 2

[4922]-1004
M.Sc.
PHYSICS
PHY UT - 504 : Atoms and Molecules
(2013 Pattern) (4 Credits) (Semester - I)

Time : 3 Hours] *[Max. Marks : 50*

Instructions to the candidates:

1) ***Solve any five questions.***
2) ***Draw neat diagrams wherever necessary.***
3) ***Figures to the right indicate full marks.***
4) ***Use of logarithmic table and electronic pocket calculator is allowed.***

Given:

Rest mass of electron	=	9.901×10^{-31} ***kg***
Charge on electron	=	1.6021×10^{-19} ***coulomb***
Plank's constant	=	6.626×10^{-34} ***Js***
Boltzman constant	=	1.38054×10^{-23} JK^{-1}
Avogadro's number	=	6.022×10^{26} $(Kmole)^{-1}$
1eV	=	$1.6021 \times 10^{-19}J$

Q1) a) Explain Pashen-Back effect for 2s-2p transition. **[4]**

b) Explain the principle of NMR? How does NMR frequency related to external magnetic field applied. **[3]**

c) State the importance of Land of factor? Calculate it for $^2D_{5/2}$ term. **[3]**

Q2) a) Derive the expression for geometrical structure factor for a fcc structure. **[4]**

b) State and explain atomic quantum numbers. **[3]**

c) Calculate the value of electronic angular momentum of one electron atom in the state $^2D_{5/2}$. **[3]**

P.T.O.

Q3) a) Explain the Laue theory of X-ray diffraction. **[4]**

b) Discuss the origin of spectral line. **[3]**

c) The Debye temperature of diamond is 2230K. Calculate the highest possible lattice vibrational frequency. **[3]**

Q4) a) State and explain Franck-Condon Principle. **[4]**

b) Explain the experimental arrangement to study the Zeeman effect. **[3]**

c) The values of *xe* & *xe*' for lower and upper states of C_2 are 0.00711 and 0.00919 respectively. Find number of levels in lower and upper states. **[3]**

Q5) a) Explain Debye model of lattice heat capacity. **[4]**

b) Write note on vibrational coarse structure. **[3]**

c) The ground state of chlorine is $^2P_{3/2}$. Find magnetic moment of chlorine. **[3]**

Q6) a) Explain the principle of ESR. What are its basic requirements. **[4]**

b) What is Normal and Umklapp process. **[3]**

c) When a H_g vapour in a discharge tube is exposed to a magnetic field 5 Wb/m^2 the line of wavelength λ = 4226.75A° exhibits normal Zeeman splitting. Calculate wavelength of three components of normal Zeeman pattern. **[3]**

Q7) a) Explain band origin and band head in relation to rotational fine structure of electronic vibrational spectra. **[5]**

b) Define atomic scattering factor and show its maximum value is equal to the atomic number Z of the atom. **[5]**

Q8) a) Derive the dispersion relation for a linear diatomic lattice and explain origin of optical mode and acoustic mode. **[5]**

b) Explain the Normal Zeeman effect. Hence derive the necessary formula for shift in wavelength $d\lambda$. **[5]**

Total No. of Questions :8]

SEAT No. :

P1939

[Total No. of Pages :2

[4922]-1005
M.Sc.
PHYSICS
PHYUT-505: Experimental Techniques in Physics - I
(2013 Pattern 4 - Credits) (Semester - I)

Time : 3 Hours] *[Max. Marks :50*

Instructions to the candidates:

1) ***Attempt any five questions.***
2) ***Draw neat diagram wherever necessary.***
3) ***Figures to the right indicate full marks.***
4) ***Use of logarithmic table and calculator is allowed.***

Q1) a) Explain auto and cross correlation functions. **[4]**

b) What are different flow regimes? explain in brief. **[3]**

c) Derive an expression for pump down time. **[3]**

Q2) a) Explain construction and working of molecular drag pump. **[4]**

b) Write note on periodic and random signals. **[3]**

c) Give the applications of vacuum. **[3]**

Q3) a) With the help of neat diagram explain principle and working of rotary pump. **[4]**

b) Calculate the pump down time to reduce the pressure 760 Torr to 10^{-2} Torr if the volume of the chamber is 10 lit and pump speed in 50 lit/min. **[3]**

c) Explain the term 'Spectral Analysis' **[3]**

P.T.O.

Q4) a) Explain the vacuum system design with the help of schematic diagram. **[4]**

b) What is mean free path? For air at ambient temperature with pressure 10^{-3} Torr, calculate the mean free path. **[3]**

c) Explain construction and working of McLeod gauge. **[3]**

Q5) a) Explain the construction and working of penning gauge. **[4]**

b) Explain the principle of sputter ion pump. **[3]**

c) Define the terms:Ultimate pressure, impedance and conductance of vacuum line. **[3]**

Q6) a) Write pressure ranges of following vacuum pumps in Torr. **[4]**

i) Rotary

ii) Diffusion

iii) Sputterion

iv) Molecular drag

b) Explain viscosity, thermal conductivity and diffusion of gases. **[3]**

c) Explain the through put and pump speed of a vacuum pump. **[3]**

Q7) a) Discuss basic principles and applications of optical tweezers. **[5]**

b) With the help of neat diagram describe construction and working of diffusion pump. **[5]**

Q8) a) What is throttling process? Prove that entropy remains constant in a throttling process. **[5]**

b) With the help of neat diagram explain the principle and working of Bayard-Alpert gauge. **[5]**

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Total No. of Questions : 8]

SEAT No. :

P1927

[Total No. of Pages : 3

[4922]-101
M.Sc.
PHYSICS
PHY UT-501 : Classical Mechanics
(2013 Credit Pattern - 5 Credits) (Semester-I)

Time : 3 Hours] *[Max. Marks : 50*

Instructions to the candidates:

1) ***Answer any five questions out of eight questions.***
2) ***Draw neat diagrams wherever necessary.***
3) ***Figures to the right indicate full marks.***
4) ***Use of electronic calculator is allowed.***

Q1) a) Show that for spherical surfaces, geodecics are great circles. **[4]**

b) What is symmetry? Explain homogeneity of space and obtain law of conservation of linear momentum. **[3]**

c) Find horrizontal component of coriolis force acting on a rigid body of mass 1.5 kg moving northward with horrizontal speed 100 m/s at 30°N latitude on the earth. **[3]**

Q2) a) If $[\phi, \psi]$ be the Poisson bracket, then prove that

$$\frac{\partial}{\partial t}[\phi,\psi]=\frac{\partial}{\partial t}\left[\frac{\partial \phi}{\partial t},\psi\right]+\left[\phi,\frac{\partial \psi}{\partial t}\right]$$ **[4]**

b) Discuss Larmour precision. **[3]**

c) Obtain Lagrangian and Hamiltonian of relativistic particle. **[3]**

P.T.O.

Q3) a) Show that shortest distance between two points in a plane is straight line. **[4]**

b) Prove that plane of oscillation of Focault's pendulum rotates $130 \sin\phi$ per hour, where ϕ is latitude of the place. **[3]**

c) What are generalized coordinates? What are advantages of using them? **[3]**

Q4) a) What is coriolis force? Explain the effect of coriolis force on **[4]**

i) flow of river and

ii) air flow on the surface of the earth.

b) Show that Poisson bracket of two constants of motion is itself constant of motion. **[3]**

c) Two particles of masses m_1 and m_2 are located on a frictionless double inclined plane and connected by an in extensible string passing over a smooth peg. Use De Alembert's principle to show equation of motion is $(m_1 + m_2)\ddot{r}_1 = (m_1 \sin\theta_1 - m_2 \sin\theta_2)g$. **[3]**

Q5) a) State and prove virial theorem for a system of interacting particles. **[4]**

b) Prove that for Poisson brackets

$$[F, GS] = S[F, G] + \{F, S]\ G$$ **[3]**

c) Find Lagrange's equation of motion for an electrical circuit comprising of an inductor L and capacitor C, the capacitor is charged to q coulomb and current through circuit is 'i' ampere. **[3]**

Q6) a) Show that transformation **[4]**

$$P = 2(1 + q^{1/2} \cos p)q^{1/2} \sin p$$

$$Q = \log(1 + q^{1/2} \cos p)$$

is canonical.

b) Draw configuration space, phase space and state space diagrams for one dimensional simple harmonic oscillator. **[3]**

c) A mass m moves in a circular orbit of radius r_0 under the influence of central force whose potential is $\frac{-k}{r^n}$. Show that circular orbit is stable under small oscillations if $n < 2$. **[3]**

Q7) a) What is Focault's pendulum? Obtain an equation of motion for such pendulum. **[5]**

b) An inclined plane is given horizontal acceleration a in virtual plane of incline, α is angle of inclination. Calculate horrizontal acceleration to prevent sliding of any frictionless block placed on incline. **[5]**

Q8) a) Show that for a particle moving under central force $f(r)$, the equation of orbit is given by

$$\frac{d^2u}{d\theta^2} + u = -\frac{m^2}{l^2u^2} \cdot f\left(\frac{1}{u}\right)$$

Here $u = \left(\frac{1}{r}\right)$ and l-is angular momentum. **[5]**

b) Obtain the Lagrangian, Hamiltonian and equations of motion for a projectile near the surface of the earth. **[5]**

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Total No. of Questions : 8]

SEAT No. :

P1928

[Total No. of Pages : 3

[4922]-102
M.Sc.
PHYSICS
PHY UT-502 : Electronics
(2013 Pattern - 5 Credits) (Semester-I)

Time : 3 Hours] *[Max. Marks : 50*

Instructions to the candidates:

1) ***Answer any five questions out of eight questions.***
2) ***Neat circuit diagrams must be drawn wherever necessary.***
3) ***Figures to the right indicate full marks.***
4) ***Use of calculator is allowed.***

Q1) a) Define precision rectifier. Draw the circuit of a fullwave rectifier and explain how it gives the average value. **[4]**

b) How is current boosting achieved in a 7805 IC? **[3]**

c) What voltage options are available in 78XX and 79XX voltage regulators? **[3]**

Q2) a) If logic '1' = 5V and logic '0' = 0V, determine the following for R - 2R type DAC. **[4]**

i) Analog output for digital input of 1111.

ii) Resolution.

b) Explain with a neat diagram the working of monastable multivibrator using IC 555. **[3]**

c) What is PLL? Define its **[3]**

i) Capture range.

ii) Lock range frequency.

P.T.O.

Q3) a) Give the block diagram of IC 566 VCO and explain its operation. **[4]**

b) Draw the frequency response of the following filters **[3]**

i) low pass

ii) high pass

iii) band pass

c) Give the block diagram of Dual-Slope A/D convertor. Explain the working of each blocks. **[3]**

Q4) a) What is foldback current limiting? Explain a low voltage regulator using current foldback in IC 723 regulator. **[4]**

b) What output voltage would be produced by a D/A converter whose output range is 0 to 10V and whose input binary number is **[3]**

i) 01 (for a 2 bit D/A converter)

ii) 1001 (for a 4 bit D/A converter)

iii) 10111100 (for a 8 bit D/A converter)

c) Define the following terms in Op-Amps: **[3]**

i) Slew Rate.

ii) CMRR.

iii) Power Supply Rejection Ratio (PSRR).

Q5) a) Derive the expression T = 0.69 RC for monostable multivibrator using Op-Amp. **[4]**

b) What does thermal shutdown mean? State at least two important features of 78XX voltage regulator. **[3]**

c) Determine the number of flipflops that would be required to build the following counters. **[3]**

i) Mod 8

ii) Mod 11

iii) Mod 31

Q6) a) Explain the working of Astable Multivibrator using Op-Amp. **[4]**

b) Draw the circuit diagram for weighted resistive ladder type converter. Discuss the advantages and disadvantages of R-2R type converter and weighted resistor. **[3]**

c) Draw the block diagram of frequency multiplier using PLL (IC 565) and explain its operation. **[3]**

Q7) a) Design the high pass active filter using IC 741 using the following specifications. (circuit diagram is essential).

$V_{cc} = \pm 15V$, $f_c = 5$ kHz. **[5]**

b) Design Astable multivibrator using IC 741 using the following specifications (circuit diagram is essential).

$V_{cc} = \pm 15V$, $V_o = 10V$, $f_o = 1$ kHz. **[5]**

Q8) a) Design a Notch filter using Op-Amp for the following specifications.

$V_{cc} = \pm 15V$, $f_o = 1$ kHz, $Q = 10$, Bkt = 0.1 kHz. **[5]**

b) Design a series voltage regulator using discrete components for the following specifications.

$V_i = 30V$, $V_o = 15V$, $I_L = 0.5A$. **[5]**

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Total No. of Questions : 8]

SEAT No. :

P1929

[Total No. of Pages : 3

[4922]-103
M.Sc.
PHYSICS
PHY UT-503 : Mathematical Methods in Physics
(2013 Pattern - 5 Credits) (Semester-I) (Credit System)

Time : 3 Hours] *[Max. Marks : 50*

Instructions to the candidates:

1) ***Answer any five questions out of eight questions.***
2) ***Neat diagrams must be drawn wherever necessary.***
3) ***Figures to the right indicate full marks.***
4) ***Use of calculator is allowed.***

Q1) a) Define vector space and subspace. Discuss whether or not R^3 is a subspace of R^4. **[4]**

b) Determine the residue of $\frac{ze^{zt}}{(z-3)^2}$ at $z = 3$. **[3]**

c) Obtain the first three Legendre polynomials using Rodrigue's formula. **[3]**

Q2) a) State Residue theorem. Explain how the Cauchy's theorem and integral formulas are special cases of residue theorem. **[4]**

b) State and prove the Parseval's identity. **[3]**

c) Let $V = R^3$. Determine whether or not W is a subspace of V.

Given: $W = \{(a, b, c) : a^2 + b^2 + c^2 \leq 1\}$. **[3]**

Q3) a) State and prove Cauchy-Schwarz inequality. **[4]**

P.T.O.

b) Determine whether or not the following form a basis for the vector space R^3: {(1, 2, 3), (1, 0, –1), (3, –1, 0), (2, 1, –2)}. **[3]**

c) Determine the region in the z plane represented by $\pi/3 \le arg(z) \le \pi/2$. **[3]**

Q4) a) Verify that the following is an inner product in R^2:

$$< u, v >= x_1\ y_1 - x_1 y_2 - x_2 y_1 + 3x_2 y_2$$

where $u = (x_1, x_2), v = (y_1, y_2)$. **[4]**

b) For what value of k is (1, k, 5) a linear combination of u = (1, –3, 2) and v = (2, –1, 1). **[3]**

c) Prove that: $J_{n+1}(x) = \frac{2n}{x} J_n(x) - J_{n-1}(x)$. **[3]**

Q5) a) Determine the first three Hermite polynomials $H_0(x)$, $H_1(x)$ and $H_2(x)$. **[4]**

b) Prove that the Laplace transform operator L is linear. **[3]**

c) Evaluate $\oint_C \frac{\cos z}{(z-\pi)} dz$ where C is the circle $|z-1| = 3$. **[3]**

Q6) a) Let $f(t)$ be continuous and have a piecewise. Continuous derivative $f'(t)$ in every finite interval $0 \le t \le T$. Suppose also that $f(t)$ is of exponential order for t > T. Then prove that $\mathcal{L}\{f'(t)\} = s\mathcal{L}\{f(t)\} - f(0)$. **[4]**

b) Prove that: $H_{n+1}(x) = 2xH_n(x) - 2_n H_{n-1}(x)$. **[3]**

c) Write the vector v = (3, 1, –4) as a linear combination of $f_1 = (1,1,1)$, $f_2 = (0,1,1)$ and $f_3 = (0,0,1)$. **[3]**

Q7) a) Find $\mathcal{L}^{-1}\left\{\frac{5s^2-15s+7}{(s+1)(s-2)^3}\right\}$. **[5]**

b) Consider the following basis of Euclidean space R^2: $\{v_1 = (1, 1, 1), v_2 = (0, 1, 1), v_3 = (0, 0, 1)\}$. Use the Gram-Schmidt orthogonalization process to transform $\{v_i\}$ into an orthonormal basis $\{u_i\}$. **[5]**

Q8) a) Let $A = \begin{pmatrix} 1 & 2 \\ 3 & 4 \end{pmatrix}$ and let T be the linear operator on R^2 defined by $T(v) = Av$ (where v is written as a column vector). Find the matrix of T in each of the following bases: **[5]**

i) $\{e_1 = (1, 0), e_2 = (0, 1)\}$, i.e. usual basis;

ii) $\{f_1 = (1, 3), f_2 = (2, 5)\}$.

b) State and prove the orthogonality property of Hermite functions. **[5]**

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Total No. of Questions : 8]

SEAT No. :

P1930

[Total No. of Pages : 3

[4922]-104
M.Sc.
PHYSICS
PHY UT-504 : Atoms Molecules & Lasers
(2013 Pattern - 5 Credits) (Semester-I)

Time : 3 Hours] *[Max. Marks : 50*

Instructions to the candidates:

1) ***Solve any five questions.***
2) ***Draw neat diagrams wherever necessary.***
3) ***Figures to the right indicate full marks.***
4) ***Use of logarithmic table and electronic pocket calculator is allowed.***

Given:

Rest mass of electron = 9.901×10^{-31} kg

Charge on electron = 1.6021×10^{-19} coulomb

Plank's constant = 6.626×10^{-34} Js

Boltzman constant = 1.38054×10^{-23} JK^{-1}

Bohr magneton = 9.27×10^{-24} amp. m^2

Avogadro's number = 6.022×10^{26} $(Kmole)^{-1}$

1 ev = 1.6021×10^{-19} J

Q1) a) Discuss the construction and working of CO_2 laser. **[4]**

b) Explain briefly the information one can get from vibrational analysis of electronic vibration spectra. **[3]**

c) What is Lande of factor? Calculate of factor for $^3D_3$ state. **[3]**

P.T.O.

Q2) a) What is NMR? Draw block diagram of NMR and explain its working. **[4]**

b) State Pauli's exclusion principle. What is Hund's rule of maximum multiplicity. **[3]**

c) Calculate the ratio of spontaneous emission to stimulated emission if wavelength of radiation is 550 nm at 2000 K. **[3]**

Q3) a) Calculate the Zeeman shift observed in the normal Zeeman effect when a spectral line of wavelength 600 Å is subjected to magnetic field 0.4 Wb/m^2. **[4]**

b) What is holography? How it differ from photography. **[3]**

c) Write short note on vibrational coarse structure. **[3]**

Q4) a) What are the industrial applications of Laser. **[4]**

b) Define gyromagnetic ratio. State the relation connecting $\bar{\mu}_s$ & $\bar{s}$ of an electron. **[3]**

c) What is the nuclear g_N factor for ^{19}F nucleus which has a magnetic moment of 2.6273 μ_N. Nuclear spin quantum number $I = \frac{1}{2}$. **[3]**

Q5) a) State & explain Frank-Condon principle. **[4]**

b) State the atomic quantum numbers, their values and functions. **[3]**

c) A gas laser is generating a beam of 3 mW power. Calculate the number of photons emitted by laser (λ = 670 nm). **[3]**

Q6) a) What is ESR? What are basic requirements of ESR spectrometer? Draw its block diagram. **[4]**

b) Show that the threshold condition for lasing is

$$\gamma_{th} = \alpha_s + \frac{1}{2L} ln \frac{1}{r_1 r_2}.$$ **[3]**

c) What do you mean by pumping? Why two level pumping is rarely used? **[3]**

Q7) a) Discuss rotational finestructure of electronic vibrational transition. **[5]**

b) Differentiate between spatial and temporal coherence. **[5]**

Q8) a) Explain Pashen-Back effect for 2s-2p transition. **[5]**

b) The values of $\bar{\gamma}_e$ and X_e for lower and upper states of CO are 2,170.21 cm^{-1}, 0.0062 and 1,515.61 cm^{-1}, 0.0114 respectively. The (0, 0) transition is observed at 64746.55 cm^{-1}, calculate the energy difference of the two electronic states. **[5]**

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Total No. of Questions : 8]

SEAT No. :

P1940

[Total No. of Pages : 2

[4922]-2001
M.Sc.
PHYSICS
PHY UT - 601 : Electrodynamics
(2014 Pattern) (4 Credits System) (Semester - II)

Time : 3 Hours] *[Max. Marks : 50*

Instructions to the candidates:

1) ***Attempt <u>any five</u> questions out of eight questions.***
2) ***Draw neat labelled diagrams wherever necessary.***
3) ***Figures to the right indicate full marks.***
4) ***Use of logarithmic tables and calculators is allowed.***

Q1) a) Write Maxwell's equation in differential and integral form. **[4]**

b) Explain the term 'skin effect and skin depth'. **[3]**

c) Describe magnetic interaction between two current loops. **[3]**

Q2) a) Explain the term 'Four vector potential'. **[4]**

b) Explain the term 'Multiple moments'. **[3]**

c) Derive Faraday's Law of induction for moving medium. **[3]**

Q3) a) Prove that: **[4]**

$$\vec{E}\cdot\frac{\partial\vec{D}}{\partial t}=\frac{\partial}{\partial t}\left(\frac{1}{2}\vec{E}\cdot\vec{D}\right) \text{ and}$$

$$\vec{H}\cdot\frac{\partial\vec{B}}{\partial t}=\frac{\partial}{\partial t}\left(\frac{1}{2}\vec{H}\cdot\vec{B}\right)$$

P.T.O.

b) Explain Minkowski's space-time diagram. **[3]**

c) An electron is moving at a speed of 1.8×10^8 m/s. Find the ratio of its effective mass to its rest mass. **[3]**

Q4) a) Prove that the space time internal $x^2 + y^2 + z^2$ is not invariant under Lorentz transformation, while the combined space-time interval $x^2 + y^2 + z^2 - c^2 t^2$ is Lorentz invariant. **[4]**

b) Write a short note on 'Hertz potential $\vec{Z}$'. **[3]**

c) Find the ratio of skin depth in copper at 1kHz to 100MHz. **[3]**

Q5) a) Obtain an expression for electro magnetic field tensor $F_{\mu\nu}$. **[4]**

b) Derive an expression for potential at a distant point due to a small linear quadrupole. **[3]**

c) Starting from Maxwell's equation establish the equation of continuity. **[3]**

Q6) a) State and prove poyntings theorem. **[4]**

b) Describe Lorentz force an a charged particle. **[3]**

c) Show that $(C^2B^2 - E^2)$ is invariant under Lorentz transformation. **[3]**

Q7) a) Describe the Michelson-Mosley experiment and discuss the results obtained by them. **[5]**

b) Starting from Maxwell's equation, derive in homogeneous wave equation in terms of scalar potential (ϕ) and vector potential $(\vec{A})$. **[5]**

Q8) a) Obtain an expression for Fresnel's equation if the electric field vectors are perpendicular to the plane of incidence. **[5]**

b) Show that the square of four wave vector K_μ is Zero. **[5]**

Total No. of Questions : 8]

SEAT No. :

P1941

[Total No. of Pages : 3

[4922]-2002
M.Sc.
PHYSICS
PHY UT - 602 : Solid State Physics
(2014 Pattern) (4 Credits) (Semester - II)

Time : 3 Hours] *[Max. Marks : 50*

Instructions to the candidates:

1) *Attempt any five questions.*
2) *Draw neat and labelled diagrams wherever necessary.*
3) *Figures to the right indicate full marks.*
4) *Use of logarithmic tables and calculators is allowed.*

Constants:

Boltzmann constant	=	1.38×10^{-23} *J/K*
Planck's constant	=	6.623×10^{-34} *J-S*
Avogadro's number	=	6.023×10^{26} *per kg mole*
Mass of electron	=	9.1×10^{-31} *kg*
Electronic charge	=	1.6×10^{-19} *C*
Bohr magneton	=	9.27×10^{-24} $A.m^2$
Permeability of free space	=	$4\pi \times 10^{-7}$ *H/m*

Q1) a) Explain the reduced zone, extended zone and periodic zone schemes for representing energy bands with neat diagrams. **[4]**

b) Explain Type I and Type II superconductors with suitable examples. **[3]**

c) For Helium atom in ground state, the mean radius in the Langvin's formula is approximated by Bohr radius of 0.528 nm. Calculate the diamagnetic susceptibility of helium atom. Given : Density of helium = 0.178 kg/m^3. **[3]**

Q2) a) Prove that for Kronig - Penny potential with $p << 1$, the energy of the lowest energy band at K = 0 is $E = \frac{h^2 p}{4\pi m a^2}$ **[4]**

b) Show that the flux coming from the hollow space of the super conducting ring is quantised. **[3]**

P.T.O.

c) An electromagnet with iron core can be magnetised typically upto 1 tesla. Compare the magnetic interaction energy $\mu_B B$ of an electron spin magnetic diapole moment with thermal energy $K_B T$ at room temperature. Hence show that at ordinary temperature, the approximation $K_B T / \mu_B B > > > 1$ holds good. **[3]**

Q3) a) Using equation $m\left[\frac{dv}{dt}+\frac{v}{\tau}\right]=-eE$ for electron drift velocity v, show that the d.c. electrical conductivity of metal is $\sigma = ne^2 \tau$ m. Symbols have usual meanings. **[4]**

b) Explain the paramagnetism in iron group ions on the basis of quenching of orbital angular momentum. **[3]**

c) A magnetic material has a magnetisation of 3300 A/m and flux density of 0.0044 wb/m^2. Calculate the magnetising force and relative permeability of the material. **[3]**

Q4) a) Explain the formation of energy gap on the basis of nearly free electron model. **[4]**

b) For a simple 2-D square lattice, show that the Kinetic energy of a free electron at the corner of the first Brillouin Zone is higher than the electron at the midpoint of a side face of a zone by a factor of two. **[3]**

c) The critical temperature (T_C) for mercury with isotropic mass 199.5 is 4.185 K. Calculate its critical temperature when its isotropic mass changes to 203.4. **[3]**

Q5) a) Explain the phenomenon of hysteresis and hysteresis curve on the basis of domain theory. **[4]**

b) Describe the assumptions of BCS theory of super conductivity. **[3]**

c) The saturation magnetic induction of nickel is 0.65 wb/m^2. Calculate the magnetic moment of nickel atom in Bohr magneton. **[3]**

Given:

i) Density of nickel = 8906 kg/m^3.

ii) Atomic weight of nickel = 58.7.

Q6) a) Derive London equation for superconducting state. Hence obtain an expression for penetration depth. **[4]**

b) For a specimen of V_3Ga, the critical fields are respectively 1.4×10^5 and 4.2×10^5 A/m for 14K and 13K. Calculate the transition temperature and critical fields at 0K and 4.2K. **[3]**

c) A paramagnetic substance has 10^{28} atoms /m^3. The magnetic moment of each atom is 1.8×10^{-23} A.m^2. Calculate the paramagnetic susceptibility at 300K. **[3]**

Q7) a) Give an account of the Weiss molecular exchange theory of ferromagnetism. Hence derive Curie-Weiss law. **[5]**

b) Explain quantum theory of paramagnetism. Derive Curie law. **[5]**

Q8) a) Distinguish between metals, semiconductors and insulators on the basis of band theory of solids. **[5]**

b) Describe the motion of electron in 1-D periodic potential. Explain the concept of effective mass m*. Draw E-K, V-K and m* -K diagrams. **[5]**

Total No. of Questions :8]

SEAT No. :

P1942

[Total No. of Pages :3

[4922]-2003
M.Sc.
PHYSICS
PHYUT-603: Quantum Mechanics - I
(2014: 4 Credit Based System Pattern) (Semester - II)

Time : 3 Hours] *[Max. Marks :50*

Instructions to the candidates:

1) ***Attempt ANY FIVE questions.***
2) ***Draw neat diagrams wherever necessary.***
3) ***Figures to the right indicate full marks.***
4) ***Use of logarithmic table and calculator is allowed.***

Q1) a) Define Hilbert space. Write expression for norm and scalar product of wave functions in this space. Hence show that $\left\langle a \left| \hat{A} \right| a' \right\rangle = a' \delta a a'$. **[4]**

b) Give physical significance of eigen values, eigen functions and expansion coefficients. **[3]**

c) Show that the eigen functions $\psi_n = \sqrt{\frac{2}{L}} \sin\left(\frac{n\pi x}{L}\right)$ for a deep potential well of width L are orthonormal. **[3]**

Q2) a) Define projection operator. Show that the sum of all the projection operators leaves any state vector $|\psi\rangle$ unchanged. **[4]**

b) Wave function of a particle moving in free space in given by, $\psi = e^{ikx} + 2e^{-ikx}$. Find the energy of the particle. **[3]**

c) Use Dirac notation to prove that eigen values of Hermitian operator are real. **[3]**

P.T.O.

Q3) a) Starting from perturbation equations, obtain the first order and second order energy correction in case of stationary non- degenerate state. **[4]**

b) State and explain postulates of quantum mechanics. **[3]**

c) Find the value of $[x^3, p_x]$. **[3]**

Q4) a) Given that $J_+ | j,m\rangle = C^+_{jm} | j,m+1\rangle$, where J_+ is a raising angular momentum operator. Obtain the expression for C^+_{jm}, where $| j,m\rangle$ are simultaneous eigenstates of J^2 and Jz operators. **[4]**

b) State connection formulae for WKB approximation. **[3]**

c) Write down equation defining Paulli matrices σ in terms of $\bar{S}$ for spin ½ particle and show that

i) $\sigma_x^2 + \sigma_y^2 + \sigma_z^2 = 3$

and ii) $\sigma_x \sigma_y = i\sigma_z$ **[3]**

Q5) a) What is harmonic perturbation? Calculate transition probability per unit radiation of intensity of a harmonic perturbation. **[4]**

b) Find the energy levels and eigen functions of Hamiltonian,

$$H = \begin{bmatrix} 1+\in & \in \\ \in & -1+\in \end{bmatrix}$$

Where $\in << 1$, corrected upto first order in $\in$ using perturbation theory. **[3]**

c) Show that variation method gives an upper bound to the ground state energy. **[3]**

Q6) a) Obtain the ground state energy of one dimensional harmonic oscillator using variation method. Assume the trial wave function $\psi_{(x)} = A e^{-\alpha x^2}$. **[4]**

b) Define adjoint operator, $\hat{A}^+$. Show that $\left(\hat{A}^+\right)^+ = \hat{A}$. **[3]**

c) Prove that the operator $L_+ = L_x + iLy$ is a raising angular momentum operator. **[3]**

Q7) a) Obtain matrices representing the operators J^2, $\hat{J}_{\pm}, \hat{J}_x, \hat{J}_y$ and $\hat{J}_z$ *for* $j = ½$. **[5]**

b) When a set of functions $\{\psi_a\}$ will be orthonormal and complete? Hence, obtain the closure relation $\Sigma_a \psi_a(x)\psi_a^*(x) = \delta(x - x')$. **[5]**

Q8) a) Using operator method obtain energy eigen value of one dimensional harmonic oscillator. **[5]**

b) Develop time dependent perturbation theory to obtain first order correction to the amplitude $a_m^{(1)}(t)$. **[5]**

x x x

Total No. of Questions :8]

SEAT No. :

P1943

[Total No. of Pages :2

[4922]-2004
M.Sc.
PHYSICS
PHYUT-604: Lasers
(2014 Pattern) (4 Credits) (Semester - II)

Time : 3 Hours] *[Max. Marks :50*

Instructions to candidates:

1) ***Solve any FIVE questions out of EIGHT questions.***
2) ***Neat diagrams must be drawn wherever necessary.***
3) ***Figures to the right indicate full marks.***
4) ***Use of calculator is allowed.***

Values of constants:

1) ***Boltzmann constant (kB) = 1.38×10^{-23} J/k***
2) ***Planck's constant (h) = 6.63×10^{-34} Js***
3) ***Charge of electron (e) = 1.6×10^{-19}c***
4) ***Velocity of light (c) = 3×10^{8}m/s***

Q1) a) Derive the inter relation between three Einstein's coefficients and state its physical significance. **[4]**

b) What do you mean by coherence? Differentiate between spatial and temporal coherence. **[3]**

c) The gain profile of He-Ne laser has a half-width of 2×10^{-3} nm. Calculate the maximum length of the cavity so as to get a single longitudinal mode of oscillation. (Given $\lambda = 632.8$ nm). **[3]**

Q2) a) How a four level laser is superior over a three level laser. **[4]**

b) What is Gaussian beam? State its properties. **[3]**

c) What do you mean by stimulated emission cross section? State its significance. **[3]**

P.T.O.

Q3) a) Why pumping is required in laser? State and explain various methods of pumping. **[4]**

b) A laser material has a gain factor of 0.0005 per cm. If reflectivities of two mirrors are 100% and 82% determine the length of cavity required for resonance. **[3]**

c) Define efficiency of laser. How it can be improved? **[3]**

Q4) a) Explain the principle, construction and working of CO_2 laser. **[4]**

b) 2 - level laser are practically difficult to achieve. Comment. **[3]**

c) a laser beam of 5 mw has a wavelength of 6328 A°. Calculate the number of photons emitted per second. **[3]**

Q5) a) How a p-n junction can be used to produce laser output? How it differs from LED? **[4]**

b) Explain any one application of laser in medicine. **[3]**

c) What is excimer laser. State the materials used as excimer. Draw its energy level diagram. **[3]**

Q6) a) Draw energy level diagram of dye molecule. State and explain various transitions. Which of these is responsible for laser emission. **[4]**

b) For an ordinary source, the coherence time is 10^{-10} sec. Obtain the degree of non-monochromaticity for $\lambda_o = 5400A^{\circ}$. **[3]**

c) Differentiate between ordinary light and laser light. **[3]**

Q7) a) Write a note on Nd:YAG Laser. **[5]**

b) Explain any two applications of laser in material processing. **[5]**

Q8) a) Explain the principle, construction and working of He-Ne laser. **[5]**

b) Explain the phenomenon of 'line broadening' in laser. **[5]**

x x x

Total No. of Questions :8]

SEAT No. :

P1944

[Total No. of Pages :3

[4922]-2005
M.Sc.
PHYSICS
PHYUT-605: Experimental Techniques in Physics - II
(2014 : 4 Credit Based System Pattern) (Semester - II)

Time : 3 Hours] *[Max. Marks :50*

Instructions to the candidates:

1) ***Attempt ANY FIVE questions.***
2) ***Draw neat diagrams wherever necessary.***
3) ***Figures to the right indicate full marks.***
4) ***Use of logarithmic table and calculator is allowed.***

Constants:

1) ***Boltzmann constant*** $k_B = 1.38\times10^{-23} J/K$
2) ***Planck's constant*** $h = 6.63\times10^{-34} Js$
3) ***Avogadro's number*** $N = 6.02\times10^{23}/gm\ mole$
4) ***Mass of electron*** $m_e = 9.1\times10^{-31} kg$
5) ***Charge on electron*** $e = 1.6\times10^{-19} C$
6) ***Velocity of light*** $c = 3\times10^{8} m/s$

Q1) a) Derive the scherrer formula for the average nanoparticle size calculation. **[4]**

b) How the resolution is improved in Scanning Electron Microscope (SEM) than optical microscope? **[3]**

c) Explain the principle of operation of humidity sensors with examples. **[3]**

Q2) a) Explain principle, construction and working of Atomic Force Microscope. **[4]**

b) Explain the principle of FTIR spectrometer. **[3]**

c) Write short note on pressure sensors. **[3]**

P.T.O.

Q3) a) Calculate the value of static magnetic field of an ESR spectrometer, if the frequency of excitation is 9500 MHz.

[Given:electron magnetic moment, $\mu_e = 9.285 \times 10^{-24} JT^{-1}$ and the angular momentum quantum number can have values +½ or –½]. **[4]**

b) Write short note on microwave generator. **[3]**

c) Explain the working of TGA. **[3]**

Q4) a) In an electron microscope system, calculate the wavelength in nm if the applied accelerating voltage is 30kV. **[4]**

b) Explain the principle of Diffused Reflectance Spectroscopy (DRS). **[3]**

c) Write short note on ESR. **[3]**

Q5) a) Write note on Differential Thermal Analysis. **[4]**

b) What will be the resolution of an optical microscope, whose numerical aperture is 1 and suppose wavelength used is 400 nm? Also comment on the result. **[3]**

c) Calculate the wavelength of photon in nm having 2eV energy. **[3]**

Q6) a) Write note on classification of sensors. **[4]**

b) Derive the relation for Bragg's diffraction condition. **[3]**

c) What are the advantages of AFM over STM. **[3]**

Q7) a) Discuss the principle and instrumentation of XPS. **[5]**

b) In a X-ray diffractometer, wavelength of CuK_{α} = 0.154nm and interplanar distance of given sample is 0.3nm. Calculate the angles for diffraction for first and second order diffractions. **[5]**

Q8) a) Write range of wavelengths and corresponding energies for all electromagnetic radiations. **[5]**

b) With the help of schematic diagram explain the working of STM (Scanning Tunneling Microscope) **[5]**

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Total No. of Questions : 8]

SEAT No. :

P1931

[Total No. of Pages : 2

[4922]-201

M.Sc.

PHYSICS

PHY UT-601 : Electrodynamics

(2013 Pattern) (5-Credit Based System) (Semester-II)

Time : 3 Hours] *[Max. Marks : 50*

Instructions to the candidates:

1) ***Attempt any five questions from the following.***
2) ***Draw neat labelled diagrams wherever necessary.***
3) ***Figures to the right indicate full marks.***
4) ***All questions carry equal marks.***
5) ***Use of log-tables & calculator is allowed.***

Q1) a) Explain an oscillating electric dipole. Hence derive an expression for magnetic field radiation when $l << \lambda$. **[4]**

b) Explain the terms 'skin effect' and 'skin depth'. **[3]**

c) Show that $(C^2B^2-E^2)$ is invarient under Lorentz transformations. **[3]**

Q2) a) Derive an expression for potential at a point due to a small linear quadrupole. **[4]**

b) Write the Maxwell's equations for moving media and explain the significance of curl $\vec{B}$ in this case. **[3]**

c) Show that a combined space. Time interval $x^2 + y^2 + z^2 - c^2t^2$ is Lorentz invariant. **[3]**

Q3) a) Derive Faraday's law of induction for making medium. **[4]**

b) Explain the term Hertz potential. Show that the magnetic field can be expressed as $\vec{B} = \frac{1}{c^2}\frac{\partial}{\partial t}(\vec{\nabla} \times \vec{z})$. **[3]**

c) Find the velocity at which the mass of the particle is double its rest mass. Given $c = 3 \times 10^8$ m/s. **[3]**

P.T.O.

Q4) a) Starting with Maxwell's equations, derive inhomogeneous wave equations in terms of scalar potential (ϕ) ϕ vector potential $(\vec{A})$. **[4]**

b) Explain the concept of vacuum displacement current. **[3]**

c) Explain the term 'four vector potential'. **[3]**

Q5) a) Derive an expression for e.m. field tensor $F_{\mu v}$. **[4]**

b) Show that the ratio of electrostatic and magnetostatic energy densities is equal to unity. **[3]**

c) Find the ratio of skin-depth in copper at 1 kHz to 100 MHz. **[3]**

Q6) a) Write the expression for magnetic field intensity $(\vec{B})$ at a point and show that its curl equals to $\mu 0 \vec{j}$. **[4]**

b) Explain Minkowski's space-time diagram. **[3]**

c) Describe 'Thomson Cross-section' related to radiation emission. **[3]**

Q7) a) Describe Michelson-Morley experiment with a suitable diagram. Hence, derive the formula for fringe shift. **[5]**

b) With the help of suitable diagram, explain the magnetic interaction between two current loops. **[5]**

Q8) a) State and prove Poyntings' theorem. **[5]**

b) Prove the relativistic addition theorem for velocities and show that any velocity added relationistically to '*c*' gives the resultant velocity '*c*'. **[5]**

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Total No. of Questions : 8]

SEAT No. :

P1932

[Total No. of Pages : 3

[4922]-202
M.Sc.
PHYSICS
PHY UT-602 : Solid State Physics
(2013 Pattern) (5 Credits) (Semester-II)

Time : 3 Hours] *[Max. Marks : 50*

Instructions to the candidates:

1) ***Attempt any five questions.***
2) ***Draw neat and labelled diagram wherever necessary.***
3) ***Figures to the right indicate full marks.***
4) ***Use of logarithmic table and calculators is allowed.***

Constants:

1. Boltzmann constant = $k_B = 1.38 \times 10^{-23}$ J/K
2. Planck's constant = $h = 6.623 \times 10^{-34}$ J-s
3. Avogadro's number = $N_A = 6.023 \times 10^{26}$ kg mole^{-1}
4. Mass of electron = $m = 9.1 \times 10^{-31}$ kg
5. Electronic charge = $e = 1.6 \times 10^{-19}$ C
6. Bohr magneton = $\mu_B = 9.27 \times 10^{-24}$A-m^2
7. Permeability of free space = $\mu_0 = 4\pi \times 10^{-7}$ A/m
8. Universal gas constant = $R = 8.31 \times 10^3$ J/K-mole
9. Velocity of light = $C = 3 \times 10^8$ m/s

Q1) a) Derive an expression for the geometrical structure factor for a BCC structure. Discuss its values for various planes. **[4]**

b) Explain Meisner effect in superconductivity. **[3]**

P.T.O.

c) The saturation value of magnetisation of iron is 1.74×10^6 A/m. Iron has a BCC structure with an elementary cube edge of 0.286 nm. Calculate average number of Bohr magnetons contributed to the magnetisation per atom. **[3]**

Q2) a) Using equation $m\left[\frac{dv}{dt}+\frac{v}{\tau}\right]=-eE$ for electron drift velocity v, show that the electrical conductivity ω is: $\sigma(\omega)=\sigma(0)\left[\frac{1+i\sigma\omega\tau}{1+\omega^2\tau^2}\right]$, where symbols have usual meaning. **[4]**

b) What is meant by hysteresi's in magnetic materials. **[3]**

c) A paramagnetic salt contains 10^{28} ions per m^3 with magnetic moment of one Bohr magneton. Calculate the paramagnetic susceptebility and the magnetisation produced in a uniform magnetic field of 10^6 A/m when temperature is 27°C. **[3]**

Q3) a) Derive Langevin's diamagnetism formula for diamagnetic susceptebility. Write its physical interpretation. **[4]**

b) What are normal and Umklapp processes. **[3]**

c) Calculate the Debye specific heat of copper at 300 K. Given: Debye characteristic frequency is 6.55×10^{12} sec^{-1}. **[3]**

Q4) a) Derive Curie-Weiss law on the basis of Weiss molecular field theory of ferromagnetism. **[4]**

b) Explain the concept of Block wall with reference to magnetism. **[3]**

c) Calculate the critical current which can flow through a long thin superconducting wire of aluminium of diameter 10^{-3} m. The critical magnetic field for aluminium is 7.9×10^3 A/m. **[3]**

Q5) a) Explain the following terms with suitable diagrams in case of ferromagnetic materials: **[4]**

i) Exchange energy

ii) Anisotropy energy and

iii) Block wall energy.

b) Explain Type I and Type II superconductors with appropriate examples. **[3]**

c) Explain isotope effect for a superconducting material. **[3]**

Q6) a) Derive the London equation for superconducting state and obtain an expression for penetration depth. **[4]**

b) A superconducting lead has a critical temperature of 7.26K at zero magnetic field and a critical field of 8×10^5 A/m at 0 K. Find the critical field at 5 K. **[3]**

c) For copper, the lattice specific heat at low temperature has the behaviour of $[C_V]_{La} = 4.6 \times 10^{-12} \times T^3$ J/k mol K. Estimate the Debye temperature for copper. **[3]**

Q7) a) Discuss the vibrational modes in a finite one dimensional lattice of identical atoms. Hence derive the dispersion formula. **[5]**

b) Derive an expression for paramagnetic susceptibility using Langenvin's theory. **[5]**

Q8) a) On the basis of Kronig-Penny model, show that the energy spectrum of an electron consists of allowed and forbidden bands. **[5]**

b) Describe the motion of electron in I-D Periodic potential. Explain the concept of effective mass m*. Draw E-K, V-K and m*-K diagrams. **[5]**

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Total No. of Questions : 8]

SEAT No. :

P1933

[Total No. of Pages : 3

[4922]-203
M.Sc.
PHYSICS
PHY UT-603 : Experimental Techniques in Physics
(2013 Pattern) (5 Credit Based System) (Semester-II)

Time : 3 Hours] *[Max. Marks : 50*

Instructions to the candidates:

1) ***Attempt any five questions.***
2) ***Draw neat diagrams wherever necessary.***
3) ***Figures to the right indicate full marks.***
4) ***Use of logarithmic table and calculator is allowed.***

Constants:

Boltzmann constant	$k_B = 1.38 \times 10^{-23}$ J/K
Planck's constant	$h = 6.63 \times 10^{-34}$ Js
Avogadro's number	$N = 6.02 \times 10^{23}$ /gm mole
Mass of electron	$me = 9.1 \times 10^{-31}$ kg
Charge on electron	$e = 1.6 \times 10^{-19}$ C
Velocity of light	$c = 3 \times 10^{8}$ m/s

Q1) a) Explain different modes of STM (Scanning Tunnelling Microscope). Also mention it's applications. **[4]**

b) Describe the principle of XPS. **[3]**

c) Discuss the basic principle of optical tweezers. **[3]**

P.T.O.

Q2) a) Calculate the value of static magnetic field of an ESR spectrometer, if the frequency of excitation is 9500 MHz.

[Given: electron magnetic moment, $\mu_e = 9.285 \times 10^{-24}$ JT^{-1} and the angular momentum quantum number can have values $\frac{1}{2}$ or $-\frac{1}{2}$]. **[4]**

b) Explain the term 'random signal'. **[3]**

c) Describe the principle of throttling process. **[3]**

Q3) a) Calculate the average nanoparticle size using scherrer formula.

[Given: wavelength used for diffraction is Cuk_α -0.154 nm, full width at half maxima (FWHM) $\beta = 0.05$, $\theta_B = 60°$]. **[4]**

b) Write the electromagnetic radiations with their wavelength range and corresponding approximate energies. **[3]**

c) Describe time and frequency domain analysis in brief. **[3]**

Q4) a) Explain the operating principle of humidity sensor. **[4]**

b) Write short note on periodic signals. **[3]**

c) What is Getter? Explain in brief Getter ion pump. **[3]**

Q5) a) Write short note on errors. **[4]**

b) Calculate the wavelength of photon in nm having 1 eV energy. **[3]**

c) What are different pumping concepts used in vacuum pumps. **[3]**

Q6) a) In an electron microscope system, calculate the wavelength in nm if the applied acceuerating voltage is 100 kV. **[4]**

b) Write a short note on mean free path. Calculate the mean free path for air at ambient temperature with pressure 10^{-5} Torr. **[3]**

c) Describe the principle of FTIR spectrometer. **[3]**

Q7) a) Explain principle, construction and working of Scanning Electro Microscope (SEM). **[5]**

b) Write note on UV-Visible spectrometer. **[5]**

Q8) a) Write short note on Techniques for production of UV-Visible radiation. **[5]**

b) Write short note on vacuum system design. **[5]**

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Total No. of Questions : 8]

SEAT No. :

P1934

[Total No. of Pages : 3

[4922]-204

M.Sc.

PHYSICS

PHY UT-604 : Quantum Mechanics-I

(2013 Pattern) (5-Credits) (Semester-II)

Time : 3 Hours] *[Max. Marks : 50*

Instructions to the candidates:

1) ***Attempt any five questions from eight questions.***
2) ***Draw neat diagrams wherever necessary.***
3) ***Figures to the right indicate full marks.***
4) ***Use of calculators allowed.***

Q1) a) Using expansion postulate, show that eigen functions belonging to discrete eigen values are normalizable. **[4]**

b) Define adjoint of an operator A. Show that $<A^{+}A>$ is always positive. **[3]**

c) What is harmonic perturbation? How is it differs from constant perturbation? **[3]**

Q2) a) Using ladder operators a and a^{+}, obtain the energy eigen values of linear harmonic oscillator. **[4]**

b) Show that $[L_x, L_y] = i$ to L_z and $[L^2, L_x] = 0$. **[3]**

c) Explain condition of validity of WKB approximation. **[3]**

Q3) a) What is unitary operator? Show that the norm of any state $|\psi\rangle$ does not change under unitary transformation. **[4]**

P.T.O.

b) Show that Pauli spin matrices σ_x, σ_y and σ_z are unitary. **[3]**

c) Obtain the matrix of Clebsch-Gordon co-efficients for a system having $j_1 = 1/2$, $j_2 = 1/2$. **[3]**

Q4) a) Use variational method to estimate the ground state energy of harmonic oscillator with the help of trial wave function $\psi(x) = Ae^{-\alpha x^2}$. **[4]**

b) State fundamental postulates of quantum mechanics. **[3]**

c) For anti-Hermitian operator $\hat{A}$, show that $e^{i\alpha A}$ is unitary, where α is real number. **[3]**

Q5) a) Define projection operator. Show that $\Sigma|\psi_n\rangle\langle\psi_n| = I$. **[4]**

b) Show that for associated with any degenerate eigen value, there are always an infinite number of eigen functions. **[3]**

c) Normalize the eigen function $\psi_n(x) = A\sin\left(\frac{n\pi}{a}x\right)$ in the range $0 < x < a$. **[3]**

Q6) a) State and prove Fermi Golden rule. **[4]**

b) Using WKB approximation obtain Bohr - Sommerfeld quantization condition for the bound state. **[3]**

c) Obtain eigen value spectrum of J^2 and Jz operators. **[3]**

Q7) a) Calculate the first order correction to ground state energy of an anharmonic oscillator of mass *m* and angular frequency *w* subjected to potential

$$V(x) = \frac{1}{2} m w^2 x^2 + \lambda x^4 .$$ **[5]**

b) When a set of functions $\{\phi_a\}$ will be orthonormal and complete? Hence obtain closure relation $\sum_a \phi_a(x)\phi_a^*(x') = \delta(x - x')$. **[5]**

Q8) a) Obtain the equation of first order correction in energy using time independent perturbation. **[5]**

b) Explain in brief dependent perturbation theory and obtain expression for first order amplitude $a_n(t)$. **[5]**

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Total No. of Questions :8]

SEAT No. :

P1945

[Total No. of Pages :4

[4922]-3001
M.Sc.
PHYSICS
PHYUT-701: Statistical Mechanics in Physics
(2013 Pattern - 4 Credits) (Credit System) (Semester - III)

Time : 3 Hours] *[Max. Marks :50*

Instructions to the candidates:

1) ***Attempt any five questions out of eight questions.***
2) ***Draw neat diagrams wherever necessary.***
3) ***Figures to the right indicate full marks.***
4) ***Use of logarithmic tables and pocket calculator is allowed.***

Constants:

1) ***Boltzmann constant, k_B = 1.38×10^{-23} J/K***
2) ***Planck's constant, h = 6.623×10^{-34} J - sec***
3) ***Avogadro's number, N = 6.023×10^{23}/gm-mole***
4) ***Mass of electron, m_e = 9.1×10^{-31}kg***
5) ***Velocity of light, c = 3×10^{8}m/s***
6) ***Charge on electron, e = 1.6×10^{-19}C***

Q1) a) Obtain the mean energy of fermions at absolute zero. **[4]**

b) Explain the Boltzmann limit of Boson and Fermion gases. **[3]**

c) A system with just two energy levels is in thermal equilibrium with a heat reservoir at temperature 600°K. The energy gap between the levels is 0.1 eV. Find the probability that the system is in higher energy level. **[3]**

Q2) a) Discuss the distribution of energy between two systems in thermal contact and obtain the condition at thermal equilibrium. **[4]**

b) Using canonical ensemble, show that the pressure $\bar{p} = \frac{1}{\beta}\frac{\partial \ln z}{\partial V}$ **[3]**

c) The molar specific heat of lithium is 6.94 and its density 0.53 gm/cm^3. Calculate the Fermi energy and Fermi temperature of the electrons. **[3]**

P.T.O.

Q3) a) Show that the fluctuation in the number of particles in the system in grand canonical ensemble is given by

$$\left(\overline{N^2}\right) - \left(\overline{N}\right)^2 = kT\left(\frac{\partial \overline{N}}{\partial \mu}\right)_{V,T} \qquad \textbf{[4]}$$

b) "The Gibbs paradox is resolved only within the framework of quantum mechanics". Comment. **[3]**

c) A particle of unit mass is executing simple harmonic vibrations. Determine its trajectory in phase space. **[3]**

Q4) a) State the partition for B-E statistics and obtain B-E distribution in the form $\overline{n}_s = \dfrac{1}{e^{\beta(\epsilon_s - \mu)} - 1}$

where μ is the chemical potential. Hence obtain the relation

$$\frac{\overline{(\Delta n_s)^2}}{\overline{n}_s^2} = \frac{1}{\overline{n}_s} + 1 \qquad \textbf{[4]}$$

b) "The lowest energy of a gas obeying F-D statistics is much higher than that it would have if the particles had obeyed B-E statistics." Explain. **[3]**

c) Determine whether the electron gas in copper at room temperature is degenerate or non-degenerate.

(Given: Concentration of electrons in copper = $8.5 \times 10^{28}/m^3$). **[3]**

Q5) a) When chemical potential μ=0, show that Bose temperature

$$T_B = \frac{h^2}{2\pi mk}\left(\frac{N}{2.612\,V}\right)^{2/3} \qquad \textbf{[4]}$$

b) State the equipartition theorem, hence find out mean energy for 1-D and 3-D harmonic oscillator. **[3]**

c) A system of 3 particles has energy levels with energies 0,1,2,3 units. The total energy of the system is 3 units. List the accessible microstates if the particles are:

i) indistinguishable ii) distinguishable **[3]**

Q6) a) A simple harmonic 1-D oscillator has energy levels given by $E_n = \left(n+\frac{1}{2}\right)\hbar w$, where w is the characteristic frequency of the oscillator and the quantum number n=0,1,2,..... suppose that such an oscillator is in thermal contact with a heat reservoir at temperature low enough so that $\frac{kT}{\hbar w} << 1$.

i) Find the ratio of the probability of the oscillator being in the first excited state to the probability of its being in the ground state.

ii) Assuming that only the ground state and first excited states are appreciably occupied, find the mean energy of the oscillator as a function of the temperature T. **[4]**

b) Maxwell distribution of speed for a molecule is given by

$$F(v)dv = 4\pi n\left(\frac{m}{2\pi kT}\right)^{3/2} e^{-mv^2/2kT} v^2 dv$$

Show that root-mean square (R.M.S.) speed is $v_{rms} = \sqrt{\frac{3kT}{m}}$ **[3]**

c) What do you mean by **[3]**

i) Phase point

ii) Phase path

iii) Phase space

Q7) a) Show that for classical monoatomic ideal gas having N particles contained volumeV, the number of states Ω (E) to the system in the energy range E and E+ δE is given by $\Omega(E) = BV^N E^{3N/2}$ **[5]**

b) Obtain partition function of a photon gas. Hence derive Planck's radiation formula. **[5]**

Q8) a) Consider a system of N diatomic molecules each having vibrational energy levels $E=\left(n+\frac{1}{2}\right)\hbar w$ where n=0,1,2,3,-------.

Write down the partition function and derive an expression for mean energy. Hence show that at high temperature, the mean energy is given by $\bar{E}=NkT+\frac{N\hbar w}{2}$ **[5]**

b) State and prove Liouville's theorem. **[5]**

Total No. of Questions : 8]

SEAT No. :

P1946

[Total No. of Pages : 6

[4922]-3002
M.Sc.
PHYSICS
PHYUT - 702 : Physics of Semiconductor Devices
(2013 Pattern) (Semester - III) (4 - Credits)

Time : 3 Hours] *[Max. Marks : 50*

Instructions to the candidates:

1) ***Attempt any five questions.***
2) ***Draw neat diagrams wherever necessary.***
3) ***Use of logtable & electronic scientific calculator is allowed.***

Given:

Boltzmann constant $K_B = 1.3806 \times 10^{-23}\ JK^{-1}$

Charge on electron $q = 1.602 \times 10^{-19} C$

$1eV = 1.602 \times 10^{-19}\ J$

Permittivity in vacuum $\in_0 = 8.854 \times 10^{-12}\ C^2/N\text{-}m^2$

$E_{si} = 11.8$

n_i ***for Ge*** $= 2.5 \times 10^{13}/cm^3$.

Q1) a) Prove the law of mass action & state its importance. **[4]**

b) Distinguish between direct band gap & indirect band gap semiconducting materials. **[3]**

c) A Ge sample is doped with 10^{17} boron atom/cm^3. Determine the carrier concentration & also determine the position of intrinsic energy level relative to Fermi energy at room temperature. **[3]**

Q2) a) Using Schockley-Read-Hall statistics, show that minority carrier life time is inversaly proportional to trap density. **[4]**

b) State "Hall effect" and obtain an expression for "Hall coefficient". **[3]**

c) The following are the data for Hall experiment; The length of the bar is 5mm, W = 0.1mm, t = 10 μm, B_Z = 10KG = 1 Tesla.

Application of 100mV along the length of bar gives current of 1mA. The Hall voltage $V_H = -2mV$, Calculate the concentration of majority carrier of Hall coefficient. **[3]**

P.T.O.

Q3) a) Obtain expression for "depletion layer capacitance" for an abrupt p-n junction. **[4]**

b) Obtain an expression for built-in-potential of abrupt p-n junction. **[3]**

$$\psi_{bi} = \frac{KT}{q} \ln\left[\frac{N_A N_D}{n_i^2}\right]$$

c) Find the diffusion constants for electrons & holes at room temperature if given μ_n = 1350 cm^2/V-sec; μ_p = 480 cm^2/V-sec. **[3]**

Q4) a) Draw an Ideal & practical current -voltage characteristic of p-n junction diode & explain all the regions of these characteristics. **[4]**

b) Draw suitable energy band diagram of p-n junction reverse bias & explain Zener breakdown phenomenon. **[3]**

c) A p^+ -n Si-diode requires a breakdown voltage of 150Vat 300K. If the critical field strength for avalanche breakdown is 3×10^5V/cm. Determine the doping on n-side of diode. **[3]**

Q5) a) With the help of suitable diagram, explain transistor action & derive an expression for basic parameters for any bipolar junction transistor. **[4]**

b) Describe electron density profile in neutral base of n-p-n transistor for various applied voltages. **[3]**

c) Determine the injection efficiency & transport factor for a n-p-n transistor. Given: **[3]**

I_{pE} = 0.02mA, I_{nE} = 10mA & I_{nC} = 9.98 mA.

Q6) a) Explain static and transfer characteristics of Junction Field - effect Transistor (J-FET). **[4]**

b) Explain the switching characteristics of transistor. **[3]**

c) Compare the Schottky diode with p-n junction. **[3]**

Q7) a) With the help of a neat diagram explain any method to determine the barrier height of Metal-semiconductor contacts. **[5]**

b) Explain the thermionic emission theory with basic assumption. Derive expression for Richardon's constant for thermionic emission. **[5]**

Q8) a) Explain "Diffusion theory" of metal - semiconductor constants. **[5]**

b) Explain the details an ideal metal-insulator Semiconductor (MIS) diode. **[5]**

Total No. of Questions : 8]

P1946

[4922]-3002
M.Sc.
PHYSICS
PHYUT - 702 : Quantum Mechanics - II
(2013 Pattern) (Semester - III) (4 - Credits)

Time : 3 Hours] ***[Max. Marks : 50***

Instructions to the candidates:

1) ***Figures to right indicates full marks.***
2) ***Attempt any five questions.***
3) ***Use of calculator is allowed.***

Q1) a) Obtain the slater determinant for N identical particles. **[4]**

b) The scattering amplitude by partial wave is $F(\theta)=\frac{1}{K}\sum_{l=0}^{\infty}(2l+1)\exp(i\delta_l)$ $\sin\delta_l P_l(\cos\theta)$ where the symbols have their usual meaning. Hence obtain Optical theorem. **[3]**

c) Using W.K.B. approximation, explain field emission. **[3]**

Q2) a) The harmonic oscillator is perturbed by H' = bx^2, obtain first order perturbation in n = 1 state. **[4]**

b) Obtain Bohr's quantization condition that bound state satisfy. **[3]**

c) Discuss Ramsaur effect for low energy electron scattering. **[3]**

Q3) a) State and prove Fermi Golden rule for transition probability per unit time. **[4]**

b) Obtain condition for validity of WKB approximation. **[3]**

c) Discuss CM and Lab frame of reference with respect to scattering cross section. **[3]**

Q4) a) Define differential cross section. Show that differential cross section is proportional to square of amplitude. **[4]**

b) Explain concept of identical particle. What is difference between boson and fermions. **[3]**

c) Show that there is no first order stark effect in the ground state of hydrogen atom. **[3]**

Q5) a) What is W.K.B. approximation? Write connecting formula in W.K.B. approximation. **[4]**

b) Explain: Einstein's coefficient of spontaneous emission. **[3]**

c) Show that the kinetic energies in Laboratory frame (Lab) and centre of mass (CM) frame are related by $T_{Lab} = \frac{m_1}{\mu} T_{cm}$

where μ is reduced mass. **[3]**

Q6) a) Using Born approximate, calculate differential cross section for the potential **[4]**

$V(r) = -V_0$ for $r < a$

$V(r) = 0$ for $r > a$

b) Discuss concept of symmetry in Quantum Mechanics. **[3]**

c) Show that the variation method gives an Upper bound to the ground state energy. **[3]**

Q7) a) Develop time dependent perturbation theory to obtain first order correction to amplitude $a_m^{(1)}$ t. **[5]**

b) Apply variation method to obtain ground state energy of hydrogen atom using trial wave function. **[5]**

$\psi(r) = e^{-\lambda r}$ Where, λ is trial variation parameter.

Q8) a) Using the method of partial wave, obtain the cross section for scattering by a perfectly rigid sphere. **[5]**

b) Construct symmetric and antisymmetric wave functions for two electron atom. **[5]**

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Total No. of Questions :8]

SEAT No. :

P1947

[Total No. of Pages :3

[4922]-4001
M.Sc.
PHYSICS
PHY UT-801: Nuclear Physics
(New Course) (2014 Pattern - 4 Credits) (Semester - IV)

Time : 3 Hours] *[Max. Marks :50*

Instructions to the candidates:

1) ***Attempt any five out of eight questions.***
2) ***Neat diagrams must be drawn wherever necessary.***
3) ***Figures to the right indicate full marks.***
4) ***Use of logarithmic tables and electronic calculator is allowed.***

Q1) a) Explain the concept of mass spectrograph. **[4]**

b) Discuss the nuclear electric quadrupole moment. **[3]**

c) A singly charged positive ion is accelerated through a potential difference of 2kV in a mass spectrograph. It then passes through a uniform magnetic field B=2k gauss, & then deflected into a circular path of radius 0.15 m. What is the speed of the ion? **[3]**

Q2) a) What is beta decay? Explain its spectrum. **[4]**

b) Calculate the kinetic energy of alpha particles in the following decay. **[3]**

$$^{239}Pu \longrightarrow {}^{235}U + {}^{4}He$$

Given: $M(^{239}Pu) = 239.052158$ amu

$M(^{235}U) = 235.043925$ amu

$M(^{4}He) = 4.002603$ amu.

c) Describe internal conversion process. **[3]**

P.T.O.

Q3) a) What is the principle of a bubble chamber? Discuss its construction. What are its merits? **[4]**

b) Discuss the Fermi gas model of the nucleus. **[3]**

c) In a scintillation detector, the 662 keV photopeak of ^{137}Cs source is observed at 6V& the full width at half maximum of the photopeak is 0.72V. Find the percentage resolution of the detector. Also find its resolution in keV. **[3]**

Q4) a) Discuss the principle, construction and working of a high purity germanium detector. **[4]**

b) Explain various types of nuclear reactions. **[3]**

c) Find out whether the following reaction is exoergic or endoergic.

$$^{27}Al + {}^{1}H \longrightarrow {}^{27}Si + {}^{1}n$$

Given: $M(^{1}H) = 1.00727647$ amu

$M(^{1}n) = 1.008664916$ amu

$M(^{27}Al) = 26.981539$ amu

$M(^{27}Si) = 26.986704$ amu. **[3]**

Q5) a) Derive the expression for multiplication factor of finite & infinite size reactor. **[4]**

b) What is microtron? Write the principle, construction, working & theory of microtron. **[3]**

c) What radius is needed in proton synchrotron to attain particles of energy of 12GeV? Assume that a guide field 1.9 Wb/m^2 is available. **[3]**

Q6) a) Name the reactor materials & their uses. **[4]**

b) Write short note on Geiger - Nuttal law. **[3]**

c) What is induced radioactivity? Give one example. **[3]**

Q7) a) Give an account of n-p scattering. **[5]**

b) Determine whether following reactions are allowed or forbidden.

i) $P + P \rightarrow k^+ + \Sigma^+$

ii) $\mu^- \rightarrow \overline{e} + \overline{\upsilon}_e + \upsilon_\mu$ **[5]**

Q8) a) What are quarks? Give the qualitative description of quark model. **[5]**

b) What are leptons? Name any three leptons & their antiparticles. Briefly discuss the properties of leptons. **[5]**

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Total No. of Questions :8]

SEAT No. :

P1948

[Total No. of Pages :3

[4922]-4002
M.Sc.
PHYSICS
PHY UT-802: Materials Science
(2014 Pattern - 4 Credits) (Semester - IV)

Time : 3 Hours] *[Max. Marks :50*

Instructions to the candidates:

1) ***Solve any five questions.***
2) ***Figures to the right indicate full marks.***
3) ***Draw neat labelled diagram wherever necessary.***
4) ***Use of logarithmic tables and pocket calculator is allowed.***

Given:

1) ***Avogadro's number*** = 6.0225×10^{26} *(kilomole)*$^{-1}$
2) ***Boltzmann constant*** = 1.3805×10^{-23} *Jk*$^{-1}$

Q1) a) Explain any four mechanical properties of the materials. **[4]**

b) Explain a binary phase diagram in brief. **[3]**

c) What is solid solution? What are the factors governing solid solubility? **[3]**

Q2) a) Explain Gibb's phase rule. What are the degrees of freedom of a system of two components when the number of phases is one, two and three? **[4]**

b) Define defects in solids. Explain any two types of surface defects in brief. **[3]**

c) Explain the concept of regular solution. **[3]**

P.T.O.

Q3) a) Explain Fick's first and second law of diffusion. **[4]**

b) Explain Vegard's law for solid solution. **[3]**

c) Explain different diffusion mechanisms occured in solid solution. **[3]**

Q4) a) Describe Frank-Read generator for the multiplication of dislocation. **[4]**

b) Explain the condition for the solution to exhibit Raoultian ideal solution. **[3]**

c) With the help of neat diagram explain lever rule. **[3]**

Q5) a) Explain Hume-Rothery rule with examples. **[4]**

b) What do you mean by type I,II and III phase diagrams. **[3]**

c) Define the following terms: Specific heat thermal conductivity and coefficient of thermal expansion. **[3]**

Q6) a) Calculate the spacing between dislocations in a tilt boundary in FCC crystal when angle of tilt is 2°. Given: Burgers vector b = 4.50 A°. **[4]**

b) Draw a flow chart of defects. **[3]**

c) Explain five different invarient equations with the help of neat diagram. **[3]**

Q7) a) Find the equilibrium concentration of vacancies in nickel at 0K, 300 K and 900 K. (E_{Ni} = 1.74 eV). **[5]**

b) Calculate the increase in enthalpy and the entropy of copper as it is heated from room temperature (300 K) to 1000 K. Specific heat in this temperature range is given by: $Cp = 22.61 + 6.27 \times 10^{-3}$ TJ $mol^{-1}K^{-1}$.**[5]**

Q8) a) Aluminium crystal has a dislocation density of 10^{10} m^{-2}. The shear modulus of aluminium is 25.94 GMm^{-2}. Calculate the elastic energy of the line imperfection stored in the crystal.

Given: a = 4.05 A°. **[5]**

b) What is Frenkel defect? Obtain an expression for equilibrium concentration of Frenkel defect in crystals. **[5]**